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TITLE: Technologies for Assessing Behavioral and Cognitive Markers of Suicide Risk

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RECIPIENT: Ms. Michelle Lane

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

The primary aim of the proposed project is to develop cognitive and behavioral markers of suicide risk and to evaluate the predictive utility of these markers over a one year period. We propose to achieve these aims by: (a) collecting cognitive and behavioral data from Reserve component soldiers and their romantic partners in both our research laboratory and participant's homes; (b) processing these data using computer algorithms developed specifically for this study; and (c) testing the predictive accuracy of these markers using follow-up data collected from study participants over 12 months. Study enrollment is complete, but data collection is still in progress. There are no research findings to report at this this.

15. SUBJECT TERMS
Suicide risk assessment, suicide prevention, signal processing

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INTRODUCTION:

The primary aim of the proposed project is to develop cognitive and behavioral markers of suicide risk and to evaluate the predictive utility of these markers over a one year period. We propose to achieve these aims by: (a) collecting cognitive and behavioral data from Reserve component soldiers and their romantic partners in both our research laboratory and participant's homes; (b) processing these data using computer algorithms developed specifically for this study; and (c) testing the predictive accuracy of these markers using follow-up data collected from study participants over 12 months.

1. KEYWORDS:

Suicide risk assessment, suicide prevention, signal processing

2. ACCOMPLISHMENTS:

What were the major goals of the project?

Task 1: Obtain IRB approvals
1a. Initiate IRB proposal (months 1-3)
1b. Complete annual reports to IRB (months 12-36)
1c. Complete final report to IRB (month 36)
Task 2: Hire and train research staff
2a. Hire and train postdoctoral fellow (months 1-3)
2b. Train research associates (months 1-3)
Task 3: Begin and complete baseline data collection
3a. Participant screening & enrollment (months 6-18)
3b. Begin baseline data collection (month 6)
3c. Continue baseline data collection (months 6-18)
3d. Complete baseline data collection (month 18)
Task 4: Begin and complete longitudinal tracking and follow-up assessments
4a. Begin longitudinal tracking and follow-up assessments (month 6)
4b. Continue longitudinal tracking and follow-up assessments (months 10-30)
4c. Complete longitudinal tracking and follow-up assessment (month 30)
Task 5: Use existing data to adapt and refine BSP technologies
5a. Refine BSP technologies for automatically generating CIRS, SSIRS, & NORS scores (months 3-18)
5b. Refine BSP technologies for generating feature-derived behavioral markers (months 3-18)
Task 6: Use refined BSP technologies to measure behavioral markers in study data
6a. Use refined BSP technologies to automatically generate CIRS, SSIRS, & NORS scores (months 18-24)
6b. Use refined BSP technologies to generate feature-derived behavioral markers (months 18-24)
Task 7: Generate cognitive markers in study data
7a. Generate cognitive markers in study data (months 18-21)
Task 8: Data analysis, manuscript writing, report writing
8a. Begin baseline data analyses (month 24)
8b. Begin data analyses of follow-up data (month 30)
8c. Manuscript and report writing (months 24-36)
Completion of tasks:
1a. 100%
1b. Ongoing
1c. Not yet started

Completion of tasks (cont):
2a. 100%
2b. 100%
3a. Completed (65%)
3b. 100%
3c. Completed (65%)
3d. Completed (65%)
4a. 100%
4b. Ongoing (53% total [81% of 65% of proposed sample that was enrolled])
4c. Not yet started
5a. 100%
5b. 100%
6a. Ongoing (50%)
6b. Ongoing (50%)
7a. 100%
8a. Ongoing (33%)
8b. Not yet started
8c. 50%

Major activities:
1. IRB approval obtained from the University of Utah (initial approval: September 21, 2015; final approval: November 25, 2015), University of Southern California (IRB Authorization Agreement received: September 21, 2015), and HRPO (December 1, 2015).
2. Hired one graduate research assistant, Alexander Crenshaw, for year 2 (September 1, 2017).
3. Continued funding postdoctoral scholar, Feea Leifker, for year 2 (August 8, 2017).
4. Trainings for study staff held February 12, 2016; trainings repeated August 25, 2016 and August 29, 2017 to refresh study staff and to train new study staff.
5. Screening participants initiated February 16, 2016 and is ongoing.
6. Baseline data collection initiated February 26, 2016 and is ongoing.
7. Follow-up data collection initiated on August 8, 2016 and is ongoing.
8. Refinement of existing algorithms for automated coding initiated January 1, 2016 and completed .
9. Refinement of feature-derived behavioral markers initiated March 7, 2016 and is ongoing.
10. Additional, existing data sets transferred to USC to provide additional data for refining automated coding algorithms and feature-derived behavioral markers (April 14, 2016).
11. First project manuscript accepted on March 24, 2017; second project manuscript accepted on September 13, 2017; third project manuscript accepted on September 17, 2017.
12. Requested a no cost extension to continue participant recruitment into Y4 on May 22, 2018. Approval received May 31, 2018.
13. Hired additional study staff, Alex Russell and Rikki Carpenter (August 5, 2018) as well as Kent Hinkson and Michael Snell, to assist with participant recruitment (August 6, 2018).
14. Requested a no cost extension to continue follow-up data collection into Y5 on August 2, 2019. Approval received September 4, 2019.
15. Hired additional study staff, Jill Arndt, on May 24, 2019 to assist with organizational and logistic aspects of observational coding and creating integrated data bases.
16. Terminated study staff, Alex Russell, Kent Hinkson, and Michael Snell, hired in 2018 to assist with participant recruitment. Rikki Carpenter retained to assist with observational coding on a volunteer basis.

Specific objectives:
1. Receive University of Utah, University of Southern California, and HRPO IRB approval.

2. Fully train study staff in study procedures and emergency suicide risk assessment.
3. Begin enrollment of participants.
4. Collect baseline data from 120 couples.
5. Begin follow-up data collection.

Objectives 1- 5 and 7 have been met. Please note that while we have completed all baseline data from participants (Objective 4), we enrolled 78 couples (156 participants) rather than the originally proposed 120 couples (240 participants) due to sustained difficulties with recruitment.

Completion of Objective 5 involved adapting and refining existing speech signal processing algorithms for use with variable acoustic conditions in study data. The end point of Objective 5 is a large number of acoustic features (i.e., variables) that index a wide range of information encoded in speech. The study team is currently using these features to automatically generate observational coding scores (Objective 6a) and signal based behavioral markers (e.g., entrainment, affective expression, behavioral hesitation, etc.; Objective 6b) for the recorded conversations.

We conducted a set of preliminary analyses based on a subsample of 62 of the 78 couples using the outcome of Objective 5. Consistent with recommendations at previous interim progress report meetings, we analyzed the predictive accuracy of these acoustic features in distinguishing 1) individuals with no history of suicidal ideation or attempt vs. individuals with a history of suicidal ideation but not attempt vs. individuals with a history of suicide attempt, 2) individuals with no history of suicidal ideation or attempt vs. individuals with a history of suicidal ideation or attempt, and 3) individuals with no history of suicidal ideation or attempt and. individuals with a history of suicidal ideation but not attempt vs. individuals with a history of suicide attempt. Results indicated 13% - 20% (relative) increase in predictive accuracy vs. chance in all 3 comparisons (39.6% vs. 33%, 60.32% vs. 50%, and 56.77% vs 50%, respectively), with differences being statistically significant ($p < 0.05$) in each case.

Objective 7 was completed when study enrollment was completed. Cognitive markers are collected at both the laboratory and home assessments; scoring for two of the cognitive tasks is automated as part of the task itself and scoring for the third task is completed by running a statistical package script written for this study. All cognitive task data has been collected and scored and is currently being analyzed.

What opportunities for training and professional development has the project provided?

Nothing to Report.

How were the results disseminated to communities of interest?

Nothing to Report.

What do you plan to do during the next reporting period to accomplish the goals?

Our on-going goals involve completing follow-up data collection at the remaining ~20% of follow-up assessments, processing additional baseline data, and running our planned analyses. To accomplish our follow-up data collection goals, we have retained our study coordinator, Feea Leifker, PhD, and the psychology graduate students who have been most heavily involved in follow-up data collection to date. We will continue using the same procedures that we have successfully used throughout the grant to achieve a ~90% retention rate at both 6- and 12-month follow-up assessments. To process our additional baseline data, we will continue conducting observational coding using our currently trained teams of undergraduate coders who are already coding the data. We are additionally working with our collaborators at USC to process the signal processing based features so that they are ready for testing study hypotheses within the next 6 months. We submitted a set of preliminary analyses using these methods to the International Conference on Acoustics, Speech, and Signal Processing on 10/21/19 and will incorporate additional data as it becomes ready for analysis.

4. **IMPACT:**

What was the impact on the development of the principal discipline(s) of the project?

Nothing to Report.

What was the impact on other disciplines?

Nothing to Report.

What was the impact on technology transfer?

Nothing to Report.

What was the impact on society beyond science and technology?

Nothing to Report.

5. **CHANGES/PROBLEMS:**

Changes in approach and reasons for change

Nothing to Report.

Actual or anticipated problems or delays and actions or plans to resolve them

As noted in our OCT-2016 Annual review and our subsequent reports and reviews, our rate of recruitment has below what we had anticipated. In close consultation with our Scientific Officer, staff at MOMRP, and the panel at IPR meetings, we ended participant enrollment 8/31/2019 even though we did not enroll our originally proposed sample size in order to allow for sufficient time for follow-up data collection and conducting statistical tests of study aims.

Changes that had a significant impact on expenditures

Dr. Leifker's funding remained at 10% and Drs. Baucom, Garland, and Bryan did not receive funding in Y4 to preserve funds for recruitment efforts during our first NCE as well as for data collection staff during our second NCE. We have sufficient remaining monies to fund all currently funded study staff for the 2nd NCE.

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Nothing to Report.

Significant changes in use or care of human subjects

Nothing to report

Significant changes in use or care of vertebrate animals

Nothing to Report.

Significant changes in use of biohazards and/or select agents

Nothing to Report.

6. PRODUCTS:

- **Publications, conference papers, and presentations**
  Journal publications.

  Nothing to Report.

  Books or other non-periodical, one-time publications.

  Nothing to Report.

  Other publications, conference papers and presentations.

  Nothing to Report.

- **Website(s) or other Internet site(s)**

  Nothing to Report.

- **Technologies or techniques**

  Nothing to Report.

- **Inventions, patent applications, and/or licenses**

  Nothing to Report.

- **Other Products**

  Nothing to Report.

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

Personnel	Role	Percent effort
Baucom, Brian	Principal Investigator	.20
Bryan, Craig	Co-Investigator	.056
Garland, Eric	Co-Investigator	.031
Narayanan, Shrikanth	Co-Investigator	.08
Georgiou, Panayiotis	Co-Principal Investigator	.33
Leifker, Feea	Research Manager	.10
Arndt, Jill	Undergraduate Research Assistant	.325
Crenshaw, Alexander	Graduate Research Assistant	.15
Leo, Karena	Graduate Research Assistant	.50
Adamo, Colin	Graduate Research Assistant	.15
Hinkson, Kent	Graduate Research Assistant	.025
Jati, Arindam	Graduate Research Assistant	.05
Li, Haoqi	Graduate Research Assistant	.34
Md Nasir, Fnu	Graduate Research Assistant	.21
Nallan Chakravarthula, Sandeep	Graduate Research Assistant	.42
Tseng, Shao-yen	Graduate Research Assistant	.34
Tian, Kate	Undergraduate Research Assistant	.15

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

Changes in active other support for PI Baucom

Dr. Baucom is a Co-Investigator on 1 newly funded federal grants that was awarded during the reporting period:

R01 MH119084 01 Butner, Bulik (PI) Predicting binge and purge episodes in from passive and active apple watch data using a dynamical systems approach

Changes in active other support for PI Baucom, cont.

This award is a multi-year study (awarded 9/23/19) where the bulk of funding for Dr. Baucom occurs in later years of the grants. Additionally, he is serving as a statistical consultant on this grant so the vast majority of his responsibilities are limited to data analysis and assistance with manuscript preparation. None of this new funding impacts Dr. Baucom's percent effort to the project that is the subject of this report.

What other organizations were involved as partners?

Organization Name: Salt Lake City Veteran's Administration (SLCVA)
Location of Organization: 500 Foothill Drive, Salt Lake City, UT 84148
Partner's contribution to the project: The SLCVA is contributing time of its VA Information and Computing Infrastructure staff, access to VA software and computers, and collaboration with Dr. William Marchand. The VA is additionally contributing official VA business envelopes for mailing letters to potential Veteran participants.

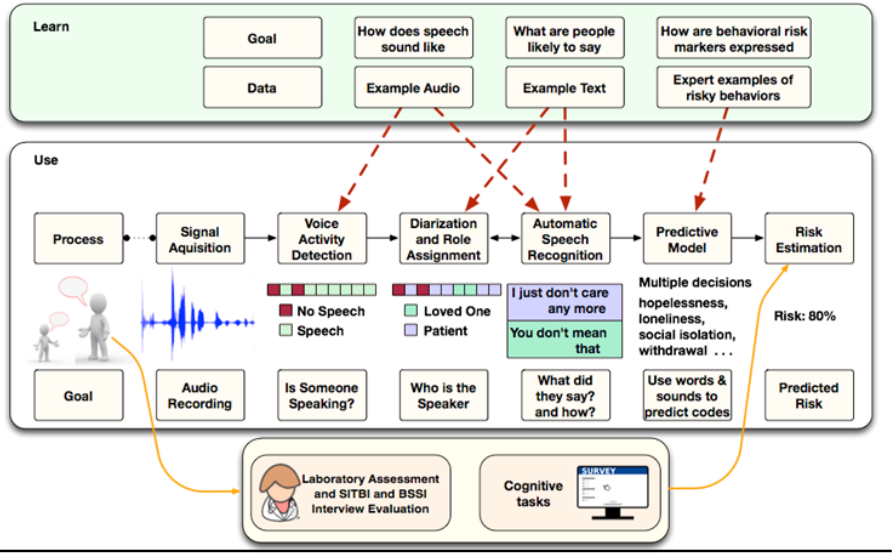
8. SPECIAL REPORTING REQUIREMENTS

Technologies for assessing behavioral and cognitive markers of suicide risk

PI: Brian Baucom, PhD **Org:** University of Utah

Background

- More than one death by suicide every 13 minutes amongst military personnel
- Accurate and timely assessment of suicide risk one of the most effective ways to prevent injury and death from suicide
- No reliable method for predicting suicide risk in military personnel
- Behavioral (e.g., hopelessness, reassurance seeking) and cognitive (e.g., attentional fixation on suicide-related information) markers could provide new method for objectively assessing risk for suicide
- Recent technology can be adapted for efficient, scalable, and reliable measurement of behavioral and cognitive markers
- Empowers family members by creating a risk assessment tool that can be used at home
- Rich, supplemental, information can be obtained by observing social circle in addition to patient



Approach

- Adapt existing technology for measuring behavioral and cognitive markers of suicide risk using existing data sets
- Observe behaviors of subject, loved ones, family, social circle, and identify behavioral deviations from norm
- Example behaviors of interest: hopelessness, agitation, loneliness, social isolation, engagement and entrainment.
- Collect behavioral, cognitive, interview, and self-report data from 120 couples where at least one partner is active duty National Guardsmen or Reservist in research laboratory
- Create secure internet interface for collecting data at home
- Collect behavioral, cognitive, and self-report data at home after 6 (all forms) and 12 (self-report only) months
- Apply and optimize adapted technology for use in newly collected laboratory and home data

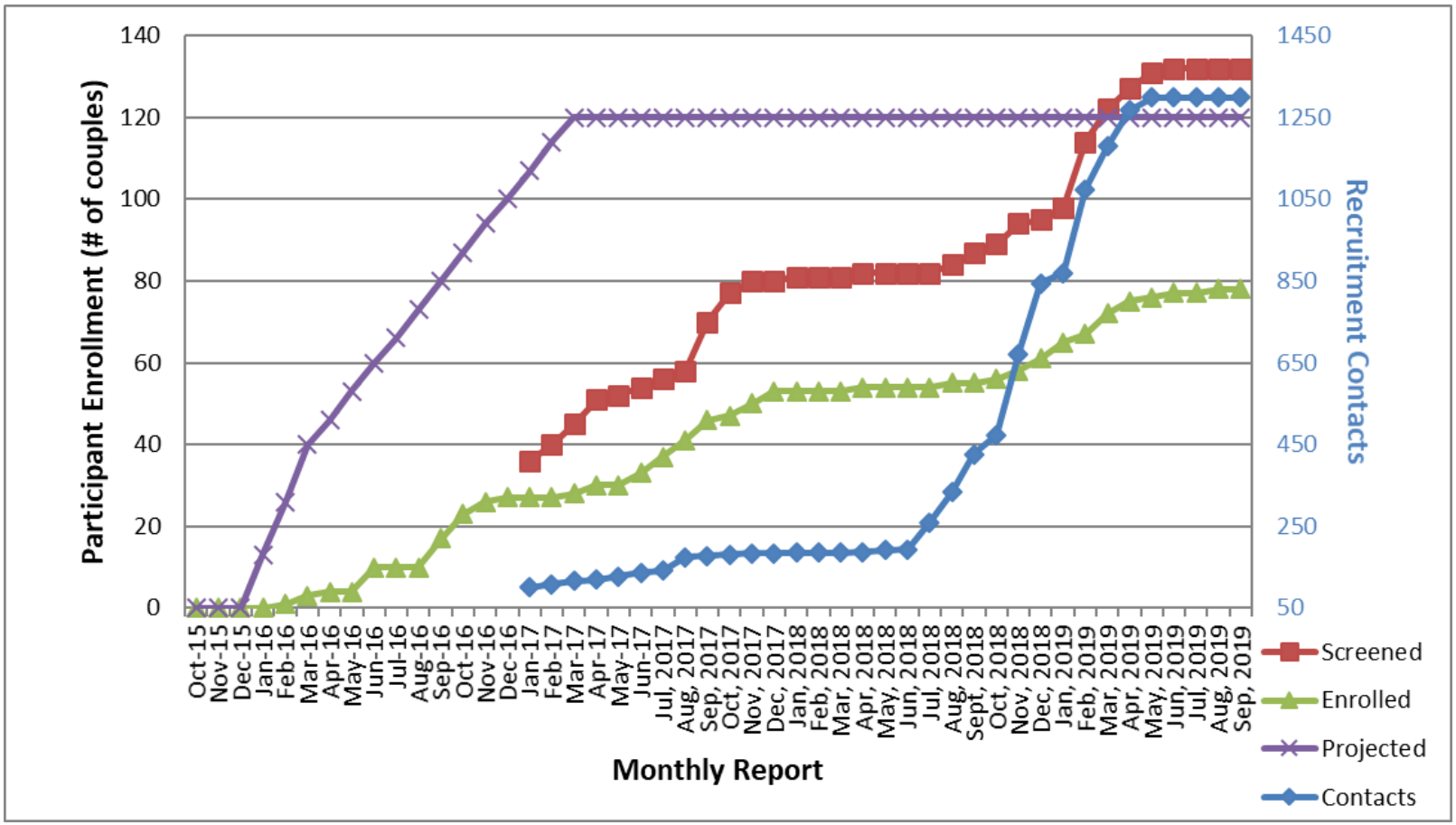
Updated: 10.29.2019

Timeline and Cost

Activities	FY 1	FY 2	FY 3	FY 4	FY 5
Train BSP algorithms					
Create secure internet interface					
Collect laboratory- and home-based data from 120 couples					
Apply and refine BSP technologies					
Collect 6 and 12 month follow-up data					
Apply and evaluate adapted technology to newly collected data					
Estimated Budget ($K)	**$833**	**$833**	**$833**	**NCE**	**NCE**

Total expenditure to date: $2,133,358

9. Recruitment Line Graph



Note. Contacts = number of couples who have contacted us about being potentially interested in participating in the study, screened = number of couples where both partners have verbally indicated a willingness to participate in the study, both partners have completed the screening assessment, and are eligible for study participation, enrolled = number of couples who have completed at least one study assessment.

Number of couples screened, enrolled, and projected are plotted on the vertical axis on the left, and number of couples contacted are plotted on the vertical axis on the right.

Enrollment table (*N* = 78 couples)

	Index participants with no history of suicidal ideation or attempt	Index participants with a history of suicidal ideation	Index participants with a history of one or more suicidal attempt(s)
Men	25	20	14
Women	10	4	8
Reserve Component SMs	35	20	10
Veterans	0	4	12
Army NG	20	16	8
Air Force NG	9	2	1
Army Reserve	3	2	0
Air Force Reserve	3	0	1
Army Veteran	0	3	5
Air Force Veteran	0	0	2
Marines Veteran	0	0	1
Navy Veteran	0	1	4

***Note*:** Total number of participants in this table is greater than the number of couples both partners being eligible and reporting either previous suicidal ideation or attempt in 3 couples.

Sample size for analysis table (*N* = 78 couples, 86 individuals)

	Military participants with no history of suicidal ideation or attempt	Military participants with a history of suicidal ideation	Military participants with a history of one or more suicidal attempt(s)
Men	34 (25 index + 9 non-index)	18	10
Women	11 (10 index + 1 non-index)	5	6
Reserve Component SMs	43 (35 index + 8 non-index)	20	10
Veterans	2 non-index	3	6
Army NG	24	16	8
Air Force NG	11	2	1
Army Reserve	4	2	0
Air Force Reserve	4	0	1
Army Veteran	2	2	0
Air Force Veteran	0	0	2
Marines Veteran	0	1	2
Navy Veteran	0	0	4

***Note*:** Total number of participants in this table is greater than the number of couples in the enrolled participants table due to both partners being in the Reserves in 10 couples. In eight of these dual participant couples, both partners are in the no history of suicidal ideation or attempt group. Because analyses will be conducted at the individual level, these additional 10 participants will be included in analyses resulting in a total of sample size 86 participants for the purpose of analysis.