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How can advancing computational narrative analytics impact **health** and **healthcare**?

Bob Gramling MD, DSc (Health Team)
Matthew Price PhD (Project B3)
David Jangraw PhD (Project B2)
Donna Rizzo PhD (Project B1)

“

To improve the quality of communication,
one must be able to measure it.

Scientific Consensus Panel, *JAMA IM*, 2017

“

.... dependence on human manual coding makes [existing methods] slow and cumbersome and not easily disseminated. For such methods to provide feedback to clinicians or reviewers on a mass scale, high-quality automated coding will be required.

Scientific Consensus Panel, *JAMA IM*, 2017

25 August 5:30pm

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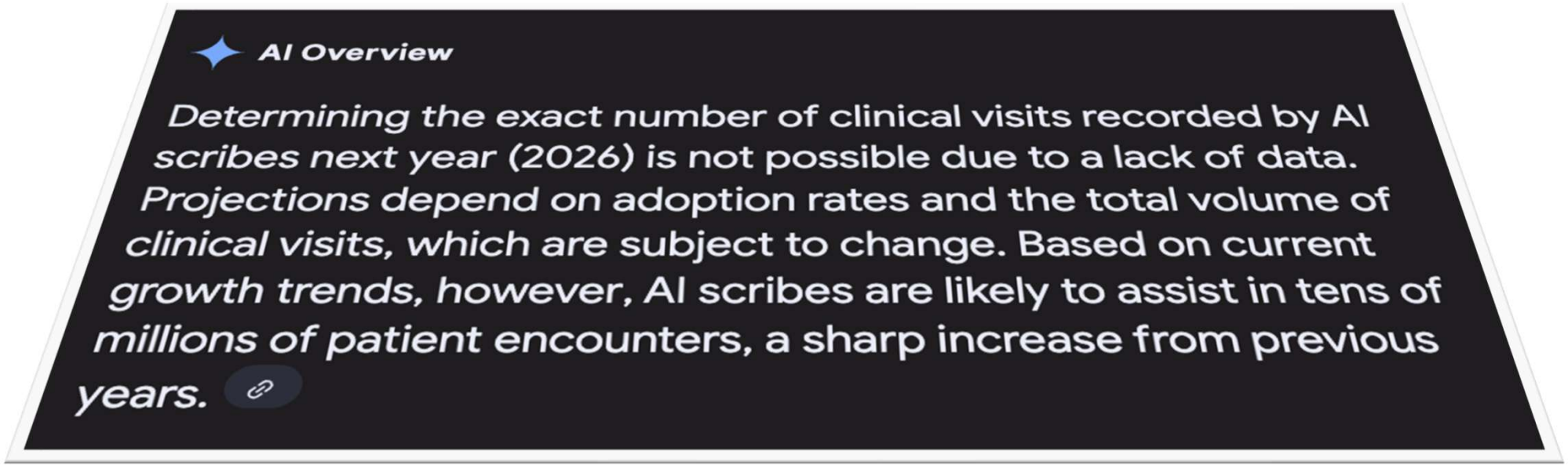

WCAX, Ch. 3

August 2025

”

[Scalable computational methods] allows us to see things that we would not otherwise have seen.

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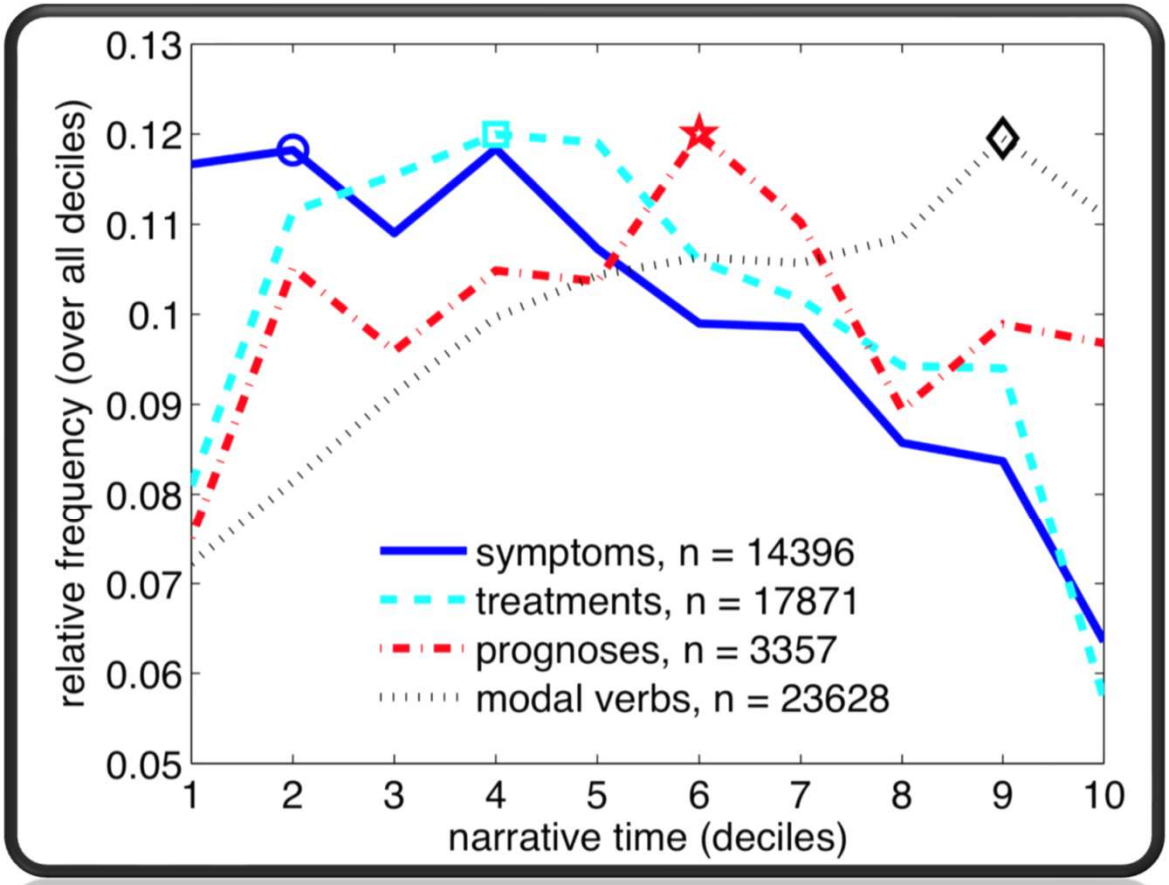
S.O.C.K.S.
SCIENCE OF ONLINE CORPORA, KNOWLEDGE, AND STORIES



”

Understanding the person – how they define who they are, how they make meaning from their experiences, what suffering means for them and how decisions might affect them– happens over an arc of conversation and frequently organizes in the form of narrative

Ross et al, *PEC*, 2020

When Sticks and Stones Have Broken Bones, Do Words Hurt You?: Narratives as a Digital Phenotype for Recovery from Trauma.

Matthew Price

George W. Albee Green & Gold Professor of Psychological Science

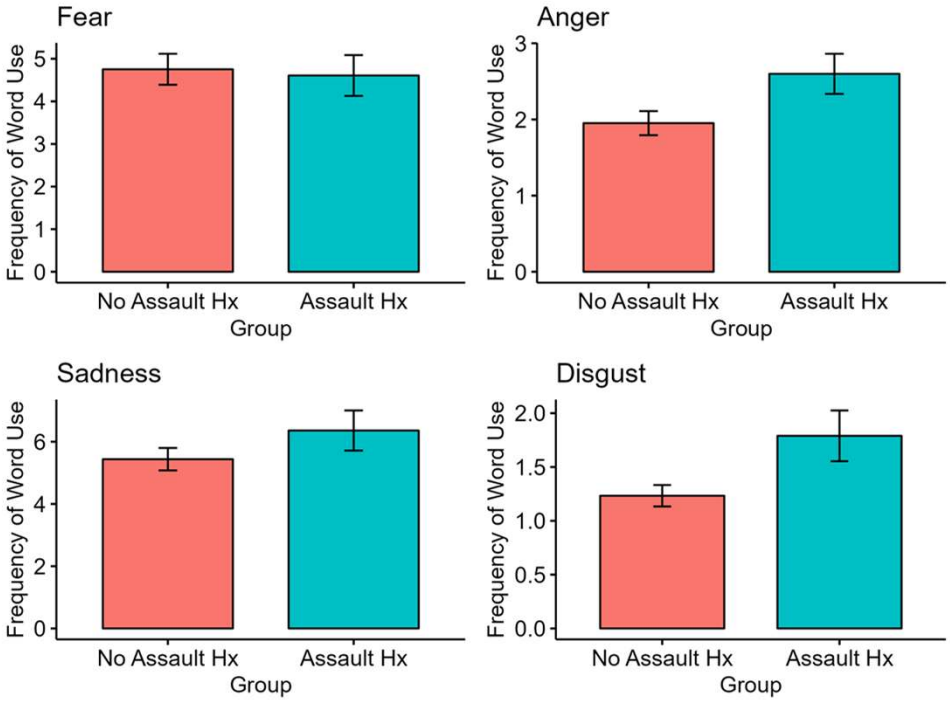
Health Project B3 Lead

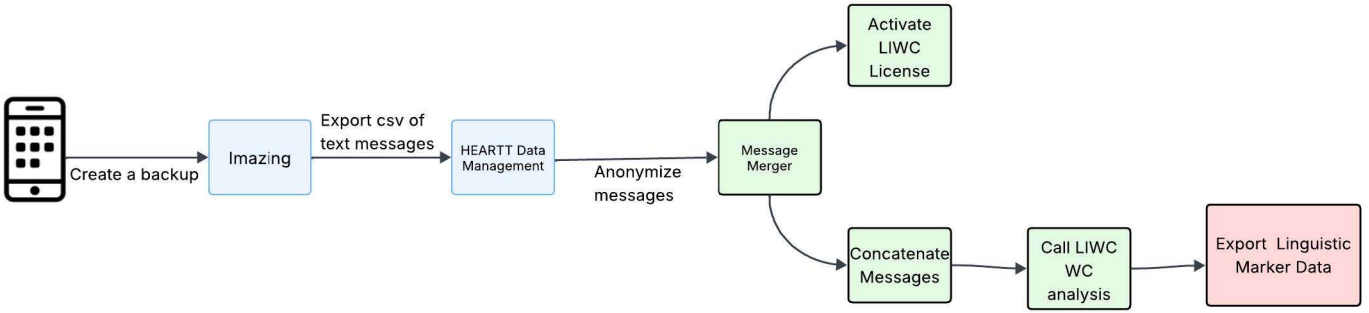
Project Objectives

- Identify the association between an individual's narrative of a traumatic event and their recovery from a traumatic event.
  - Use data collected via text messages and from shared oral narratives
- Determine the relative contribution of digital and spoken narrative data in predicting mental health recovery during a traumatic event.
  - Compare language usage from different sources
- Evaluate the utility of the Hedonometer and Ouisometer as clinical tools that can enhance prediction of recovery from traumatic events.
  - Investigate the Potential of Additional Tools

Research Progress

- Completed Phase I Project (N = 100) analyzing writing
  - Results highlight promise of digital phenotyping approach
- Created “Message Merger”
  - Data collection pipeline to extract text messages automatically and confidentially from mobile devices
- ~1000 words vs ~75000





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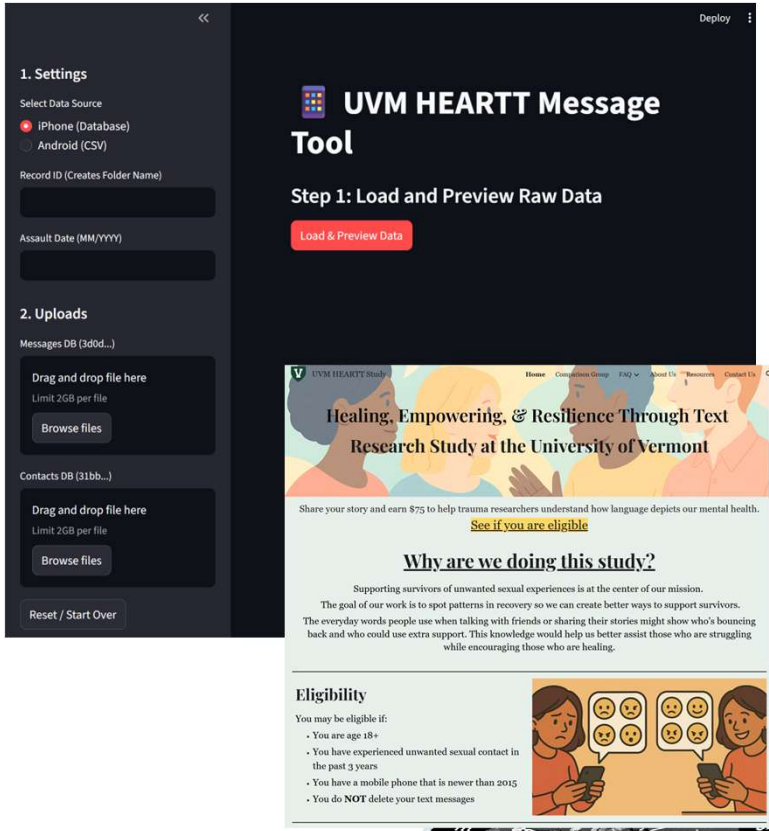
Expanded Message Merger for Remote Data Collection

- Challenge of In-Person Data Collection
  - 6 participants in 5 months
- Developed Remote Data Collection Tool
- Recruitment for remote data collection underway



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Research Impacts

- Established Message Merger Pipeline
  - Sharing with colleagues at Brown University and SUNY Geneseo for implementation in other research labs
- Presented Findings at the **International Society for Traumatic Stress Studies** in ‘24
- **Supported** 2 graduate students, 5 undergraduate students, 2 SOCKS summer interns
  - SOCKS Summer Interns developed the Message Merger Pipeline
- Collaboration with HEALTH Team on Automated Tools
  - Transcription Tools

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Ongoing Work & Future Plans

- Complete new data collection using message merger to identify digital phenotypes in text vs spoken language
  - Create a language-based classifier of mental health recovery using the message merger output
- Refine message merger for broader distribution across the scientific community

Unraveling structure and disruptions in conversation with Cognitive-Communication Impairments (CCIs)

David Jangraw

Assistant Professor of Electrical and Biomedical Engineering,

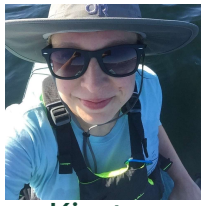
Computer Science, Neuroscience, and Complex Systems (affiliate)

Health Team Project B2

Katie Ekström Grenon

Ardyn Olszko

Mike Cannizzaro



Kirsten Bonson

Skyler Heininger

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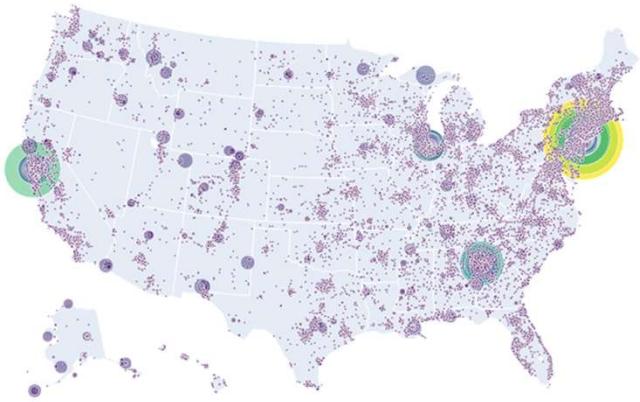
S.O.C.K.S. SCIENCE OF ONLINE CORPORA, KNOWLEDGE, AND STORIES

Project Objectives

Challenge: CCI treatment lacks large-scale normative distributions for the linguistic markers they've identified.

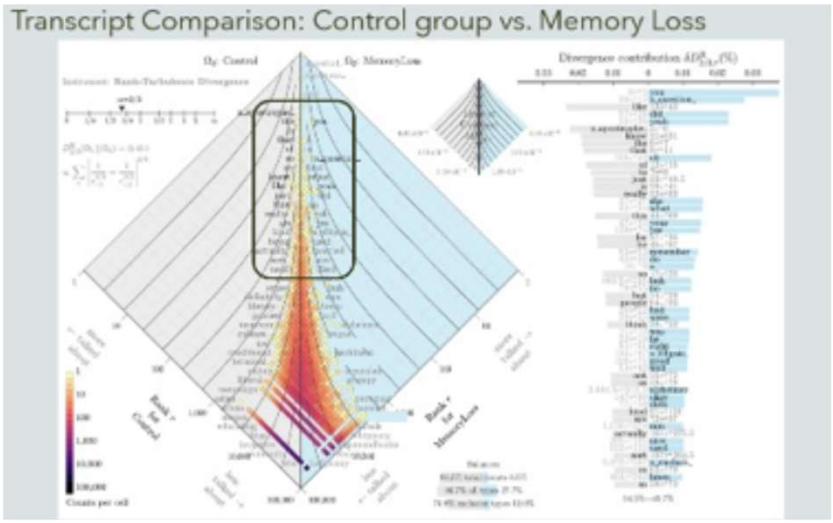
- Establish research use of the **StoryCorps Archive**, a > 300M word conversation corpus
  - > 900 stories include a CCI
- Automate clinical evaluation of storytelling elements in CCIs
  - Initial focus on cohesion
- Develop norms for storytelling elements for use in diagnosis & treatment planning

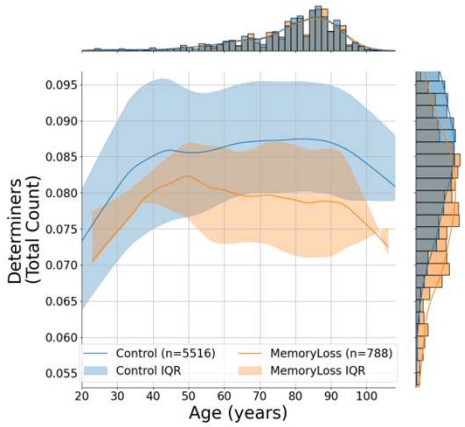


Research records courtesy of StoryCorps

Research Progress

- Signed **contract** with StoryCorps
- **Downloaded** audio & metadata at UVM
- Implemented Python **pipeline** for automated transcription & diarization
- Developed hypotheses using SOCKS' **allotaxonometer** tool
- Extracted metrics of **cohesion**
- Developed **normative distributions**, fits to memory loss & control groups
- Built **machine learning classifier** to predict dementia from conversation





Preparing Our Automated Pipeline

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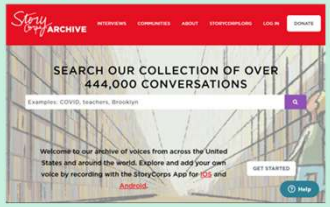
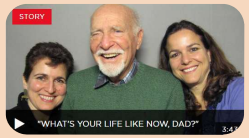
StoryCorps ARCHIVE

A mission to preserve and share humanity's stories





Memory Loss Initiative

Control (No initiative)

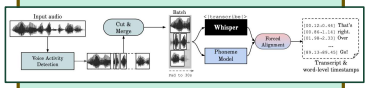
https://archive.storycorps.org/

Research agreement established with StoryCorps

Downloaded audio interviews (n=44,231)

- *English*
- *2 speakers*

Transcribed and Diarized with WhisperX



Bain et al., 2023

Collected demographics, cleaned dataset

Calculated cohesion features

TAACO

- *168 cohesion features*
- *7 additional structural features (e.g., word count, turn length, turn frequency)*

Random Forest Classifier, 5-Fold Cross-Validation

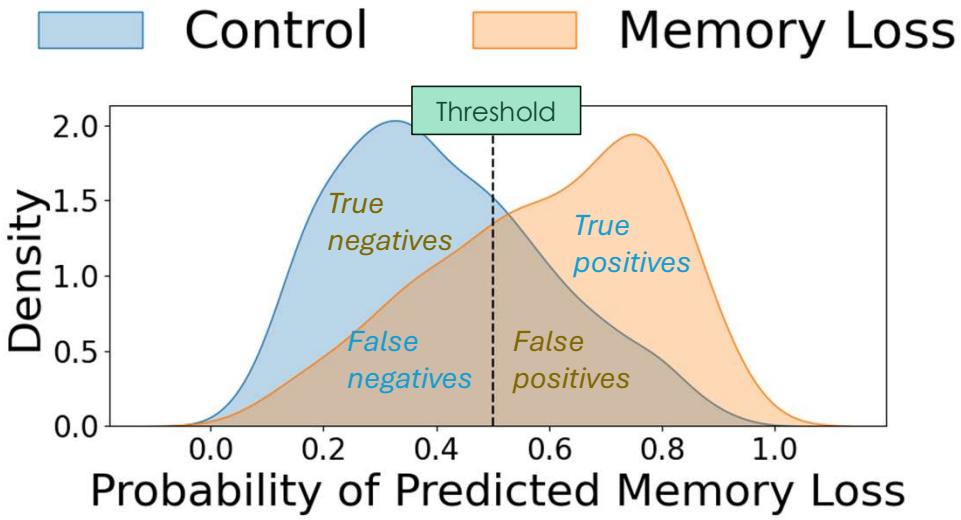
Find Important Features

Produce "Growth Curves"

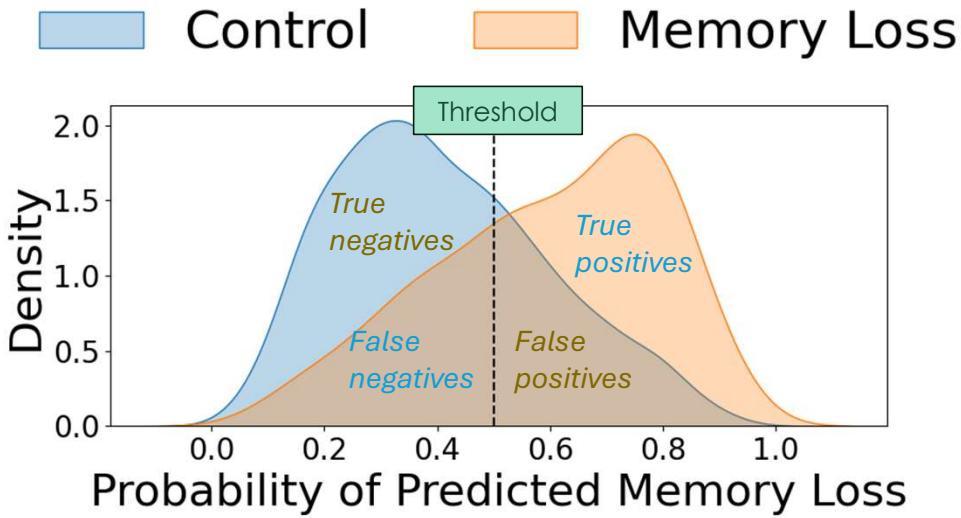
Automated Pipeline

Machine Learning Detects Memory Loss from Speech

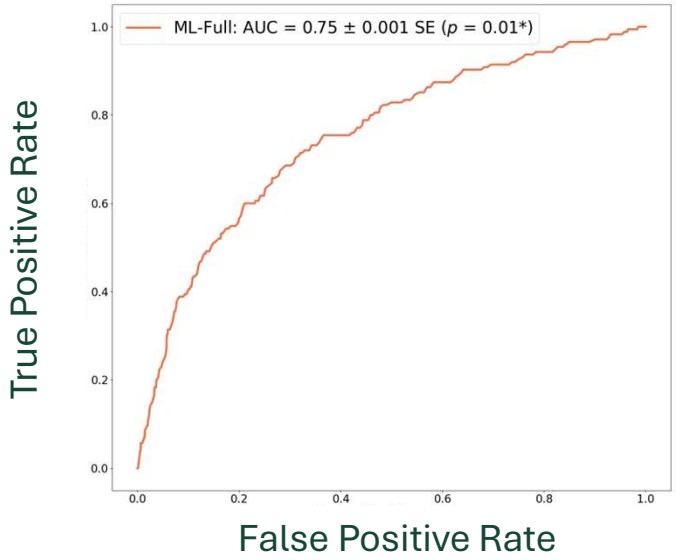
- *168 cohesion features*
- *7 additional structural features (e.g., word count, turn length, turn frequency)*



Machine Learning Detects Memory Loss from Speech



ROC Curve (AUC = 0.75)



Machine Learning Highlights Useful Features

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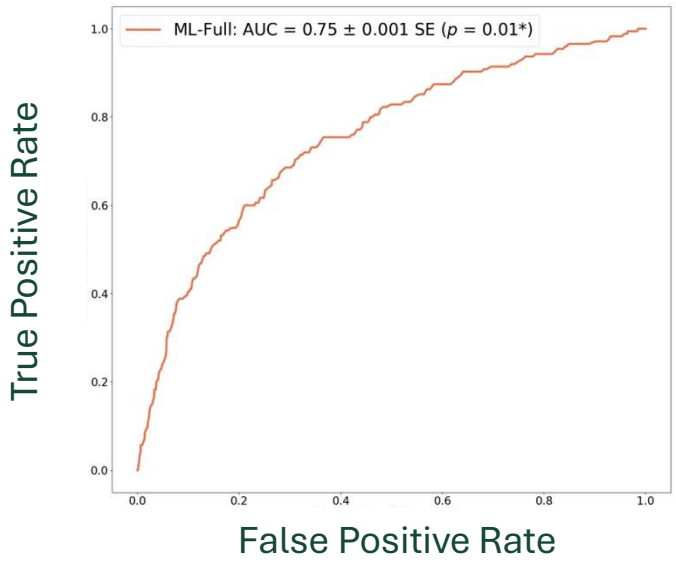
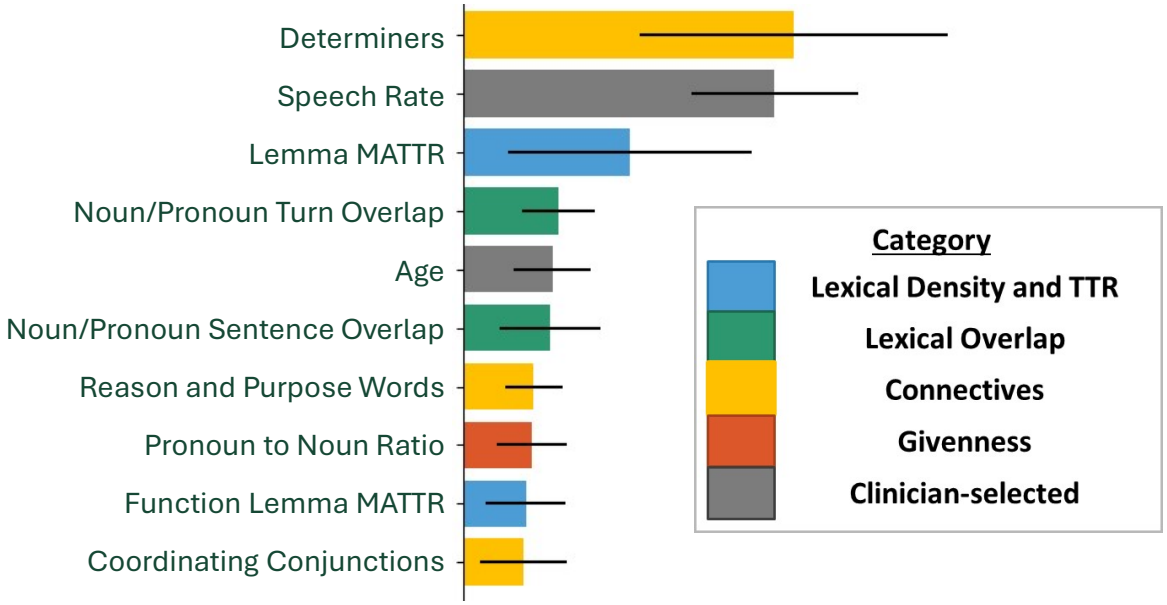
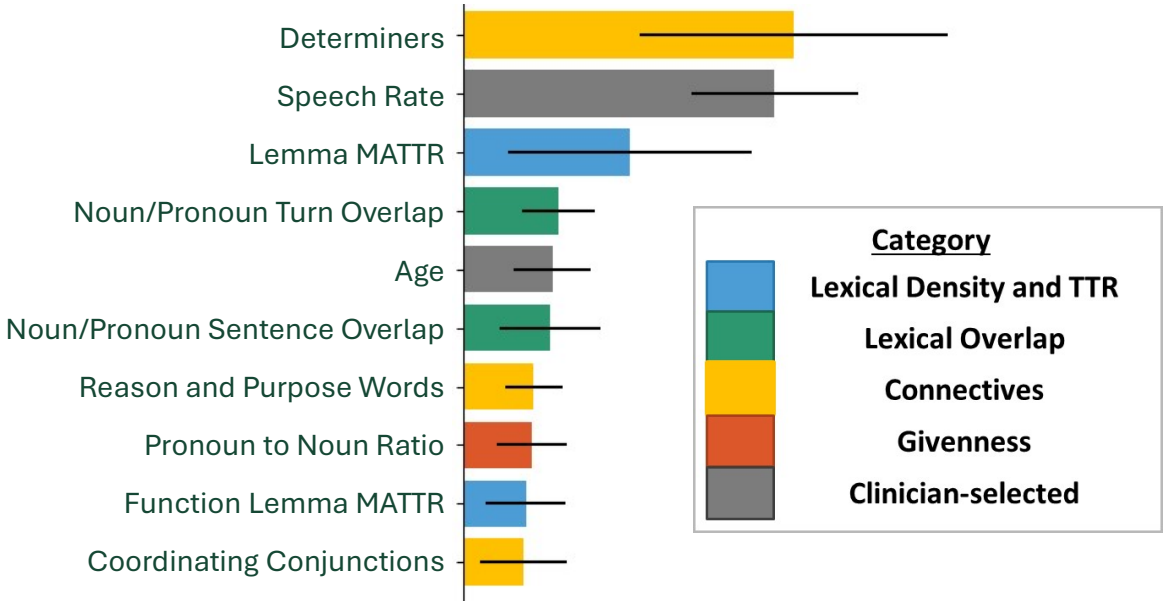
ROC Curve (AUC = 0.75)





Machine Learning Highlights Useful Features



Determiners (number of "a", "an", "the", etc.)

Possible scenario:

Less specific speech due to word-finding difficulty

Speech Rate (words per minute)

Possible scenario:

Slower speech with more frequent and longer pauses, impaired comprehension or production

Lemma MATTR (moving average type token ratio)

Possible scenario:

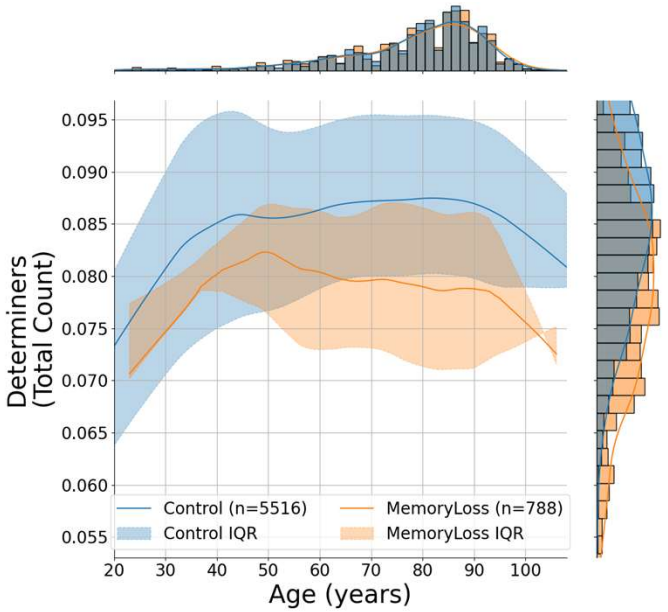
Vocabulary range reduction (lexical diversity) or perseveration

Features Change With Age

Determiners (number of “a”, “an”, “the”, etc.)

Possible scenario:

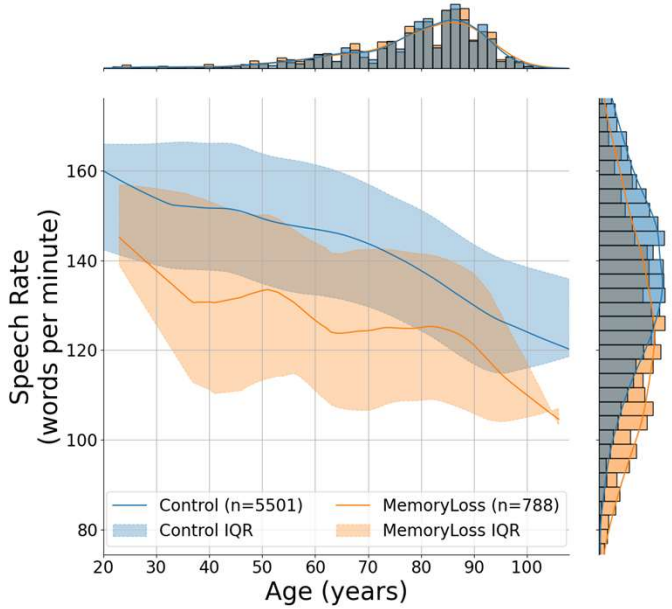
Less specific speech due to word-finding difficulty



Speech Rate (words per minute)

Possible scenario:

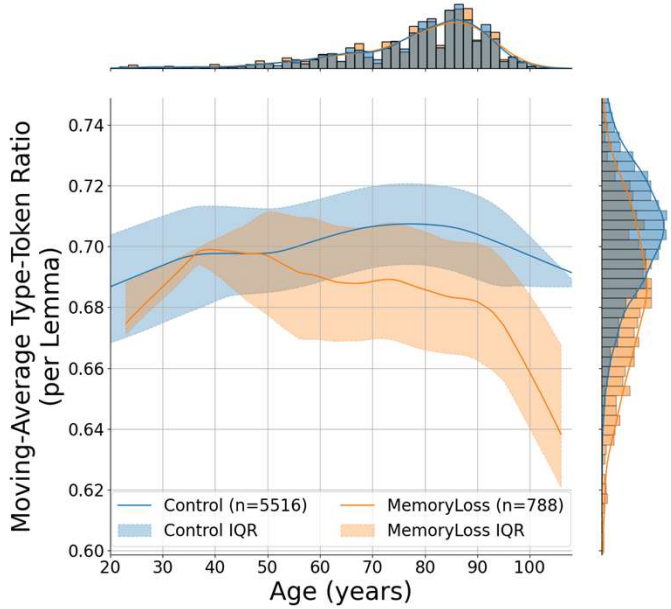
Slower speech with more frequent and longer pauses, impaired comprehension or production



Lemma MATTR (moving average type token ratio)

Possible scenario:

Vocabulary range reduction (lexical diversity) or perseveration



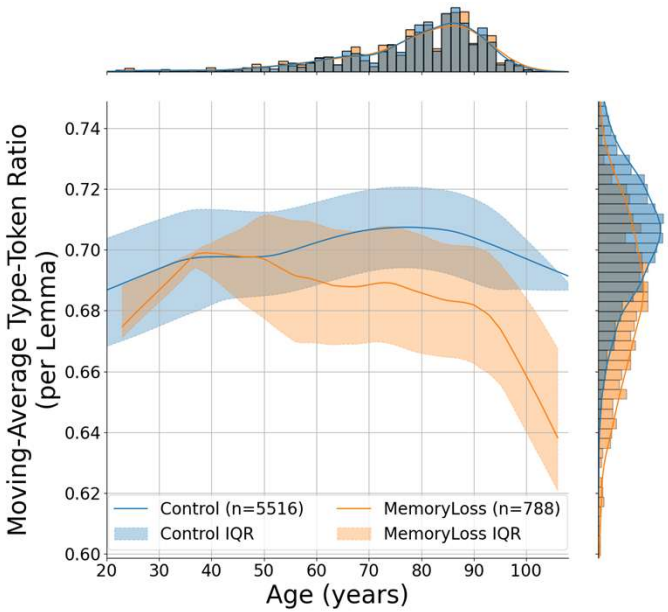
LOWESS smoothing

Towards In-Home Assessment

Lemma MATTR (moving average type token ratio)

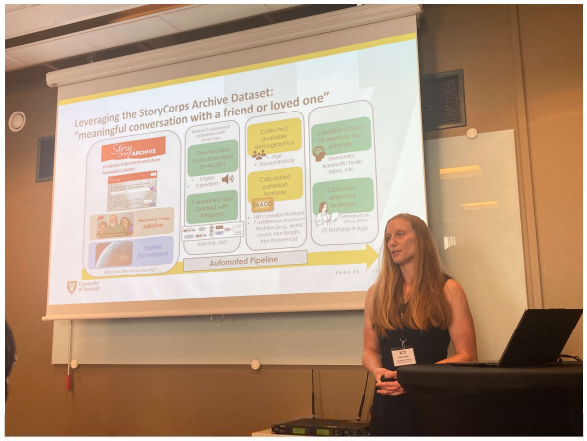
Possible scenario:

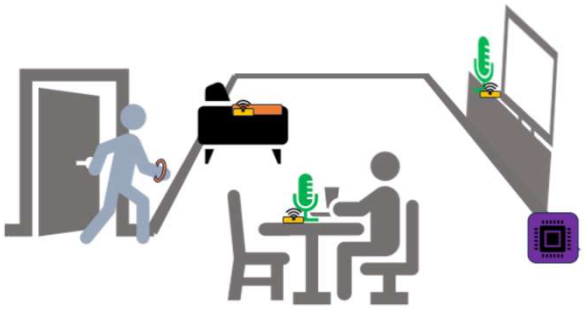
Vocabulary range reduction (lexical diversity) or perseveration



Research Impacts

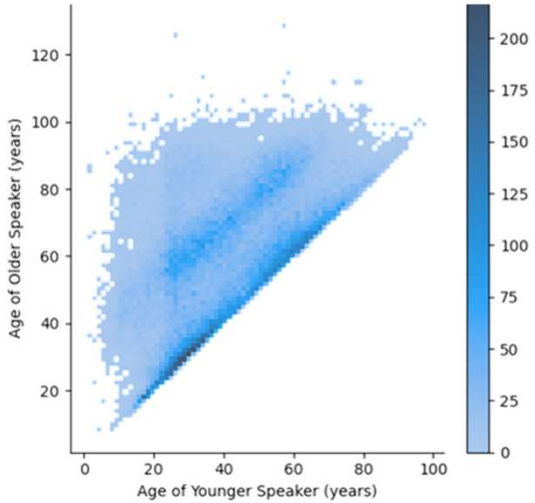
- Established StoryCorps audio & transcripts as a **SOCKS shared resource**
- **Trained** 2 PhD, 1 MS, and 18 undergraduate students
- 7 Conference Publications + 1 Journal Submission:
  - Presented a Talk to **American Speech-Language-Hearing Association** conference in 2023, '24, '25 (4 total)
  - Presented a Talk to International Conference on **Computational Social Sciences** in 2025
  - Presented a Talk to International **Cognitive-Communication Disorders** Conference in 2026
  - Presented a Poster to Intrinsic Capacity, Frailty and Sarcopenia Research Conference for **Healthy Longevity** in 2026
  - Invited Manuscript Submitted to Americal Journal of **Speech-Language Pathology** in 2026
- Grant support for NLP study of conversations at UVM
  - **NIMH R01**: Automated Coding of Exposure Therapy Quality using Natural Language Processing (2024-28)
  - **UVM Center on Aging Award**: Usability and Validity of In-Home Assessment of Mobility and Speech Production in Aging Rural Vermonters with and without Mild Cognitive Impairment (2024-26)
  - **Johns Hopkins AI & Technology Collaboratory Pilot Grant**: Unobtrusive In-Home Assessment of Mobility and Speech Production in Aging Rural Vermonters

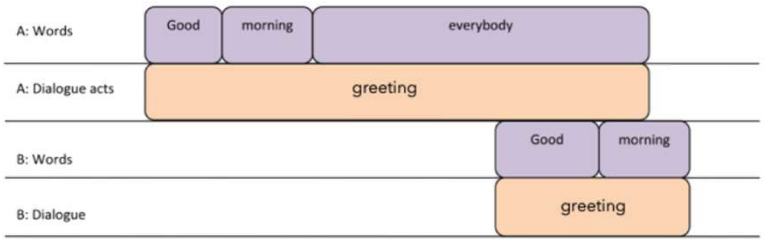




Ongoing Work & Future Plans

- Split Features by Speaker
  - Match each utterance to a participant
  - Appraise patient & **partner's contributions** to cohesion
- Examine more granular structure
  - Label and norm **dialog acts**
  - Extract prosodic markers, **intonation units**
- Collect conversations with **diagnostic data** in aging participants
  - Evaluate language markers vs. dementia severity
  - Explore fMRI study of neural correlates of conversation risk factors for dementia





Nouwens, I. (2018). Predicting dialogue state transitions using prosodic markers exploring AMI corpus backchannels.

Project B1. Conversational storytelling in serious illness

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Create, Apply, and Refine NLP & ML algorithms for clinical environments

Nick Cheney

Associate Professor
Computer Science

Bob Gramling

Palliative Medicine Physician
Larner College of Medicine (LCOM)

Maija Reblin

Associate Professor
LCOM Family Medicine

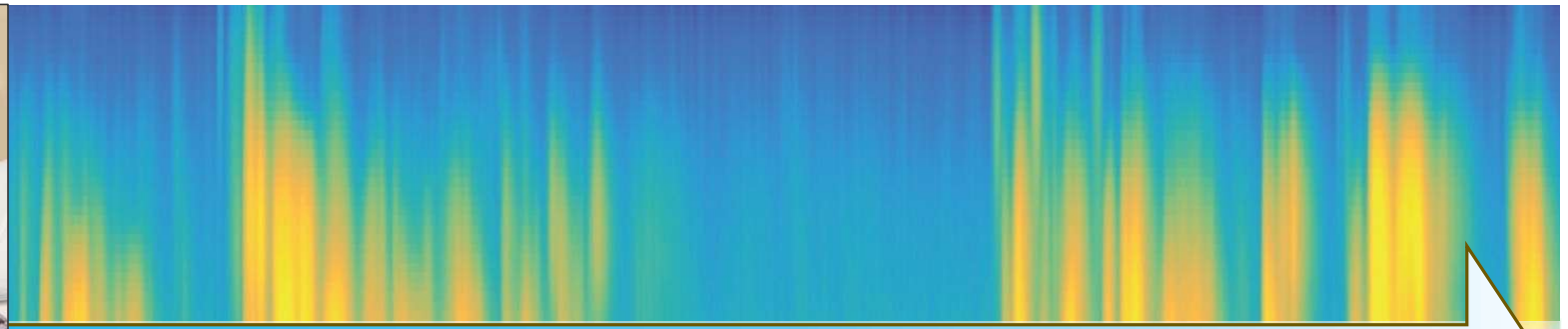
Donna Rizzo

Professor
Civil & Env. Engineering

Elise Tarbi

Assistant Professor
College of Nursing & Health Sci.

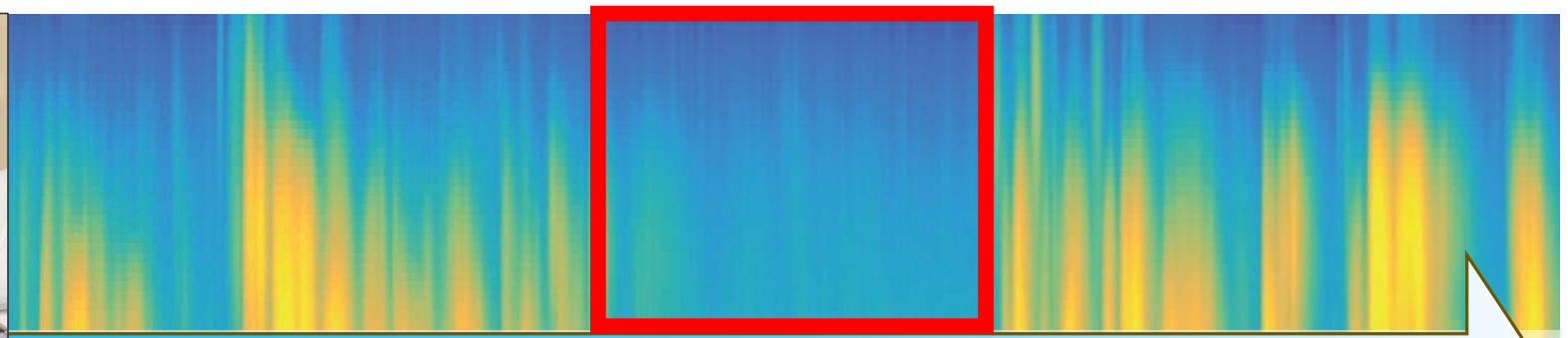
Objective B1.1. Identify communication characteristics in need of measure development, to honor cultural variation in conversational narratives, and ID human connection & interactions



ID Measurement Targets

Extract Features

Objective B1.1. Identify communication characteristics in need of measure development, to honor cultural variation in conversational narratives, and ID human connection & interactions



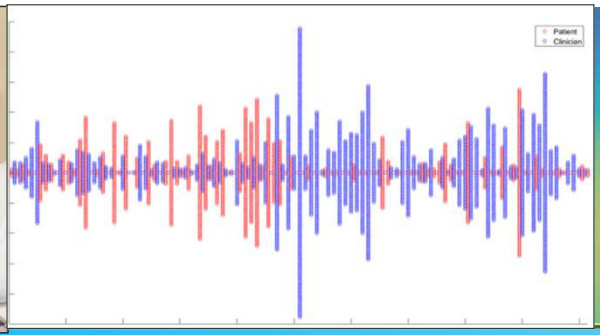
ID Measurement Targets

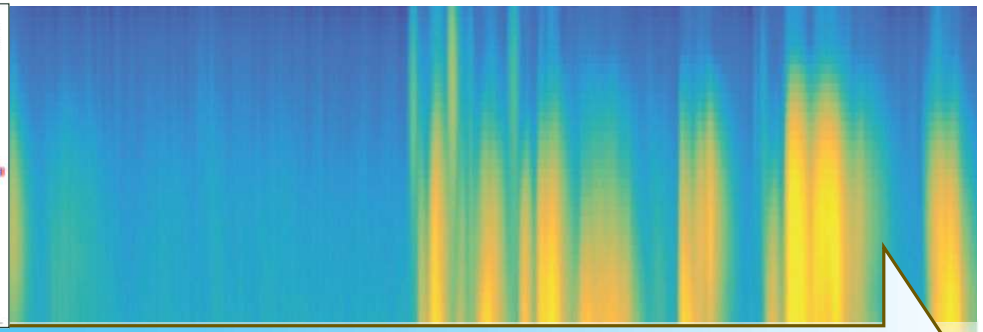
Extract Features

"....[moments of Connectional Silence] exhibited intriguing patterns of association with indicators of decision-making and quality-of-life."

Gramling et al. *PEC*. 2022

Objective B1.1. Identify communication characteristics in need of measure development, to honor cultural variation in conversational narratives, and ID human connection & interactions



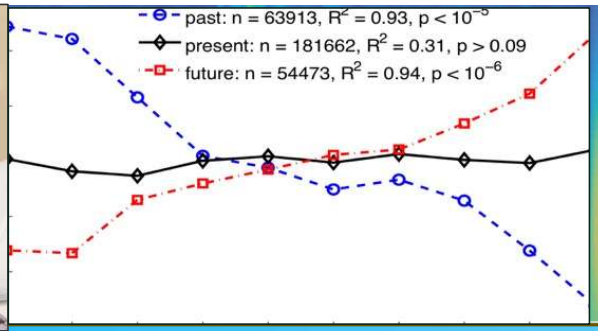


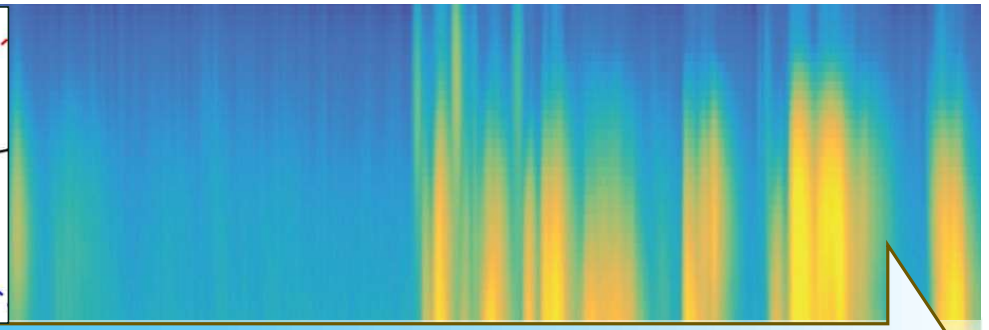
ID Measurement Targets

Extract Features

Turn-taking
between patients and clinicians

Objective B1.1. Identify communication characteristics in need of measure development, to honor cultural variation in conversational narratives, and ID human connection & interactions



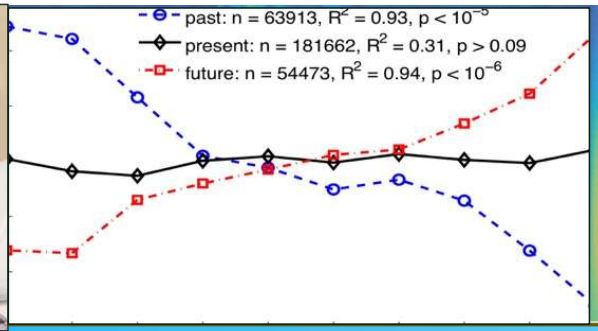


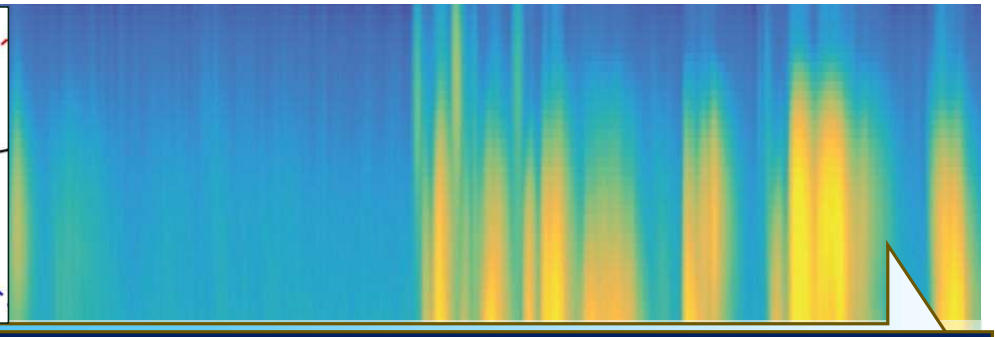
ID Measurement Targets

Extract Features

Temporal reference
(past, present, future verb tense)

Objective B1.1. Identify communication characteristics in need of measure development, to honor cultural variation in conversational narratives, and ID human connection & interactions





"

The ability to monitor, report, and respond to how well patients feel heard and understood is critical to ensuring a caring environment for seriously ill individuals.

National Quality Forum

Research Progress

- **Obtained/downloaded** video, audio & metadata for 3 storytelling study datasets - not stored on VACC except during active computational analyses

- Established **data management plans & agreements** for additional PAT clinical trial data for analysis with SOCKS' tools & additional ML algorithm)

Kirsten Bonson, PhD
Data Manager

Cailin Gramling, PhD Student
Complex Systems & Data

Katie Greon, PhD Student
Communication Science

Ardyn Olszko, PhD Student
Biomedical Engineering

Research Highlight (1)

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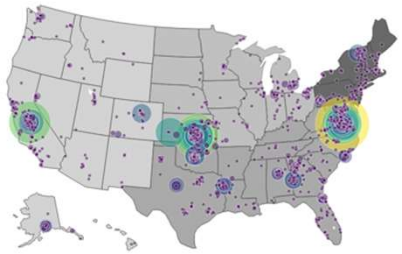
"**One Small Step** brings strangers with **different political views** together to record a 50-minute conversation—not to debate politics, but to learn who we are as people." – StoryCorps

StoryCorps ARCHIVE
ONE SMALL STEP



1,393 virtual interviews

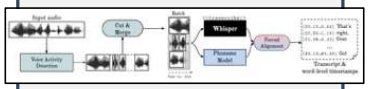
2,786 participants

48 states + D.C.

Downloaded audio interviews

- *English*
- *2 speakers*

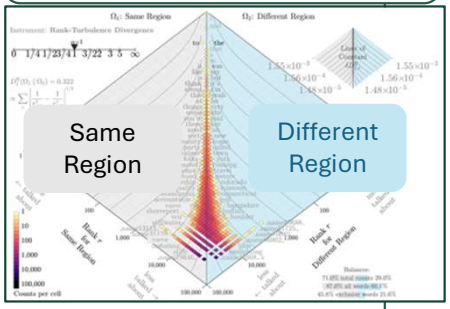
Transcribed and Diarized with WhisperX

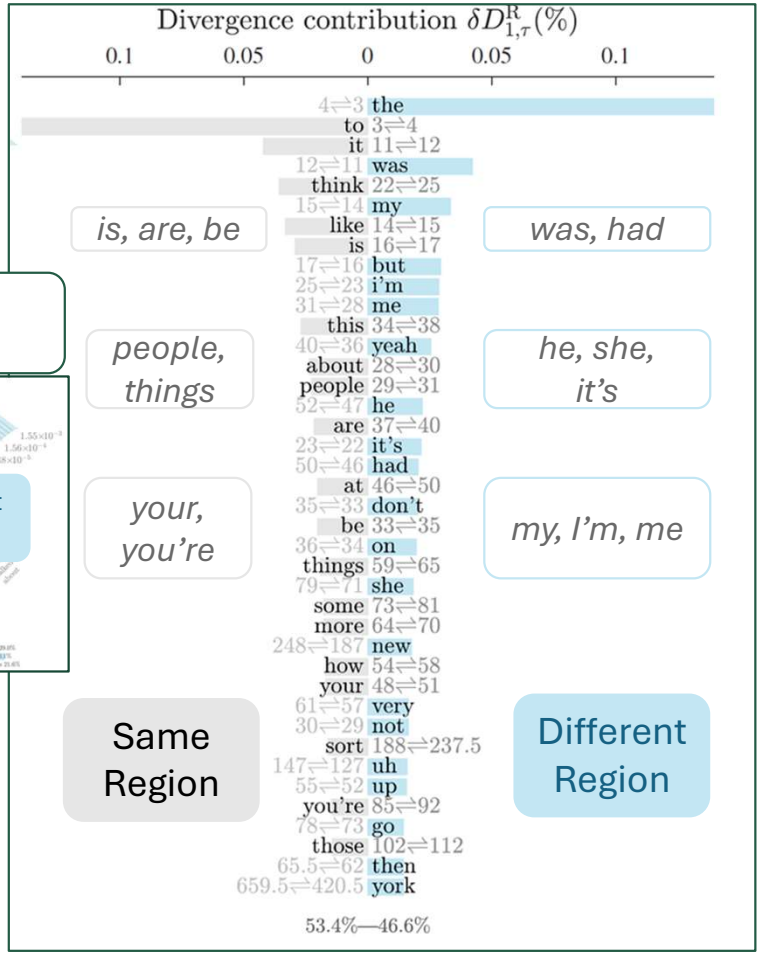


Bain et al., 2023

Allotaxonometry

Dodds et al., 2023





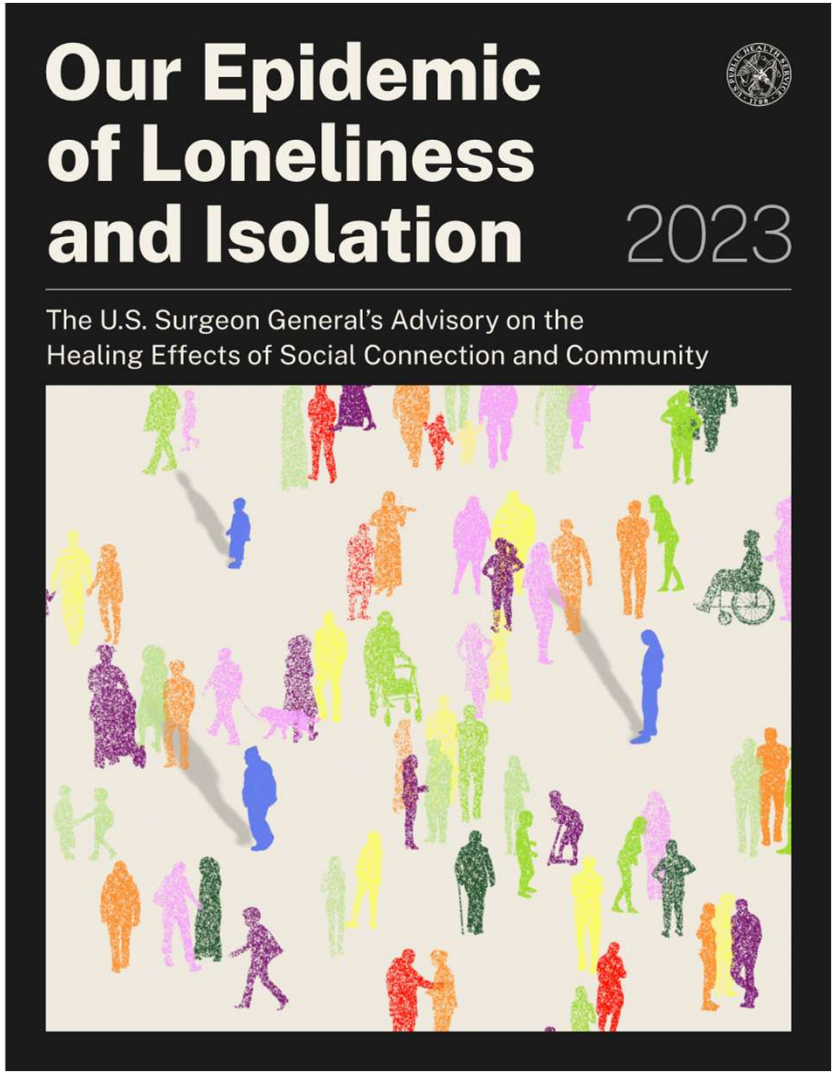
Research Highlight (2)

Loneliness in Palliative Care Consultations

Palliative Care consultations involving 231 hospitalized people with advanced cancer and 54 specialty clinicians were audio recorded and transcribed

Human coders identified speaker turns containing expressions of connection or loneliness (Kappa>0.6)

Patients self-reported measures before and following the consultation.



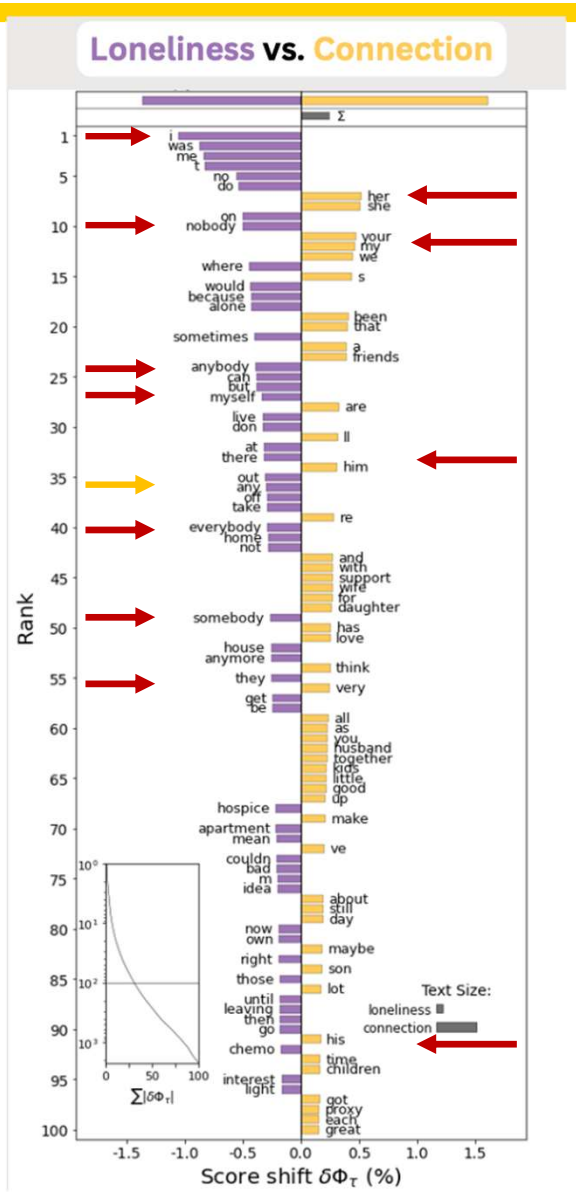
Research Highlight (2)

Able to ID expressions of connectivity in a speaker turns and differentiate between loneliness and connection.

Social Connectivity expressions are common (24% of consultations included >1 loneliness expression; 71% included >1 expression of connection).

Frequency and presence of loneliness expressions are a **predictor of short-term worsening quality of life** (OR: 2.0; 95% CI: 1.03-3.86; mean difference: 0.56, p,0.001)

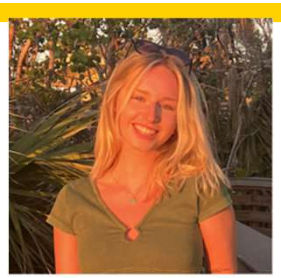
Pronoun usages differed by the presence or absence of connectivity.



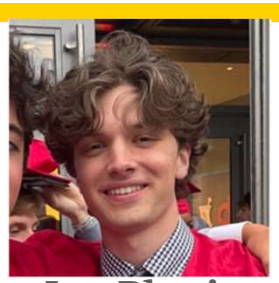
Research Highlight (3)

PAT *(psilocybin-assisted therapy)*

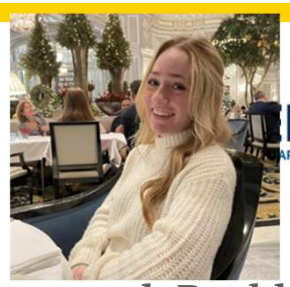
Identified & characterized
expressions of awe
within PAT over 2 phases of
codebook refinement



Maggie Demeo
Biological Sci.



Ian Bhatia
Psychological Sci.



Suzannah Buehler
Political Sci.

Nabil Balach
Linguistics

7 therapists | **8** people
16,760 minutes audio/video

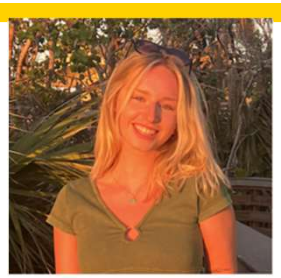
Elise Tarbi, PhD, MBE, APRN
Department of Nursing

Emily Manetta, PhD
Professor of Linguistics

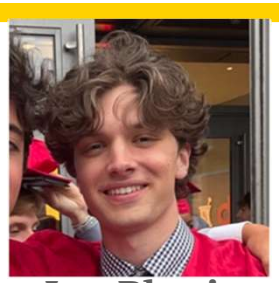
artwork by **Brigitte Durieux**, 2024

Research Highlight (3)

PAT *(psilocybin-assisted therapy)*



Maggie Demeo
Biological Sci.



Ian Bhatia
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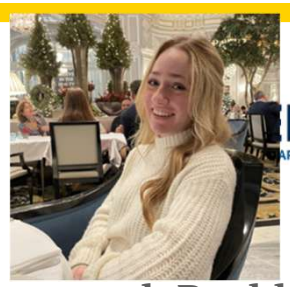


Suzannah Buehler
Political Sci.

Nabil Balach
Linguistics

Elise Tarbi, PhD, MBE, APRN
Department of Nursing

Emily Manetta, PhD
Professor of Linguistics

Awe => hypothesized as a crucial mediator of the positive
effects of psilocybin-assisted therapy (PAT)

Vastness => relates to anything being much larger than the self (4,8).

Accommodation => relates to discussion of a shift in mental structures to make sense of this new experience (4).

Ineffability => something too extreme to be expressed in words (9,10).

Research Highlight (3)

PAT *(psilocybin-assisted therapy)*

246 moments of awe expression

Methods for Recognizing and Characterizing Directly Observable Awe in Psilocybin-Assisted Therapy

A Feasibility Study

Authors: Elise C. Tarbi,[1,2] Ian Bhatia,[2] Nabil Balach,[2] Suzannah Buehler,[2] Maggie Demeo-Meres,[2] Cailin Gramling,[2,3] Tej Thambi,[4] Maija Reblin,[2] Donna M. Rizzo,[5] Robert Gramling,[2] Manish Agrawal,[6] Emily Manetta[7]

Abstract

Background: Awe has been hypothesized as a crucial mediator of the positive psycho-existential effects of psilocybin-assisted therapy (PAT), yet rigorous investigations of its properties within this context have not been pursued. Recognizing and characterizing awe during PAT is essential to understanding how this complex emotion manifests and contributes to an understanding of therapeutic mechanisms of PAT.

Purpose: To develop a direct observation coding system for the natural setting of PAT for human coders to systematically identify moments of awe narration and evaluate them for key definitional properties.

Methods: We analyzed audio and video recordings from a recent Phase 2 open-label study of psilocybin-assisted therapy in patients with cancer and depression. Building off the work of Keltner and Haidt (2003), we initially operationalized awe expressions as those that included one or more of the following primary features: vastness, need for accommodation, and ineffability. We selected eight unique participants, maximizing variability in therapists and gender pairs, for iterative refinement of our coding approach. Each video was independently double-coded, using a structured checklist, to record start-stop times, the audible and visible cues marking the event, interaction qualities (e.g., emotional expressions), and coder level of confidence. We report here on our formative cycles of codebook refinement and the resulting insights about how awe observably manifests in this setting.

Results: During 16,760 total minutes of PAT video, coders collectively recorded 246 moments of awe expression. Over two iterative phases of codebook refinement, we made three critical

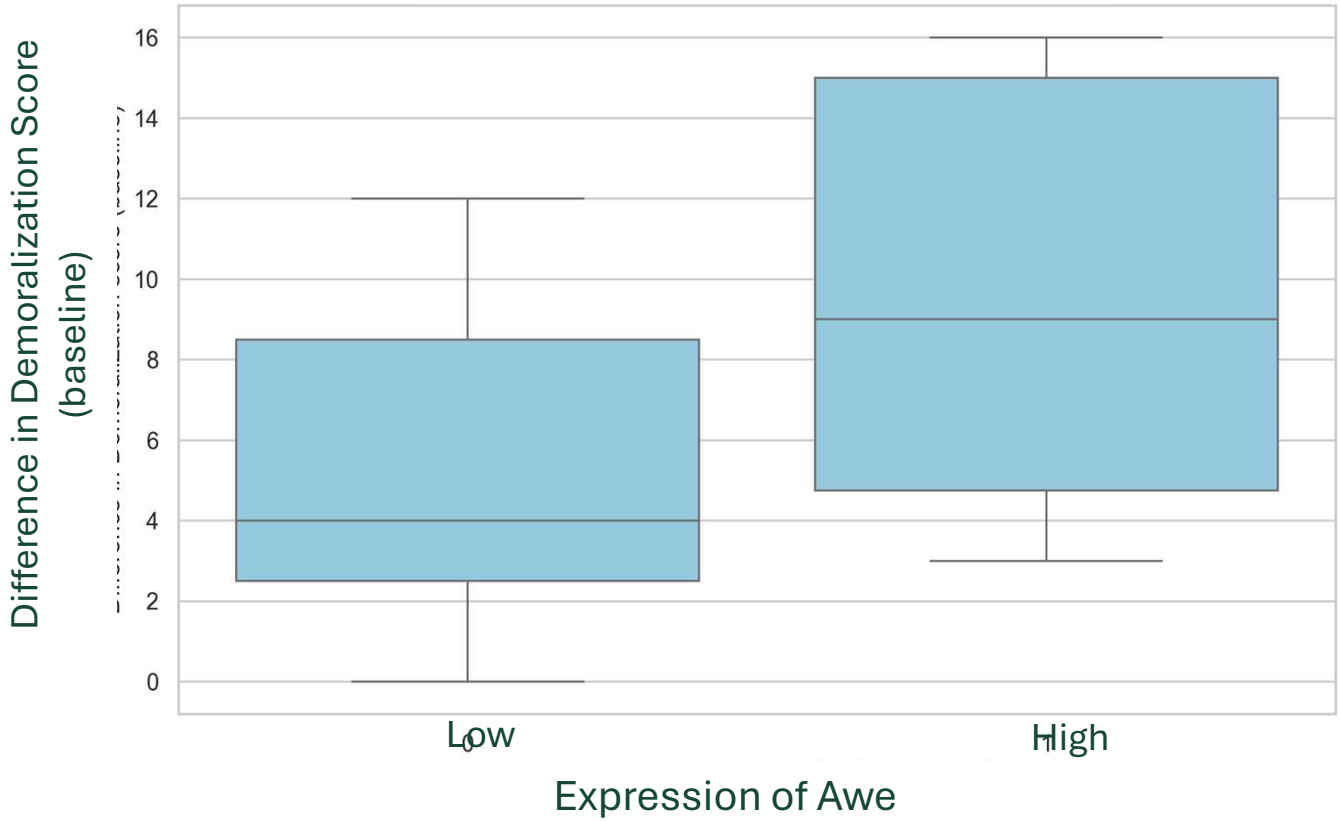
consciousness and requires evaluation of audible and visual data.

[vastness and (cognitive disruption or ineffability)]

Then AWE

Research Highlight (3)

PAT *(psilocybin-assisted therapy)*



Research Progress (Cont.)

- Implemented Python **pipeline** - automated transcription of inpatient PC conversations

- **Extracted** features (lexicon, et al.)

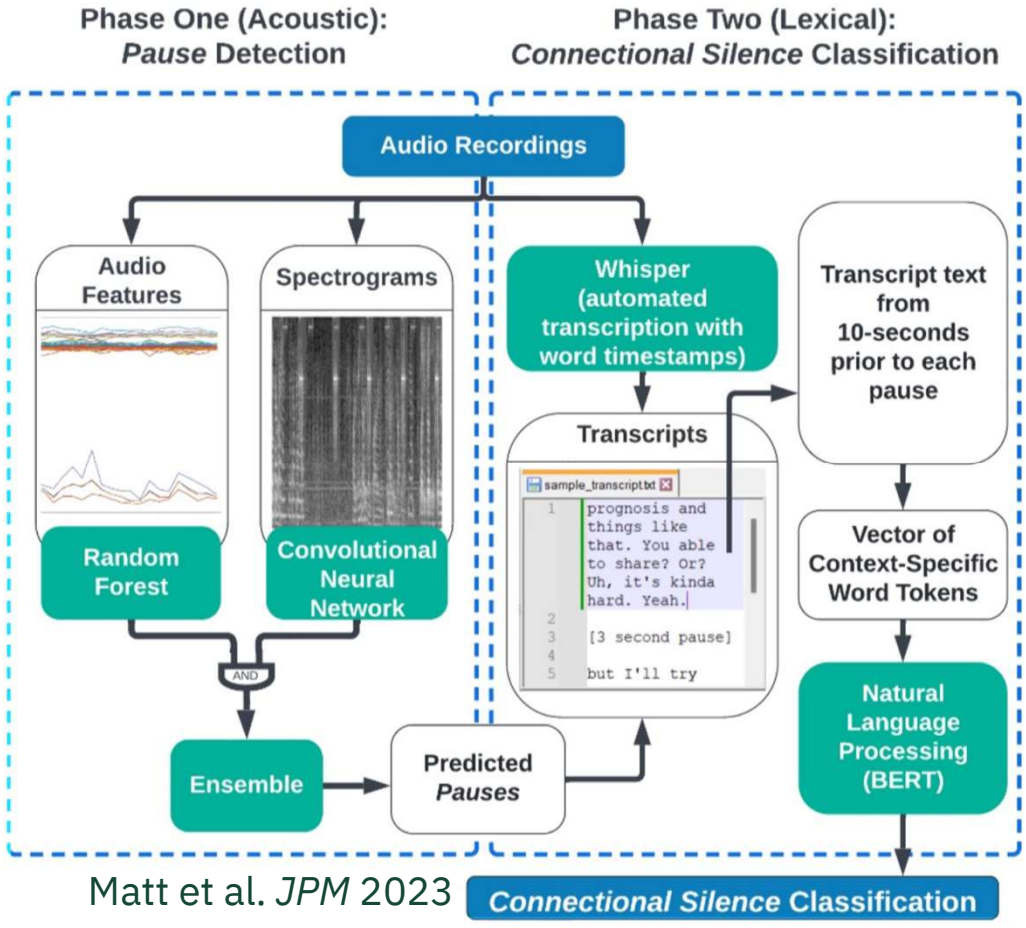
231 patients | **54** PC specialists
10,500 minutes audio
~99,000 speaker turns
~1.4 million words


Kirsten Bonson


Cailin Gramling


Ardyn Olszko

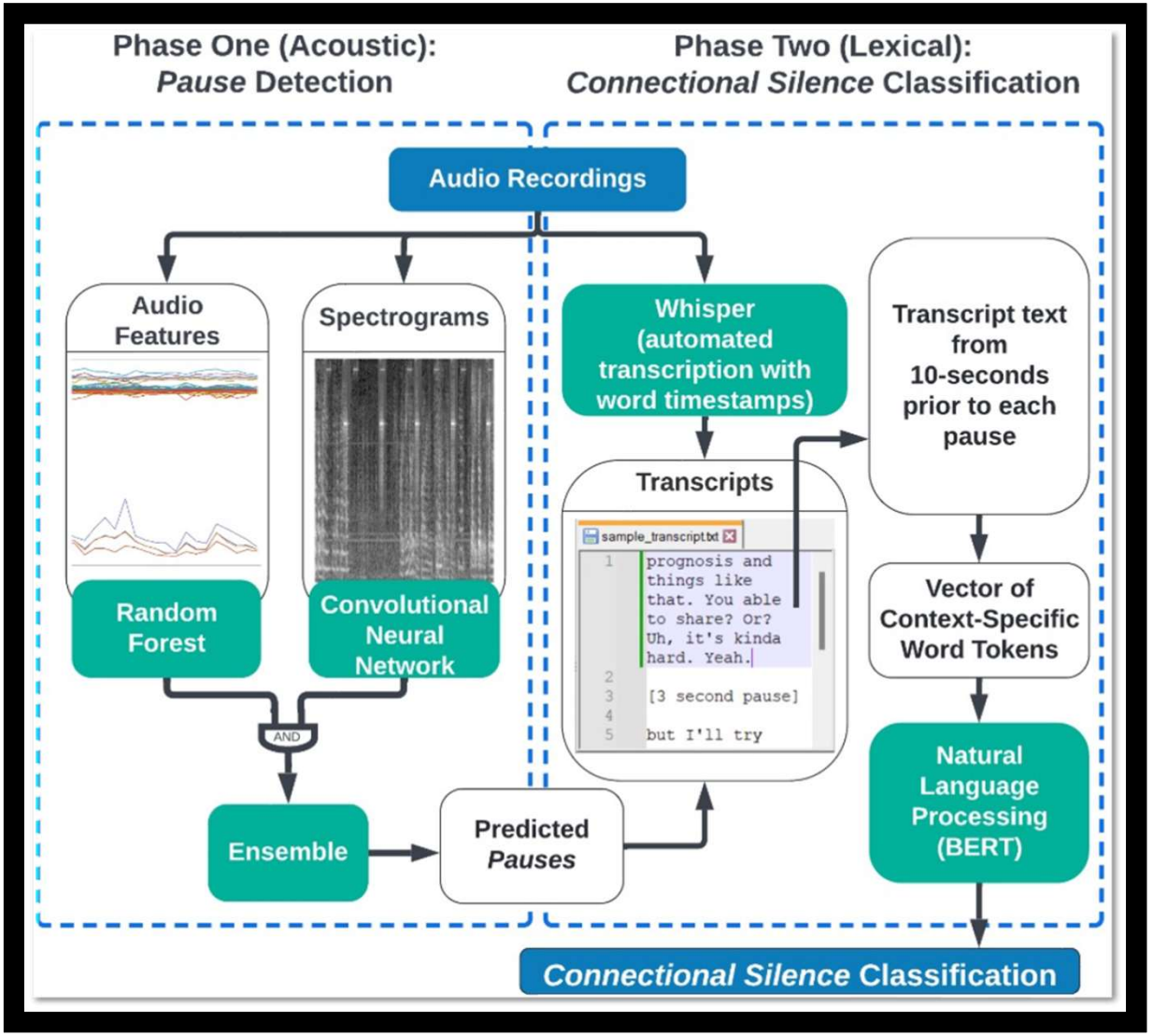

Jeremy Matt



Matt et al. *JPM* 2023

84%
sensitivity

92%
specificity



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Research & Future Work (Cont.)

- Use SOCKS' tools & **newly developed ML** classifiers to describe taxonomies associated w/ patient outcomes of interest

3 Features:

Pause Taxonomy

prosodic	Mean pitch w/in human vocal range (Hz), pause duration (s), mean speech rate (syllables/second)
lexical	Temporal Reference word count for past, present, and future words; Uncertainty words total count
dialog acts	Total events in the following classes: statement-opinion, acknowledge-backchannel, open-question, rhetorical-questions


Kirsten Bonson


Cailin Gramling

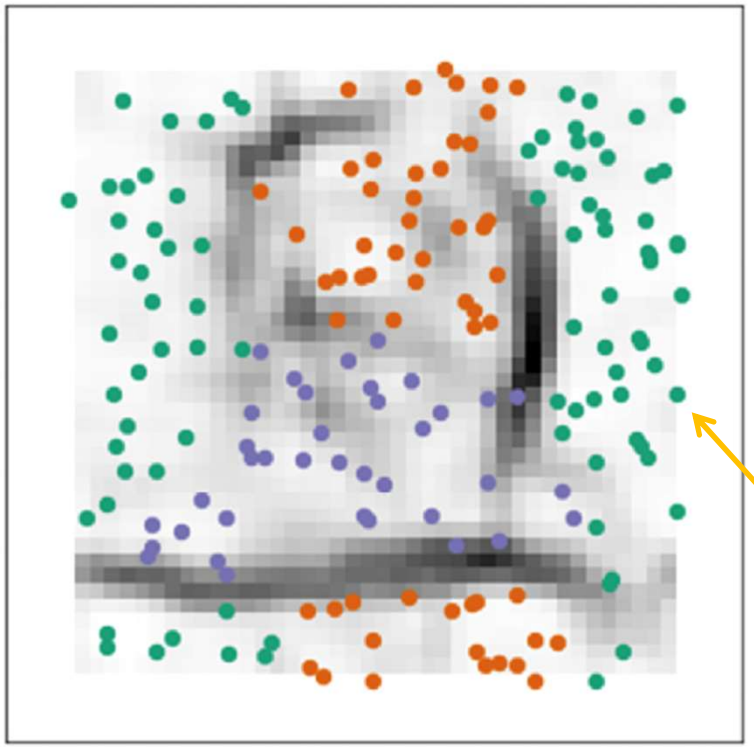

Ardyn Olszko


Katie Grenon

Research & Future Work (Cont.)

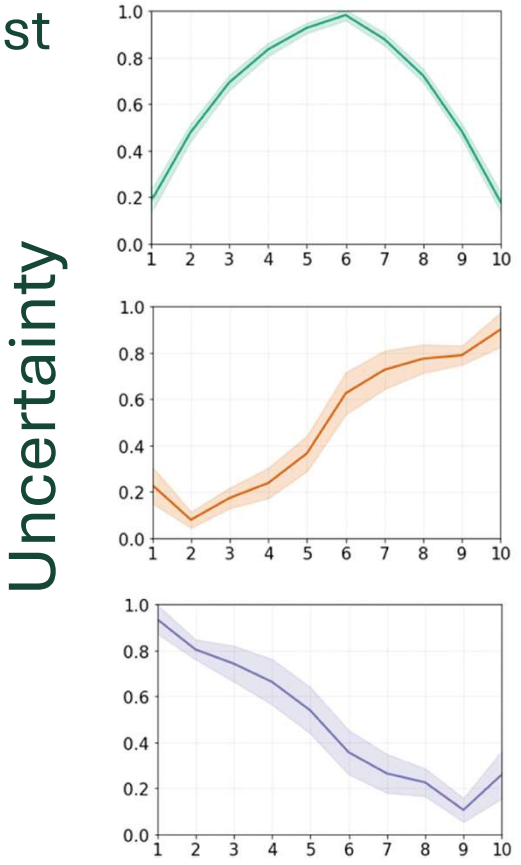
- Use SOCKS' tools & **newly developed ML** classifiers to describe taxonomies associated w/ patient outcomes of interest

SOMTimeS



Cluster 1
Cluster 2
Cluster 3

Each "dot" represents a conversation



Some Research Impacts

- Established audio & transcripts as a **SOCKS shared resource**
- Presented at:

  - ***International Conference on Communication in Healthcare*** in '23, '24, '25
  - ***American Academy of Hospice and Medicine*** in '25
  - ***American Academy of Hospice and Palliative Medicine State of the Science*** in '25
  - ***NSF EPSCoR National Conference*** in Oct. '24

- **Trained** 3 graduate and 8 undergraduate students
- Submitted 3 manuscripts since last update:

1. Tarbi, E., I. Bhatia, N. Balach, S. Buehler, M. Demeo-Meres, C. Gramling, T. Thambi, M. Reblin, D.M. Rizzo, R. Gramling, M. Agrawal and M. Emily, "Methods for Recognizing and Characterizing Directly Observable Awe in Psilocybin-Assisted Therapy", *Psychedelic Medicine*, (In Review, 2025).
2. Dewoolkar A., R. Gramling, K. Bonson, and D.M. Rizzo, "Hysteresis Curves: Scalable measures of lagged conversation events for communication science", *Journal of Pain & Symptom Management*, (in Review, 2025).
3. Tarbi, E.C., B.N. Durieux, A. Kwok, D.M. Rizzo, C. Lindvall, "Artificial intelligence for serious illness communication: Proactive approaches to mitigating harm", *Journal of Medicine and Philosophy*, (2025).

- Grants:

Submitted: National Institutes of Health proposal that expands SOCKS tools to application in new clinical conversation contexts with meaning-making as core importance (PI Elizabeth Kessler University of Colorado).

Title: *Deep Neural Networks to Identify Moments of Human Connection in Cancer Communication*
Source of Support: National Institutes of Health (NCI) (R21CA259543) - 501827
PI Robert Gramling (Larner College of Medicine)
Award Period: 24 mos., 02/01/20224– 01/31/2026