The Path to Zero is One
Detection in the Digital Era

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RACIAL DIVERSITY IN THE UNITED STATES OF AMERICA
Research Situation

Digital Voice

Not Demented: 2009

Mild Cognitive Impairment: 2015
Digital Voice Biomarkers

Voice data

Predictive algorithm

Impaired

Not Impaired

Classification Performance (AUC)

Dementia vs. ND

Dementia vs. CIND

Health  Acoustic  Quantitative
Digital Written Biomarkers

Fig. 1 Summary of results for screening

Souillard-Mandar et al. (2015) Learning Classification Models of Cognitive Condition From Subtle Behaviors in the Digital Clock Drawing Test
Cognitively Intact Individuals
Digital Clock Drawing Test (dCDT)

1791 dementia- and stroke-free FHS participants
• Age: 62±13.82
• Education: 52% college degree
• Gender: 47% women
• Average MMSE: 29

**dCDT parameters**

<table>
<thead>
<tr>
<th>Total Time To Completion</th>
<th>Higher-Order Decision Making Latencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total “Ink” Time</td>
<td>Post clock face circle latency</td>
</tr>
<tr>
<td>Total “Think” Time</td>
<td>Pre 1st hand latency</td>
</tr>
<tr>
<td>Total Strokes</td>
<td>Pre 2nd hand latency</td>
</tr>
</tbody>
</table>
Results

Command

Total Time to Completion
80s+ > 60s, 50s, 40s, 20 & 30s
   70s > 50s, 40s
   60s > 40s

Total Pen Strokes
80s+ > 40s

Pre-2nd hand latency
80s+ > 60s, 50s, 40s
   70s > 50s, 40s

Copy

Total Time to Completion
80s+ > all other groups
   70s > 50s, 40s

Total Pen Strokes
80s+ > all other groups
   70s > 40s
   60s > 40s

Post-Clock Face Latency
80s+ > all other groups

Pre-1st Hand Latency
80s+ > all other groups

Pre-2nd Hand Latency
80s+ > 70s, 60s, 50s, 40s

Surrogate Cognitive Biomarkers
Expanding FHS for AD Precision Medicine

Biomarkers

Analytics
- Deep Machine Learning
- Quantum Mathematics
- Bioinformatics

Novel Phenotypes
Richest Molecular/Phenotypic Data Resource for Alzheimer’s Disease Drug Discovery
What Next?
Cognitive Impairment

Cognitive Health
Sustaining brain health across life span
Current Situation

The Impact

Alzheimer’s Disease Onset is Insidious
Pre-symptomatic Monitoring
Brain Health Monitoring Platform

Clinic  Mobile  Home
Traditional Data Collection: Clinic
Maximize Digital Capture of Health Metrics
Active Engagement Technology
Remote Monitoring
Testing & Validating
Brain Health Monitoring Platform

Ryan Center for Sports Medicine and Rehabilitation

Clinic Mobile Home

CONCUSSION Legacy Foundation

BOSTON UNIVERSITY Alzheimer's Disease Center

NIH National Institute on Aging Alzheimer's Disease Research Centers
Digital Biomarkers
An Innovative Path
FDA Digital Health Innovation Action Plan

Promote the development and use of digital health technologies

Digital health technologies may act as susceptibility/risk biomarkers

Source: [https://www.fda.gov/MedicalDevices/DigitalHealth/default.htm](https://www.fda.gov/MedicalDevices/DigitalHealth/default.htm)
Digital Biomarkers
What We Are Doing
Build Plug and Play System
Test Platform Robustness
Diverse Study Sites
Leverage NIH Investments
Deploy in Diverse Cohorts

NIH
National Institute on Aging

NIH
National Institute of Neurological Disorders and Stroke

NIH
National Heart, Lung, and Blood Institute

NIH
NATIONAL CANCER INSTITUTE
Boston University Slone Epidemiology Center
Black Women’s Health Study

NIH
National Institute of Mental Health
What We Will Build
Open Science Data Sharing Platform
How We Will Discover Digital Biomarkers
Open Science Data Challenge
How We Will Accelerate Digital Biomarker Discovery
Who We Are Doing it With

More in Pipeline

Biogen
Cohen Veterans Bioscience
Pfizer
NeuroLex
Sonde
Sage

MGH/HST Athinoulia A. Martinos Center for Biomedical Imaging
Massachusetts Institute of Technology
Tufts University
University of Pennsylvania
University of Florida

Duke Institute for Brain Sciences
Arizona State University

Koges

Always Seeking More
Where Next?
Ambient Technology
Sustainable Remote Monitoring
What We Need to Do
Precision Brain Health
Infer Cognition

- Sleep
- Physical Activity
- Medication
- Social Activity
- Eating Behavior
Achieve Representativeness
Global Citizen

- Innovative Research
- Support Lower-Middle Income Countries
- Care Support
- National Dementia Plans

Global Action Plan
New Healthcare Solutions

Earlier Treatments & Therapies

Enhanced Telehealth Clinical Interventions
Novel Market Opportunities

Automated “High Touch” Solutions

Digital Biomarkers
Impact of Success
Think Different, Be Different
...and Never Give Up

When a fast shot forces 15-year-old Chris Chen to the floor, it seems like the point is over.
Thank you.