

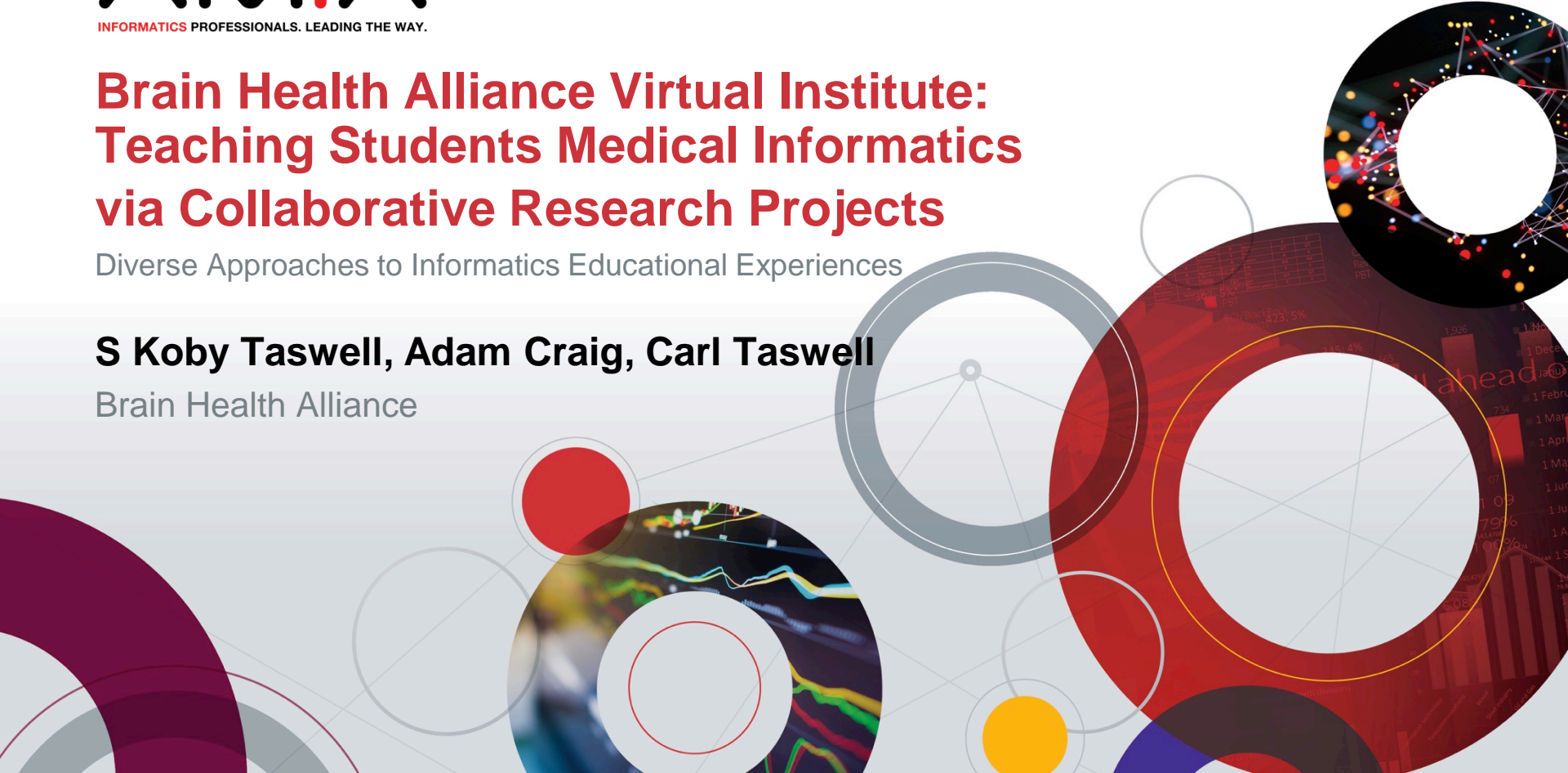


Brain Health Alliance Virtual Institute: Teaching Students Medical Informatics via Collaborative Research Projects

Diverse Approaches to Informatics Educational Experiences

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Brain Health Alliance



Disclosure

- We have no financial relationships to disclose!

Overview

- History of Brain Health Alliance
- Brain Health Alliance Virtual Institute:
 - General Guiding Principles
 - Program Structure
 - Project Areas
- Looking back on 5 Years of BHAVI
- Lessons Learned and Changes to the Program

Brain Health Alliance

- Brain Health Alliance (BHA) is a not-for-profit 501(c)(3) tax exempt organization focused on helping build bridges to better brain health.
- BHA operates the BHA Virtual Institute (BHAVI) to mentor high school, college and graduate level students interested in Science, Technology, Engineering, Math and Medicine (STEMM)
- Projects focus on problems related to brain health and diseases especially dementias and neurodegenerative disorders

BHAVI – Aims and Principles

- To build an educational research program which:
 - Is a virtual institute and operated online
 - Only requires: computer with webcam, internet access, time and effort
 - Mentors students on STEMM projects regardless of project complexity or student age
 - Works towards the BHA mission by training students regardless of field of interest (engineering, medicine, computer science, psychology, etc.)
- Our Philosophy
 - If a student sets a scholarly research goal, they can attain it with appropriate effort
 - Issues in brain health can only be solved from interdisciplinary perspectives

BHAVI – Program Structure

- Two kinds of students: new “rookies” and returning “veterans”
- BHAVI runs year round and is divided into quarters for new students:
 1. Application (Fall) – main quarter for submitting applications to join the program
 2. Evaluation (Winter) – 20-40 min writing and literature search exercises
 3. Computation (Spring) – engineering and software exercises with research project proposal
 4. Publication (Summer) – main quarter for completing research and writing a report
- Students considered for rolling admission as funded or volunteer students.
- Current stipends for full-time work in summer quarter: \$1000 for high school, \$3000 for undergraduate, and \$5000 for graduate students
- Continuing students are evaluated quarterly for advancement to next quarter

BHAVI – Program Structure

- Students sign a formal student agreement and code of conduct including:
 - Expectation to work together appropriately regardless of age, schooling level, experience, gender, ethnicity, religion, or sexual orientation
 - Students designate a contact at their degree-granting institution to serve as a local mentor and contact
- Students who complete a year of BHAVI and remain in good standing are eligible for end of year prizes valued at \$2500 each for best:
 - contribution to the mission of Brain Health Alliance – Mann Prize
 - report that extends an abstract submitted for professional publication – Siegler Sisters Prize
 - report on working software accompanied by readable source code – Golub Prize
 - report on creative solutions to problems with imagination and ingenuity – Keller Prize

BHAVI – Student Activities

- Students participate in BHAVI all year round
 - Full time during summer break (40 hours per week)
 - Part time during regular school year (hours expected is age-dependent)
- Students divide their time between three activities:
 1. Primary Research Activity ~ 50-60% of time spent
 2. Secondary Research Activity ~20-30% of time spent
 3. Software Education Activity ~10-20% of time spent
- Students are expected to attend all videoconference meetings: BHAVI program, team project meetings, and advisor presentations

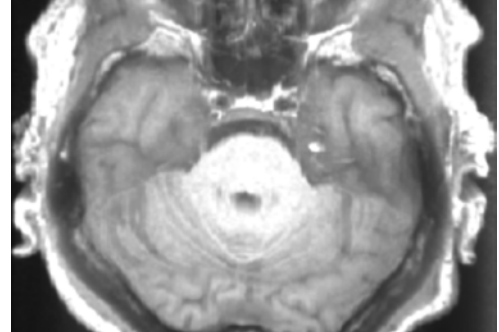
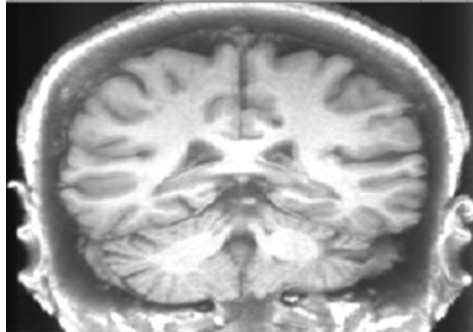
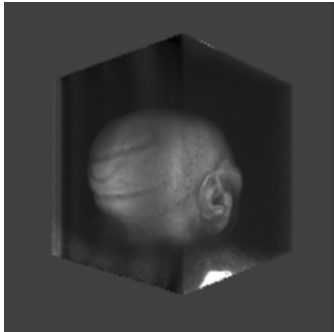
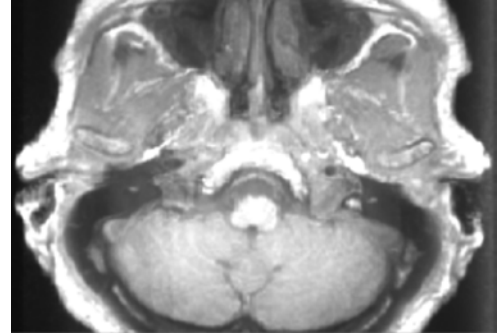
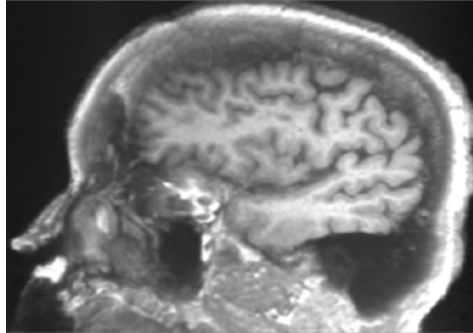
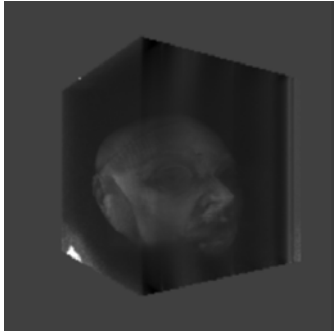
BHAVI – Student Goals

- Know and learn “4 R’s”
 - Reading, wRiting, aRithmetic, and algoRithm
- Become a “Jack of all trades” as a good pursuit
 - Learn to understand a problem broadly from numerous perspectives of: informatician, statistician, mathematician, engineer, scientist, medical provider, etc.
 - Learn to work on a solution from numerous perspectives of software engineering: numeric computing, symbolic computing, and a hybrid of numeric and symbolic
- Develop “real software that really works”
- **Learn to conduct research and write reports for presentation and publication at professional conferences and journals**
- Be a “brainiac”

BrainWatch Project (Numeric Computing)

- Humans understand a 3D world with stereoscopic vision yet scan data is often viewed slice by slice on a 2D screen
- Scan modalities are often viewed by themselves
 - PET scans is great for physiological function, not anatomical structure
 - MR is great for anatomical structure, not physiological function
 - Some MR special techniques may assess function
- To improve understanding and readability of medical imaging:
 - Image processing of PET and MR brain scans to generate fused co-registered volume
 - Volume rendering of a brain scan volume in a 3D virtual/augmented reality headset

BrainWatch Project



S. K. Taswell et al, *BrainWatch software for interactive exploration of brain scans in 3D virtual reality systems*, *IEEE EMBS 2017* doi: 10.1109/EMBC.2017.8037662

PORTAL-DOORS Project

View SOLOMON Resource Metadata Records on Nexus Server

Handle	PORTAL	DOORS	Type	Tag	Name	Nature
▶ R27A21AB3	Valid	Valid	Publication	FFDGPETIDPFOD	18F-FDG PET Improves Diagnosis in Patients with Focal-Onset Dementias	A study to determine the accuracy of FDG-PET imaging for the detection of primary progressive aphasia or corticobasal syndrome.
▶ MBD6F9E6B	Valid	Valid	Publication	UADNIA	2014 Update of the Alzheimer's Disease Neuroimaging Initiative: A review of papers published since its inception.	A review of papers published since the inception of the Alzheimer's Disease Neuroimaging Initiative (ADNI), a study designed to develop biomarkers for the early detection and tracking of Alzheimer's disease (AD).
▶ G155E74F9	Invalid	Valid	DataRecord	ADNI	ADNI Dataset	The Alzheimer's Disease Neuroimaging Initiative (ADNI)(http://adni.loni.usc.edu/)
▶ R278D0124	Pending	Pending	OnlineVirtualEntity	AHBA	Allen Human Brain Atlas	A unique multimodal atlas of the human brain, integrating anatomic and genomic information.
▶ B7450B3B8	Valid	Invalid	Organization	AAADD	Alzheimer's Association: Alzheimer's Disease and Dementia	http://www.alz.org/
▶ I658AC807	Invalid	Invalid	Organization	ADRC	Alzheimer's Disease Research Centers	The National Institute on Aging funds Alzheimer's Disease Centers (ADCs) at major medical institutions across the United States (https://www.nia.nih.gov/alzheimers/alzheimers-disease-research-centers)
▶ Y864893FB	Invalid	Valid	Publication	ADUM	Alzheimer's Disease: Unraveling the Mystery	All about Alzheimer's disease, By NIH
▶ X3500499B	Pending	Pending	ChemicalSubstance	AB	Amyloid Beta protein	Amyloid beta (A β or Abeta) denotes peptides of 36–43 amino acids that are crucially involved in Alzheimer's disease as the main component of the amyloid plaques found in the brains of Alzheimer patients.
▶ E0B311C14	Pending	Pending	Publication	AA	Audiometric evaluation in patients with Alzheimer's disease	
▶ XECCFF93D	Pending	Pending	VideoItem	BCDLB	Behavioral Challenges in Dementia with Lewy Bodies pt 1	A video about the behavioral component of Dementia with Lewy Bodies

◀ ◁ 1 ▷ ▶ 10 items per page ↻

M Skarzynski et al, *SOLOMON: An Ontology for Sensory-Onset, Language-Onset and Motor-Onset Dementias*, *IEEE BIBM 2015* doi: 10.1109/bibm.2015.7359814

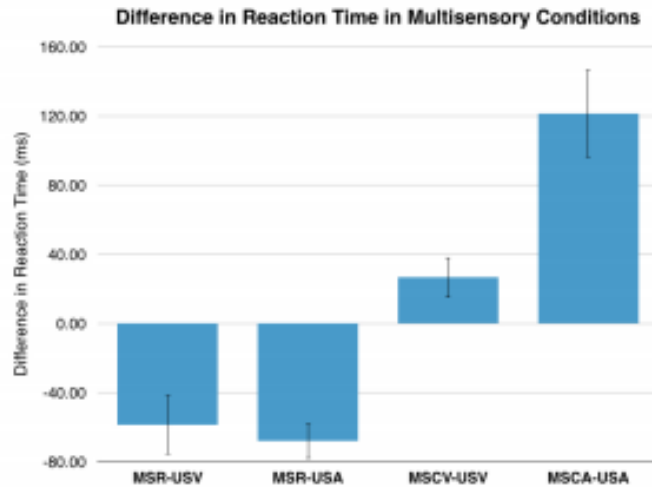
CTGaming Project (Hybrid Computing)

- Parkinson's Disease patients face a number of challenges in daily life
 - Neuromuscular difficulty – tremors, difficulty walking, and more
 - Sensory processing deficits – difficulty with understanding sensory stimuli [1]
 - Physical Therapy helps maintain mobility with exercise
 - Studies have looked at use of game systems for therapy, such as “Wii-hab” [2]
- To help patients with this issue:
 - Web accessible dynamic difficulty video game for health
 - Disease status tracking and therapy for multi-sensory stimuli processing
 - Initial testing looks at the differences of multi-sensory stimuli processing in healthy beta testers comparing multi-sensory reinforcement and conflict

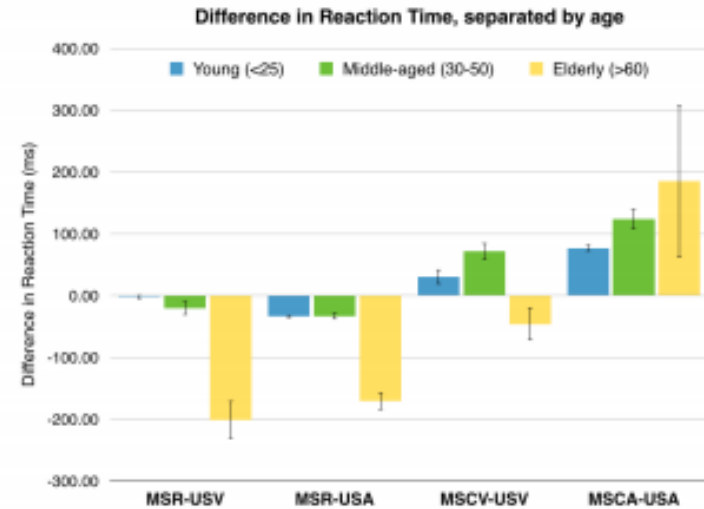
1) Keijsers et al 2005 Eur J Neurosci; 21(1):239 DOI: 10.1111/j.1460-9568.2004.03840.x

2) Herz et al 2013 PRD Journal; 19(11):1039 DOI: 10.1016/j.parkreldis.2013.07.014

CTGaming Project



(a) Pooled age groups: When compared to unisensory condition reaction times, multisensory reinforcement decreased reaction times, while multisensory conflict increased reaction times.



(b) Separated age groups: Multisensory reinforcement conditions decreased reaction times by larger amounts in elderly subjects than in young and middle-aged subjects.

Fig. 3: Comparison of reaction time in unisensory and multisensory conditions.

Looking Back on 5 Years

- As of December 2018
 - Mentored 45 students
 - Produced 14 student written papers, presented by students at professional engineering and medical conferences
 - 1 Regeneron Science Talent Search top 40 winner!
- Since Jan 2019:
 - 11 new students have joined in the year of 2019, 1 not continuing into the summer
 - 13 students participating in the summer quarter of BHAVI (3 continuing “veterans”, 10 new “rookies”)
 - 4 papers/abstracts accepted for presentations, 1 more submitted awaiting response

Lessons Learned and Program Changes

- Initially in BHAVI 2014 the program only operated in the summer
 - Some students had difficulty completing research and reports during the summer
 - Despite this challenge, some students successfully completed projects that were later presented and published
 - Extended the program to summer and fall quarters, but then concluded that a continuous year-round program was necessary to support progress of the students on their projects
- BHAVI 2017 introduced the quarter system, providing students with a clear plan and timeline throughout the entire year

Lessons Learned and Program Changes

- Operating as a Virtual Institute remains a challenge
 - Students are not required to attend and work in a lab in person
 - Hours are flexible and productivity monitoring is needed
 - Communication and productivity can be a challenge, often noticed similarly in other online coursework
- To help keep students on track:
 - Shorten meeting length but increase frequency of meetings, ideally daily
 - Students update each other and discuss progress at each meeting

BHA Web Site

- All of our papers and posters are available for download at:
<https://www.brainhealthalliance.org/BhaStemm/Papers>
- Program description at:
<https://www.brainhealthalliance.org/BhaviProgram/Programs2019>
- Feel free to contact me with questions at:
ktaswell@brainhealthalliance.org

Thank you!

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