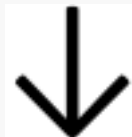




alpha



romeo



delta

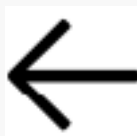


echo

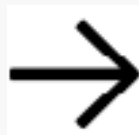
Gesture Dynamics: Features Sensitive to Task Difficulty and Correlated with Physiological Sensors



oscar



bravo



hotel



zulu



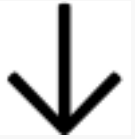
mike

Lisa Anthony, PhD
Patrick Carrington
Peng Chu

Christopher Kidd
Jianwei Lai
Andrew Sears, PhD



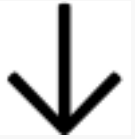
Take-aways



1. Inducing stress via task difficulty can affect some multimodal measures for fixed-attention tasks:
 - **Gesture duration and length.**
 - **Pulse rate.**
2. Other multimodal measures are not affected by task difficulty for fixed-attention tasks:
 - **Gesture size and pen pressure.**
 - **Skin temperature and respiration rates.**
3. Results from this study can be used to **detect onset of stress** in fixed-attention tasks.



Topics



1. Experiment and Task Design
2. Data Analysis and Results
 - Task Performance
 - Gesture Dynamics
 - Physiological Sensors
3. Recent Work: Machine Learning Classification of Stress
4. Future Work:
 - Cross-Modality Comparisons
 - Events of Interest

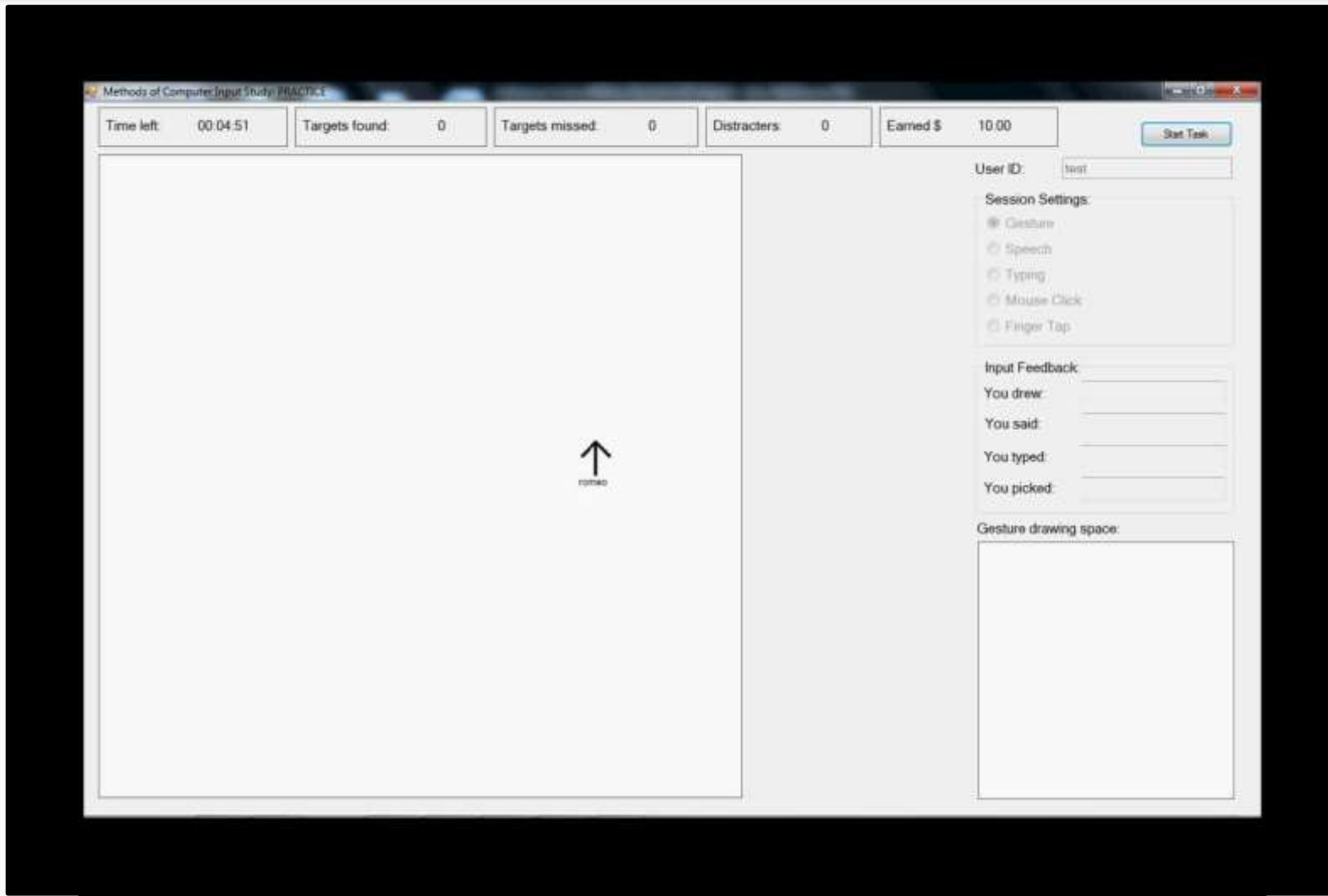
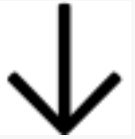




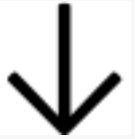
1. EXPERIMENT AND TASK DESIGN



Experiment Task: **Non-Stress**



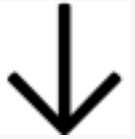
Experiment Task: Stress



The screenshot shows a software interface for a study. At the top, a status bar displays: "Time left: 00:02:30", "Targets found: 0", "Targets missed: 9", "Distracters: 0", and "Earned \$ 5.50". A "Start Task" button is on the right. The main area is split into two panels. The left panel is a large white rectangle containing five directional arrows: a left arrow at the top, a right arrow in the middle, a left arrow below it, an up arrow below that, and a down arrow at the bottom. Each arrow has the word "trace" written below it. The right panel contains a "User ID:" field with "1234" entered. Below it is a "Session Settings" section with radio buttons for "Gesture" (selected), "Speech", "Typing", "Mouse Click", and "Finger Tap". Underneath is an "Input Feedback" section with labels "You drew:", "You said:", "You typed:", and "You picked:", each followed by a horizontal input line. At the bottom of the right panel is a "Gesture drawing space" with a large empty white box.



Experiment Design



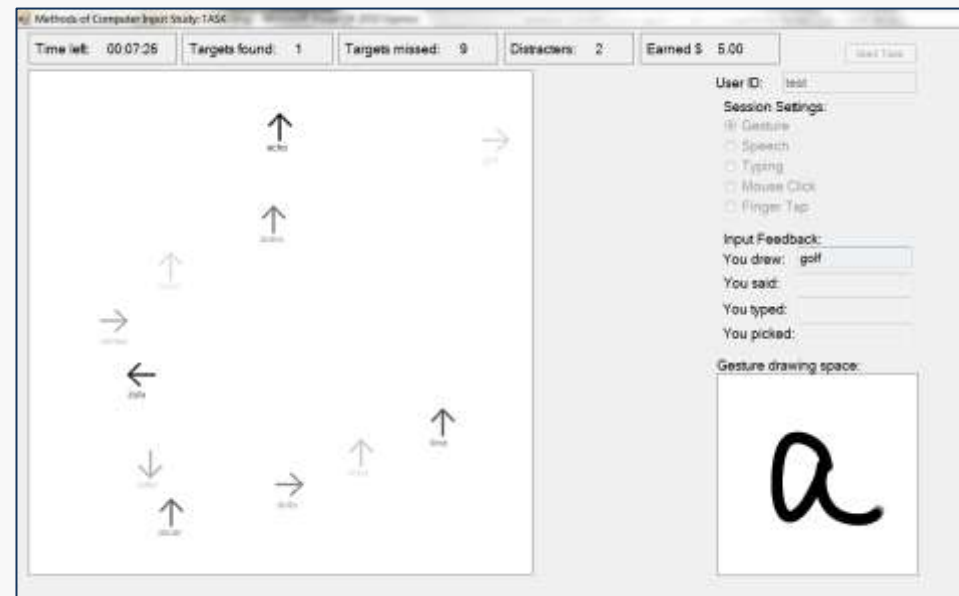
Two-factor mixed design:

- **Modality** of response (between-subjects)
- **Stress** / task difficulty (within-subjects)

5 modalities: gesture, speech, typing, mouse, finger tap

- This paper / talk focuses just on **gesture** modality.
- Responses entered by drawing first letter of identifier with digital stylus.
- Automatic recognition of input by Microsoft SDK.

Gesture Input



Gesture Input Example

Methods of Computer Input Study: PIACI

Time left: 00:04:04 Targets found: 0 Targets missed: 1 Distracters: 0 Earned \$ 9.50 [Start Task](#)

User ID: test

Session Settings:

- Gesture
- Speech
- Typing
- Mouse Click
- Finger Tap

Input Feedback:

You drew: _____

You said: _____

You typed: _____

You picked: _____

Gesture drawing space:

←
line

Normal Speed



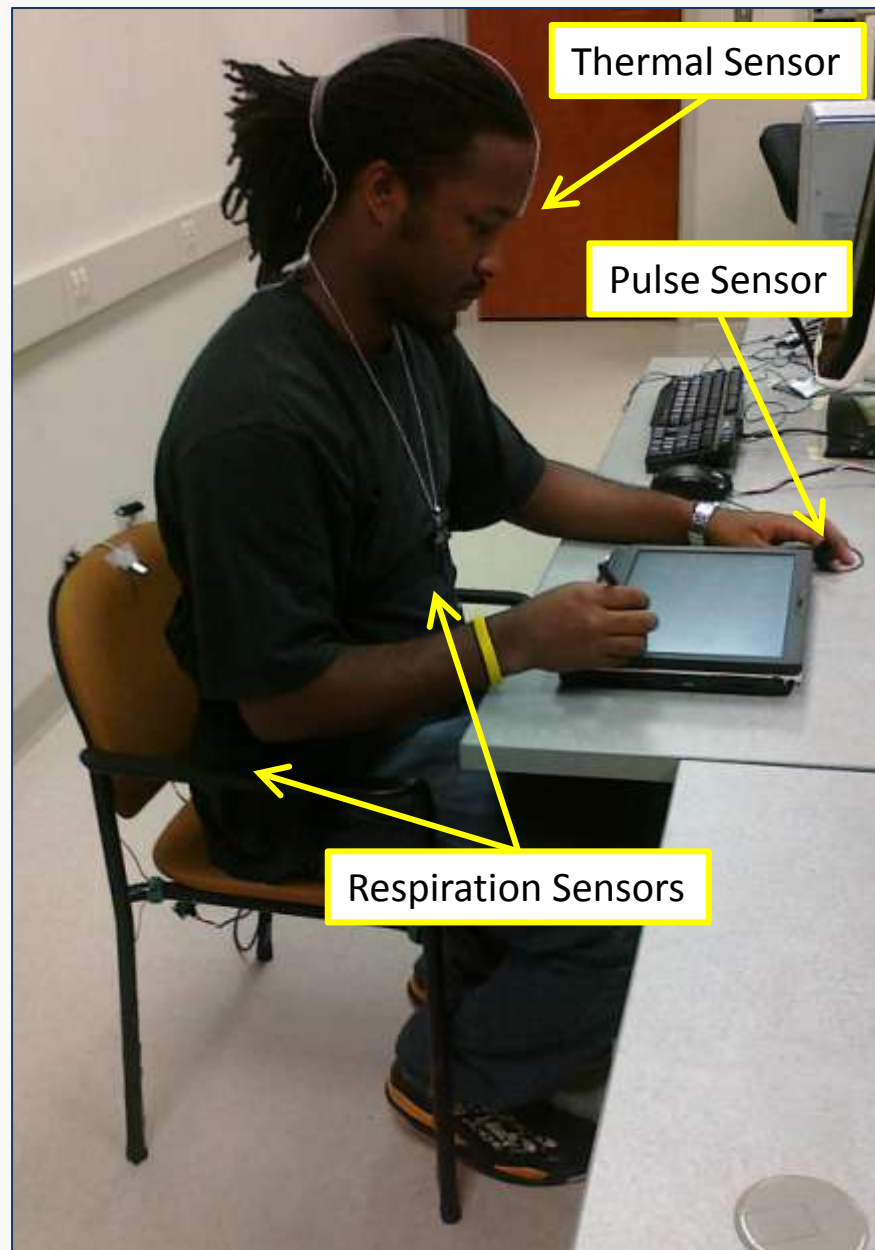
Sensors Used

Physiological:

- Skin temperature
- Pulse (finger)
- Respiration bands

Posture (chair):

- Distance
- Pressure



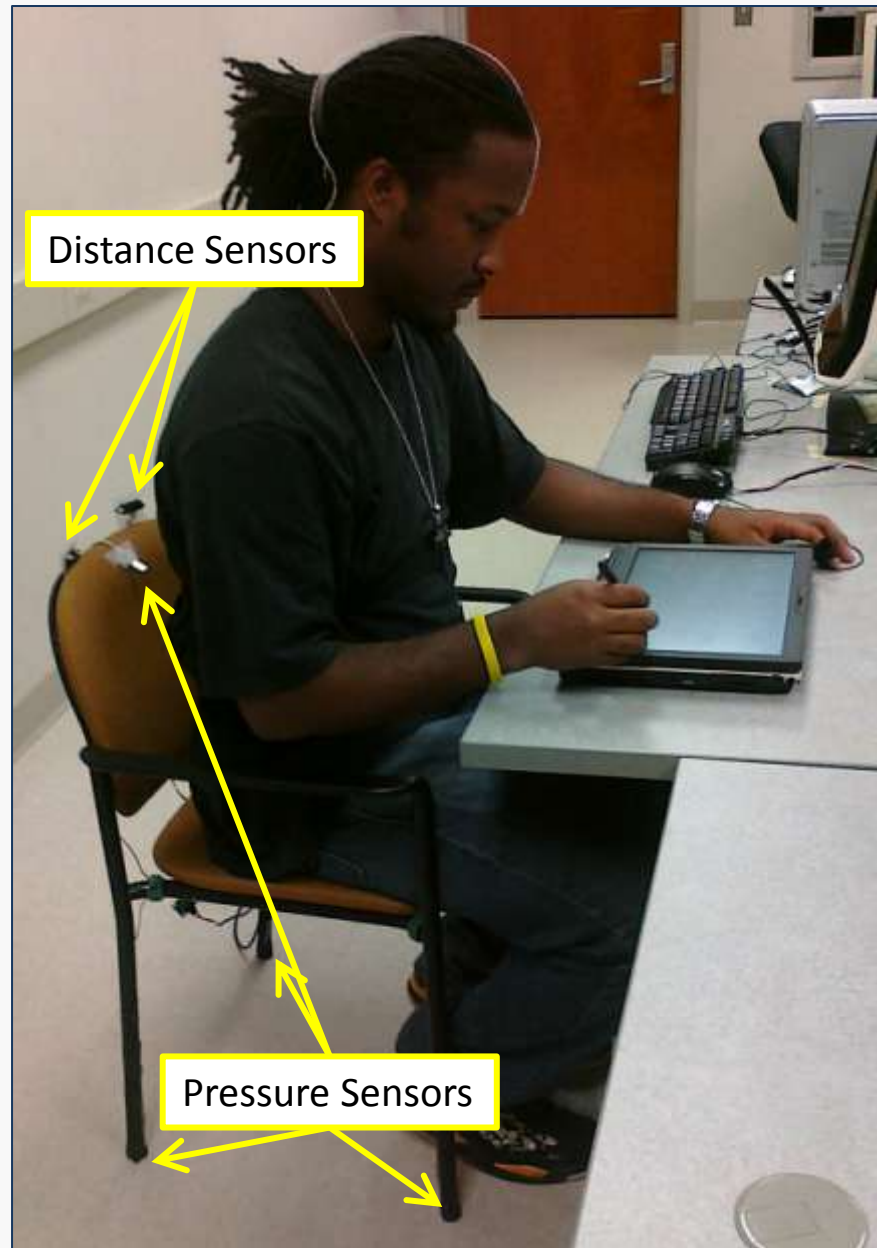
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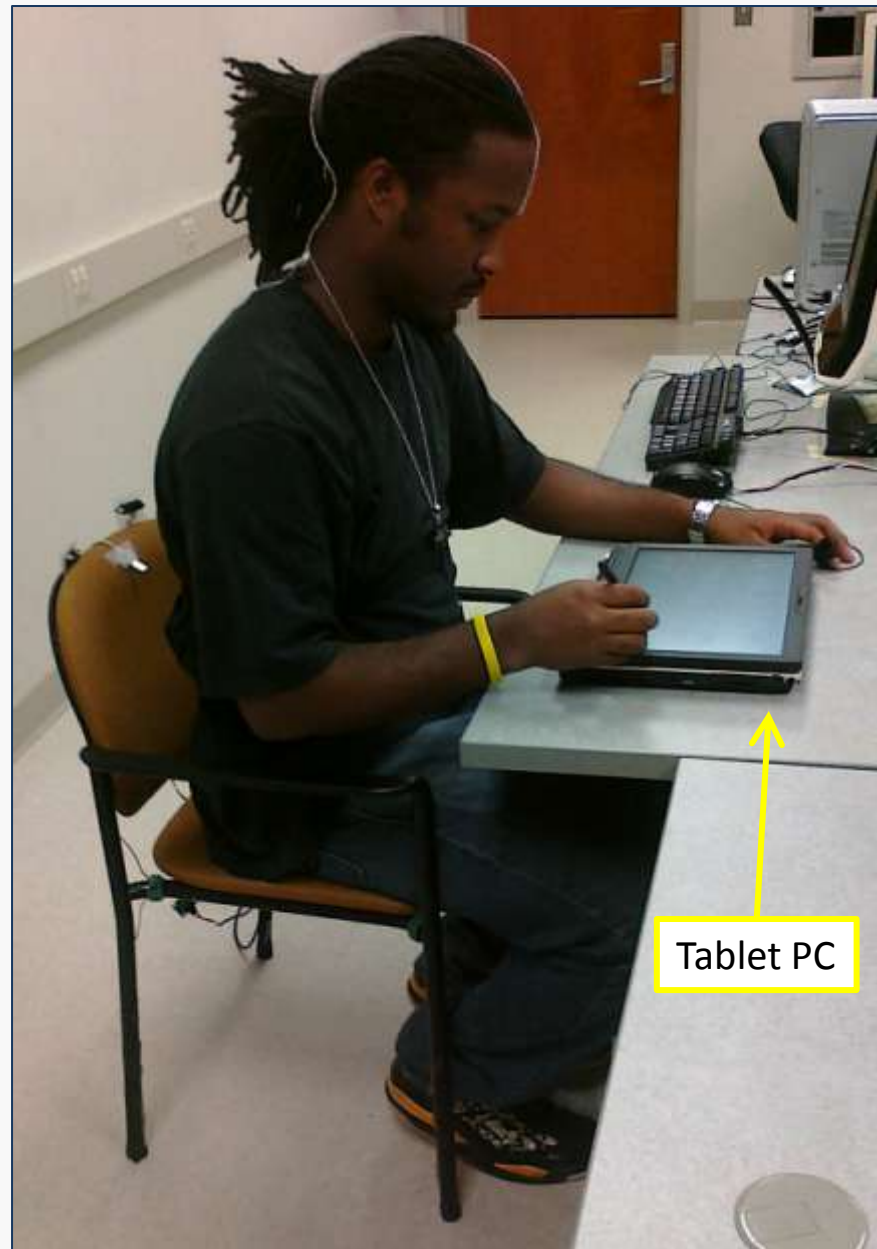
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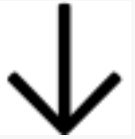
Tablet PC



2. DATA ANALYSIS



Data Analysis



12 total participants (7 male)

Categories of data:

[P = paper, T = talk, F = future work]

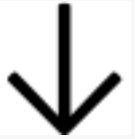
- **Task performance**—how well users did on the task **P**
during non-stress vs stress periods
- **Gesture dynamics**—properties of the gestures users **P, T**
made during non-stress vs stress periods
- **Physiological data**—sensor readings **P, T, F**
- **Posture data**—sensor readings **F**

Types of analysis:

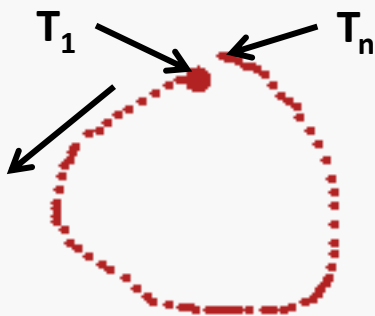
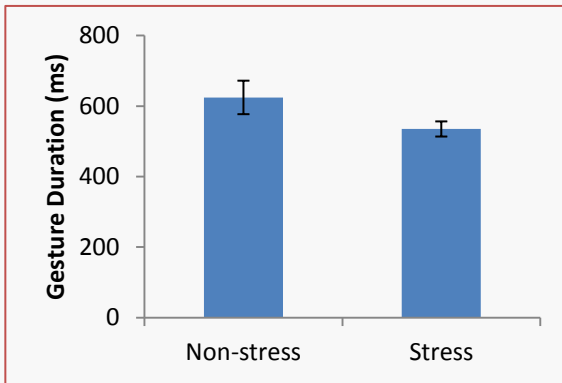
- Statistical contrasts **P, T, F**
- Machine learning classification **T, F**



“Good” Gesture Dynamics

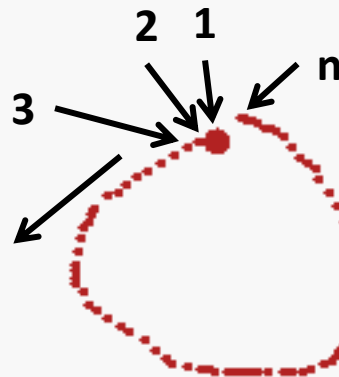
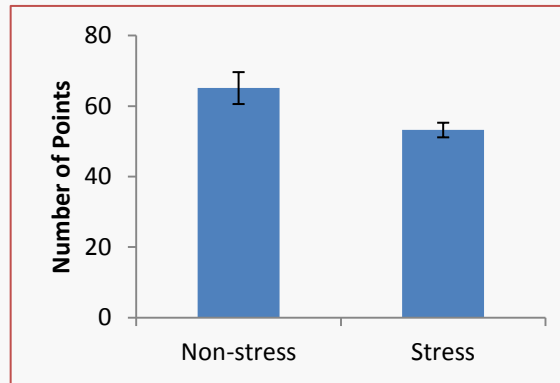


Gesture duration



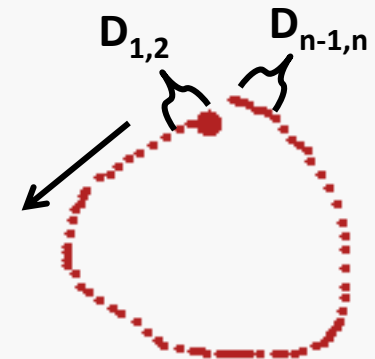
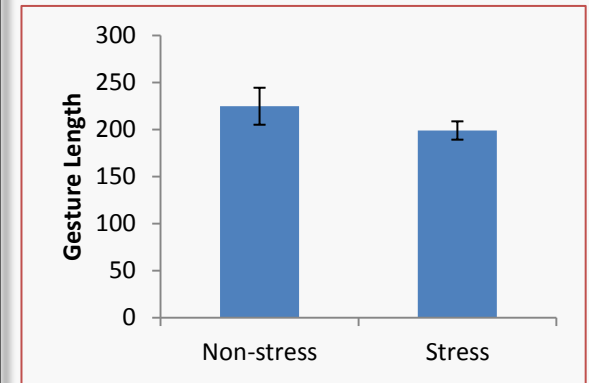
$T_n - T_1 = \text{total time} = \text{duration}$

Gesture # points



$n = \text{total number of points}$

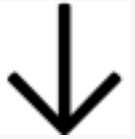
Gesture length



$\sum_{i=1}^n D_{i,i+1} = \text{total path distance} = \text{length}$



Inconclusive Gesture Dynamics



Marginal:

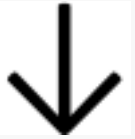
- Gesture speed

Not significant:

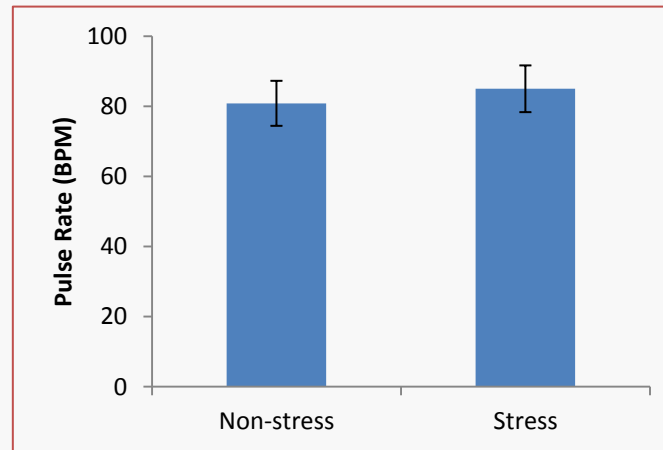
- Gesture height
- Gesture width
- Gesture area
- Gesture average pen pressure
- Gesture per-point pen pressure



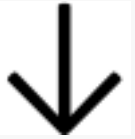
“Good” Physiological Sensors



Pulse rate (beats per minute)



Inconclusive Physio Sensors



Marginal:

- Skin temperature (°F)

Not significant:

- Respiration rate (breaths per minute, at chest and at waist)



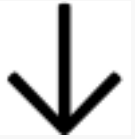
Machine Learning Classification of Stress



3. RECENT WORK



Machine Learning Classification



Building decision trees to classify readings into “non-stress” vs “stress” classes (Weka toolkit)

Data Type	Accuracy	kappa	Best Features
Gesture Dynamics	63.9%	0.28	Best features were number of points in the gesture and length. (Correct gestures only, balanced dataset.)
Physiological Sensors	98.9%	0.97	Best features were respiration rate chest and abdomen.
Posture Sensors	84.9%	0.64	Best features were the right-front chair leg and the mid-range distance sensor.

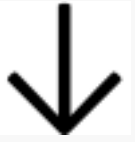
- Reasonable performance
- Need to improve for real-time detection
- Combinations of sensors and more fine-grained time windows





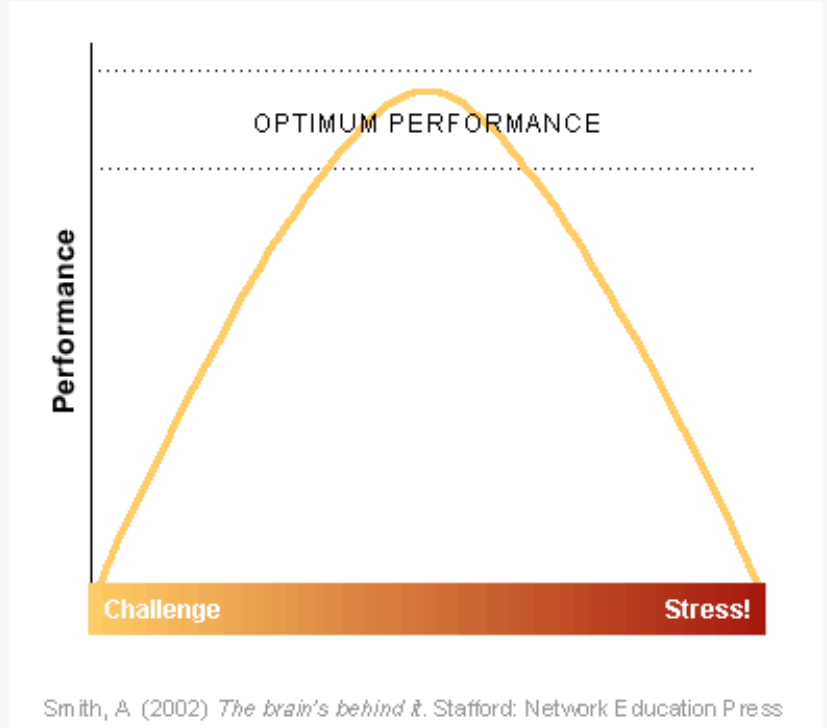
4. FUTURE WORK

Future Work



- Cross-modality comparisons
- Events of interest (e.g., responses to targets, stress onsets)
- New gesture features to compute
- Combine features from multiple sensors / sources
- Binning sensor readings to decrease noise
- Collaborations?

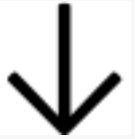
- Goal: to detect onset of cognitive stress and adapt interaction to support user needs



Smith, A. (2002) *The brain's behind it*. Stafford: Network Education Press



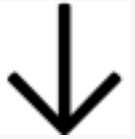
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Questions?



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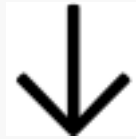
alpha



romeo

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echo



delta

Partial funding: Northrup Grumman

