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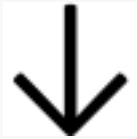
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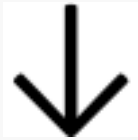
echo

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


oscar


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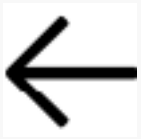
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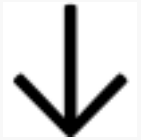
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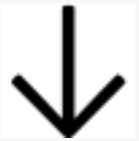
# Take-aways

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.

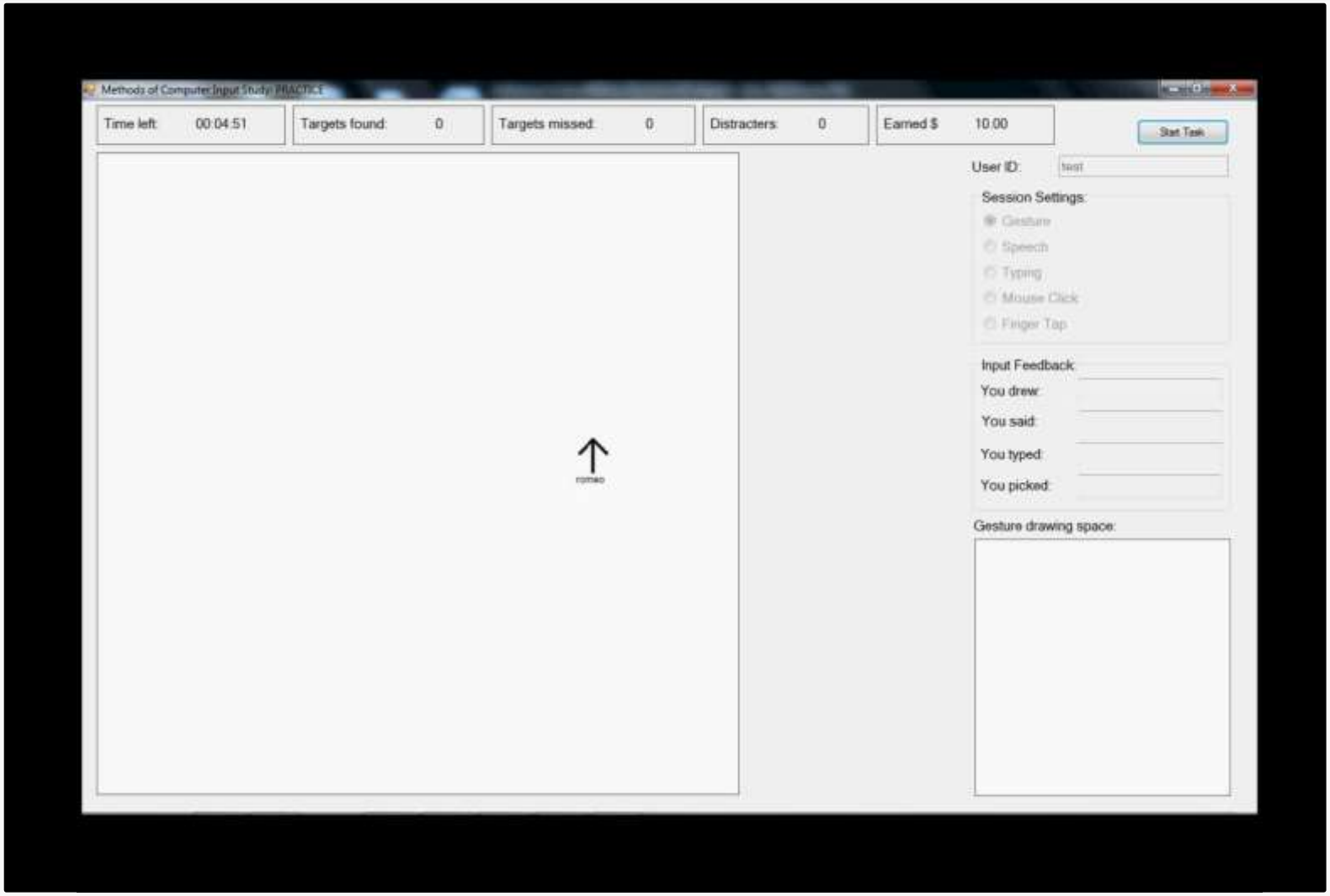
# Topics

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

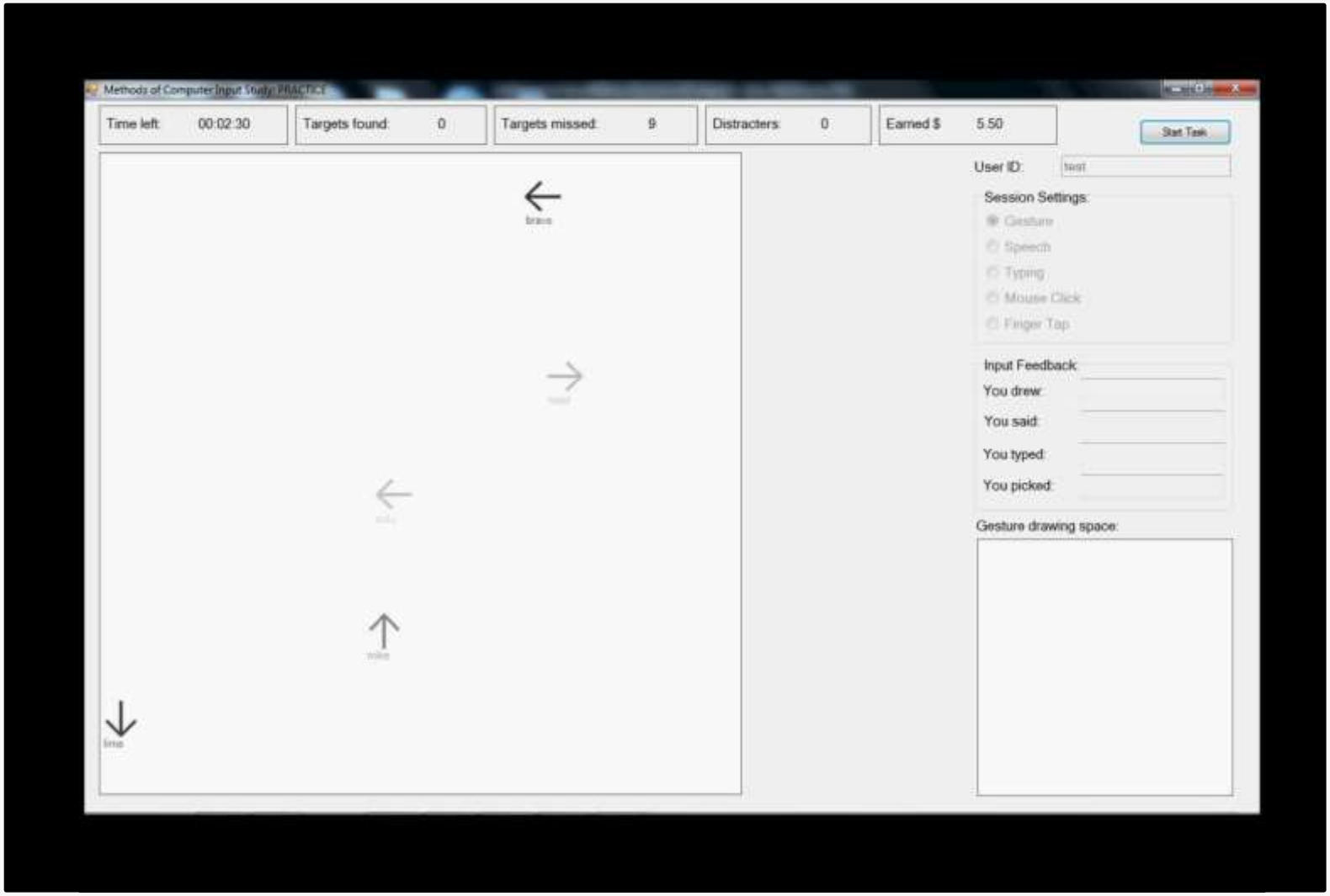


# 1. EXPERIMENT AND TASK DESIGN

# Experiment Task: Non-Stress



# Experiment Task: Stress



# Experiment Design

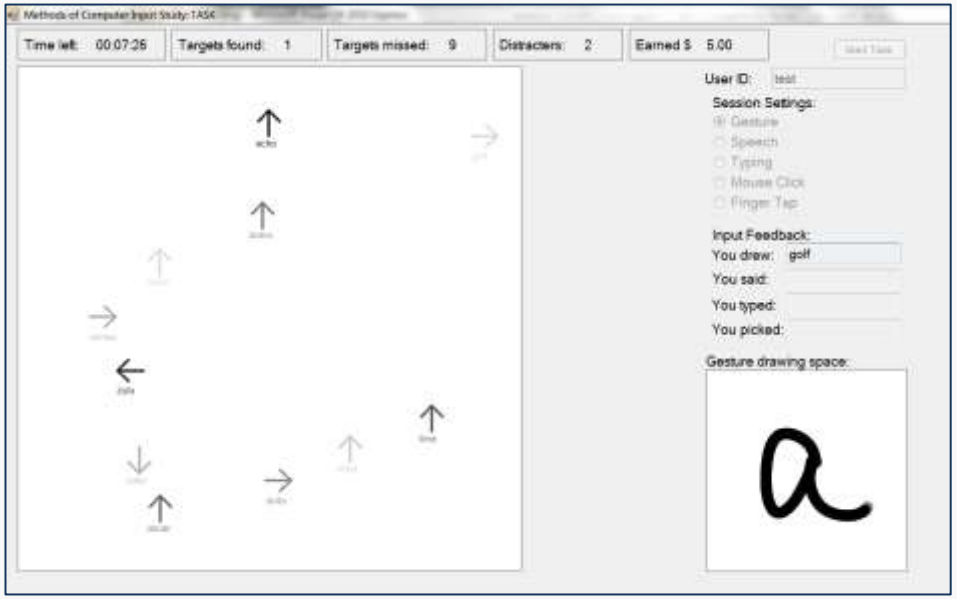
Two-factor mixed design:

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

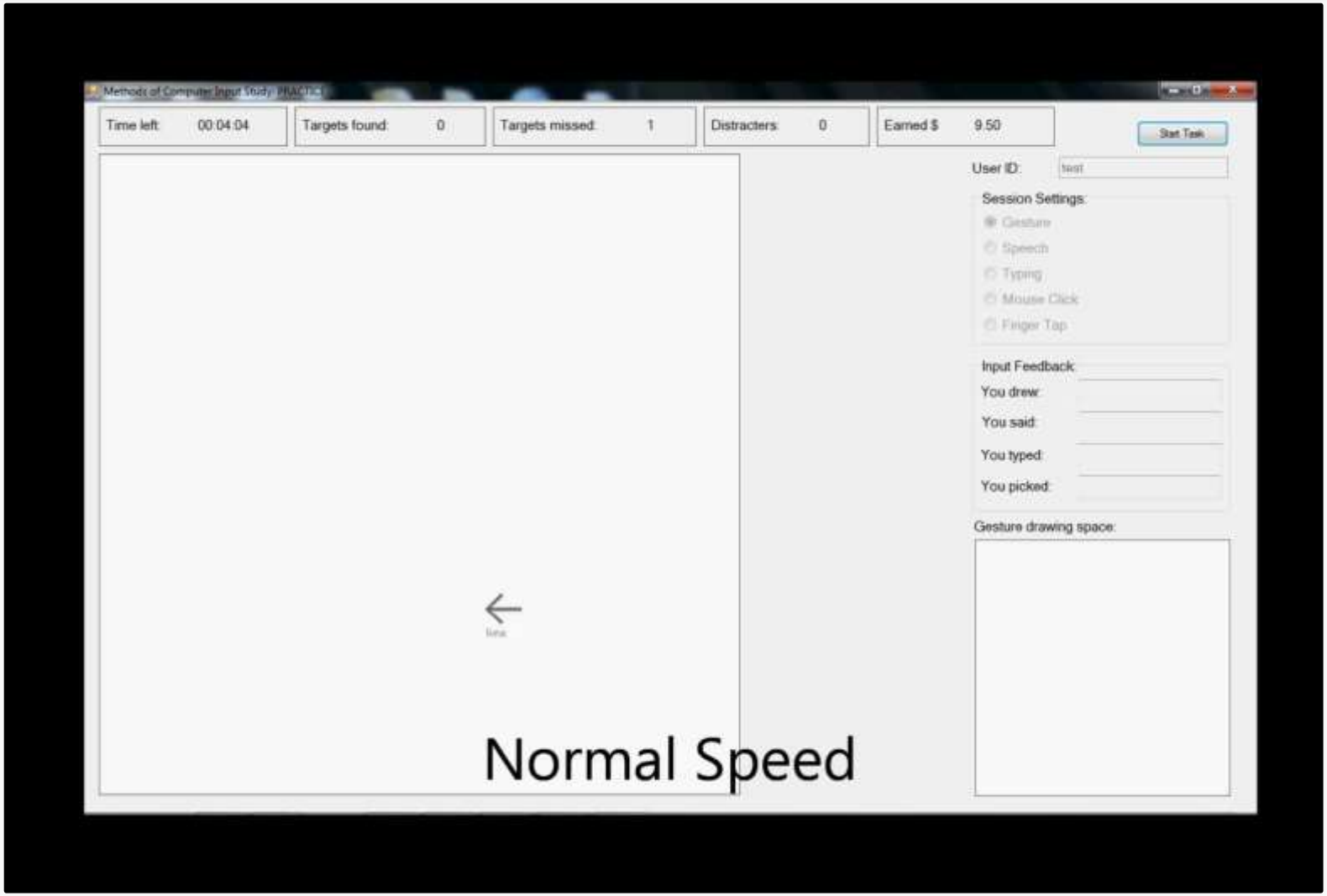
5 modalities: gesture, speech, typing, mouse, finger tap

- 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



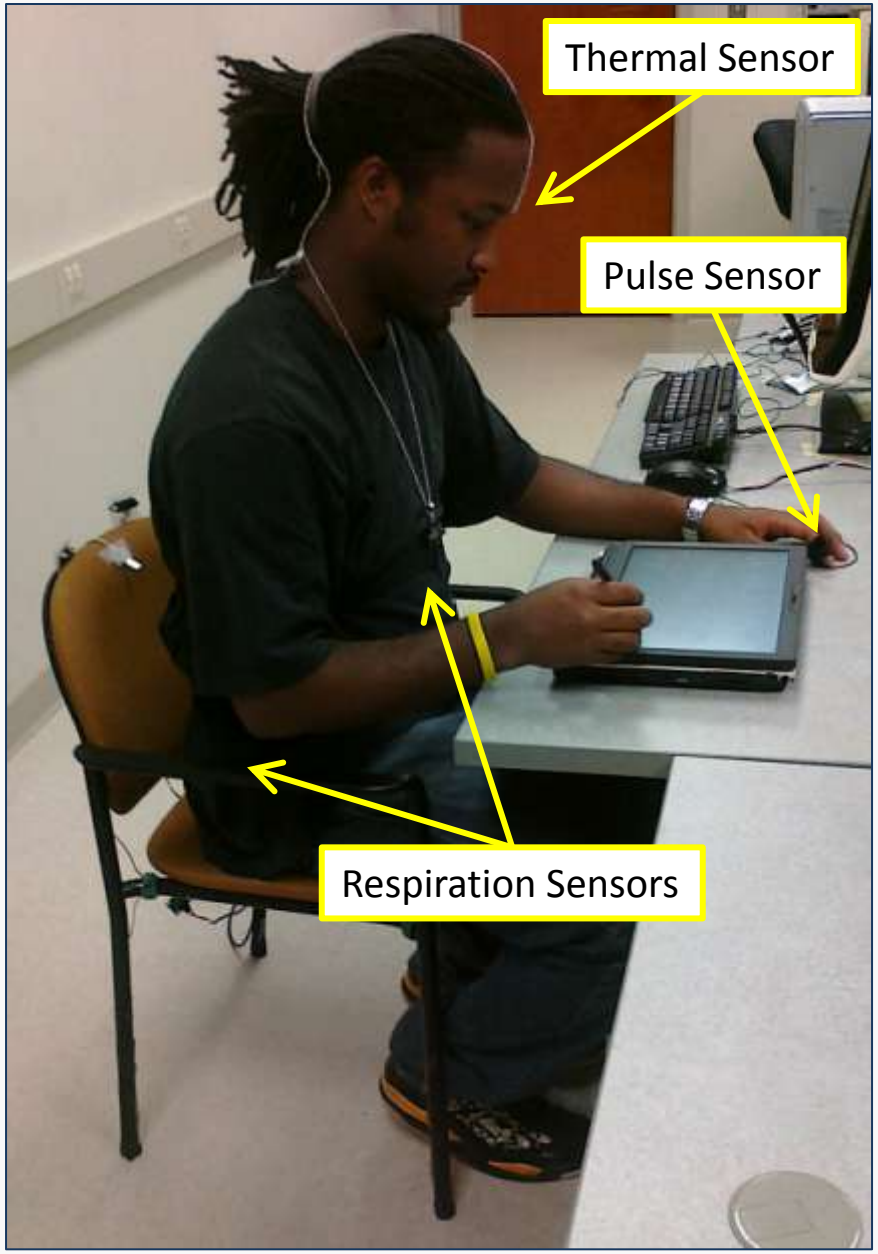
# Sensors Used

**Physiological**:

- Skin temperature
- Pulse (finger)
- Respiration bands

Posture (chair):

- Distance
- Pressure



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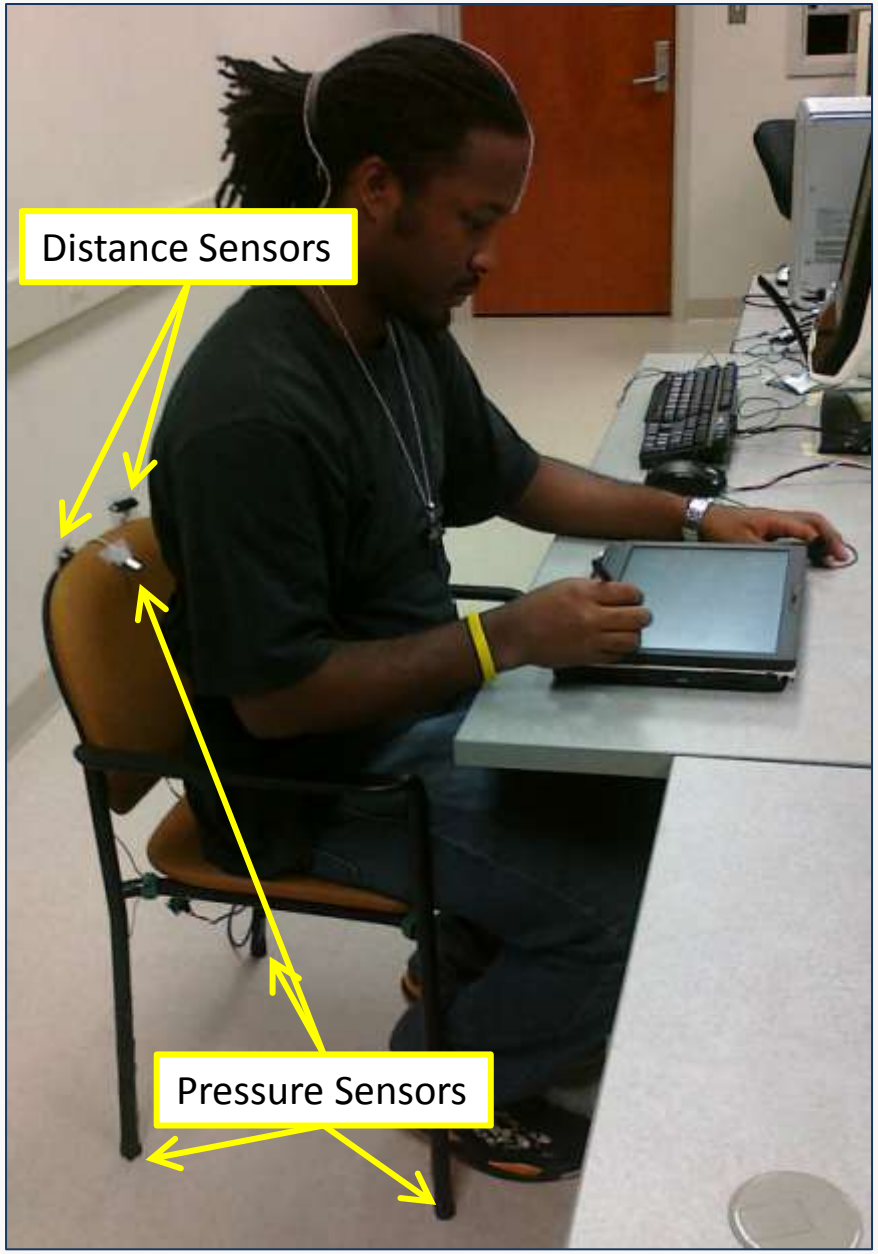

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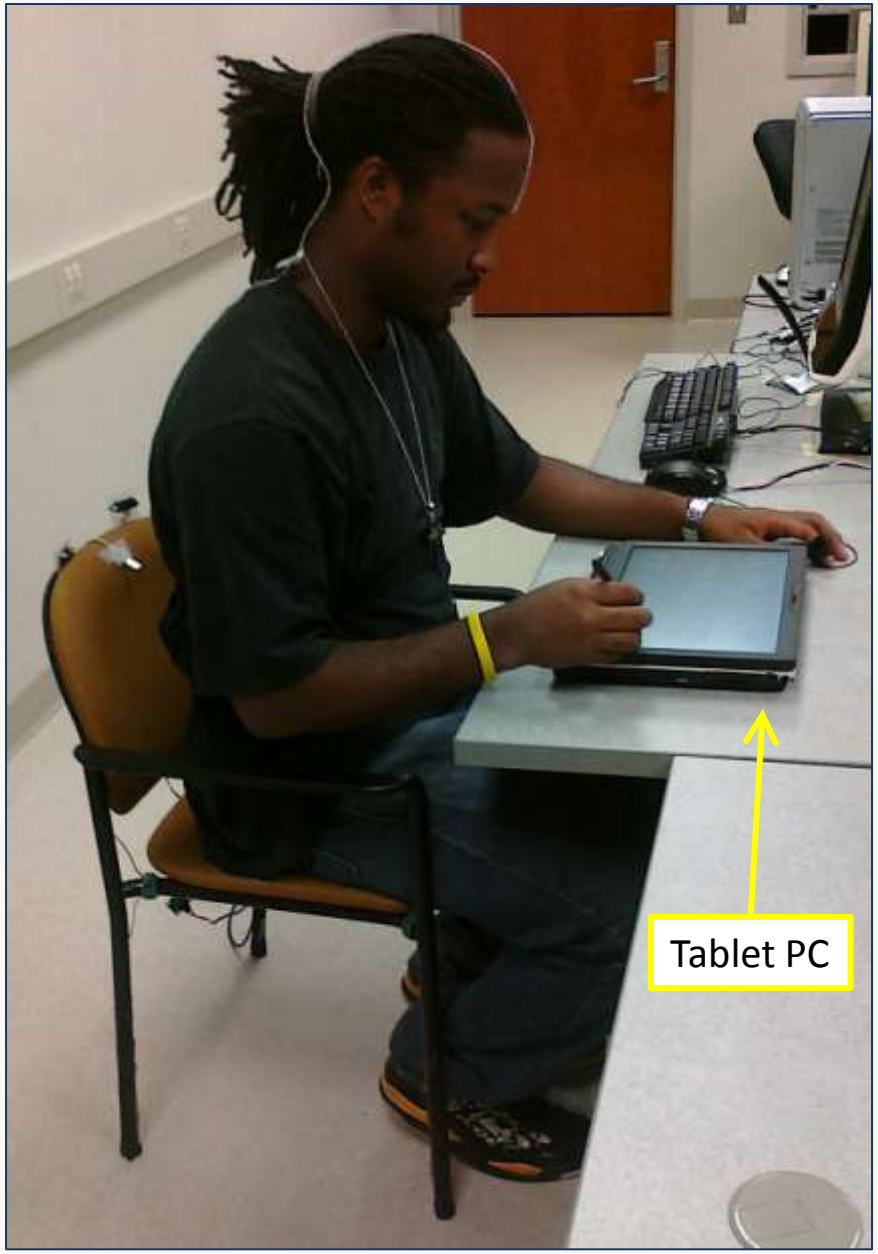
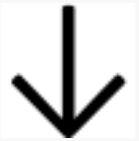




# 2. DATA ANALYSIS

# Data Analysis

12 total participants (7 male)

Categories of data:

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

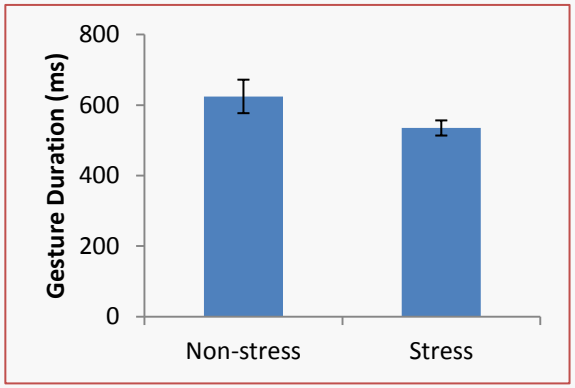
- **Task performance**—how well users did on the task during non-stress vs stress periods — **P**
- **Gesture dynamics**—properties of the gestures users made during non-stress vs stress periods — **P, T**
- **Physiological data**—sensor readings — **P, T, F**
- **Posture data**—sensor readings — **F**

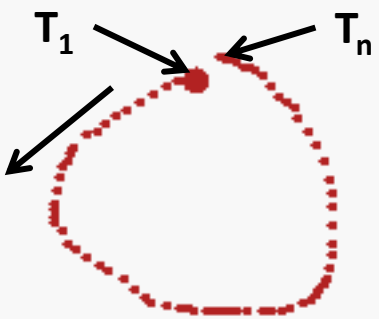
Types of analysis:

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

# “Good” Gesture Dynamics

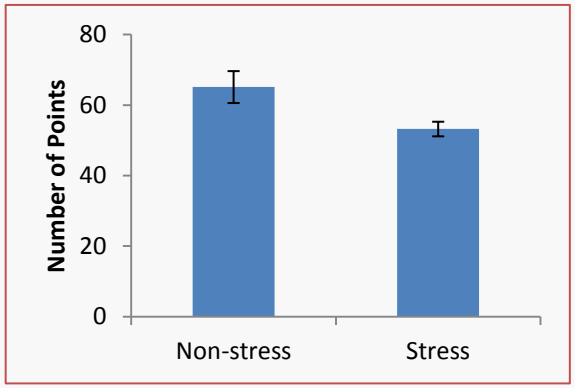
## Gesture duration

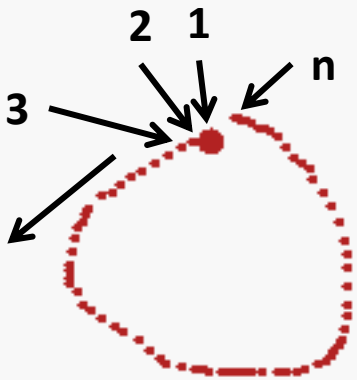



$T_n$-$T_1$ = total time = duration

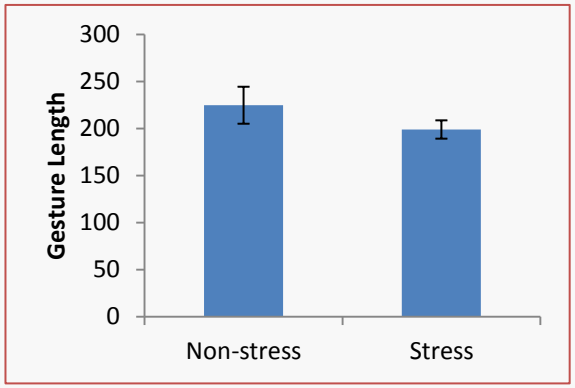
## Gesture # points

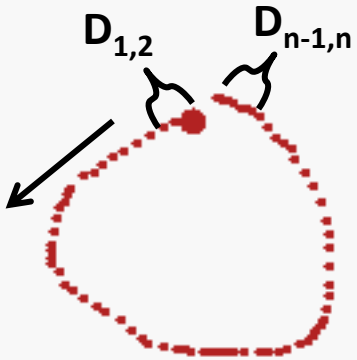



n = total number of points

## Gesture length




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

# Inconclusive Gesture Dynamics

Marginal:

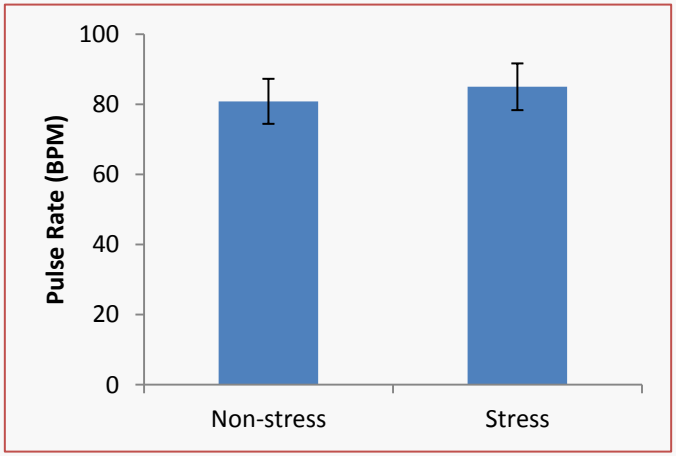
- Gesture speed

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

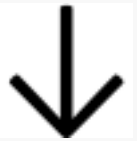
Marginal:

- Skin temperature (°F)

Not significant:

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

Machine Learning Classification of Stress



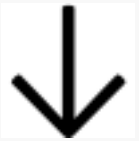
# 3. RECENT WORK

# 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)

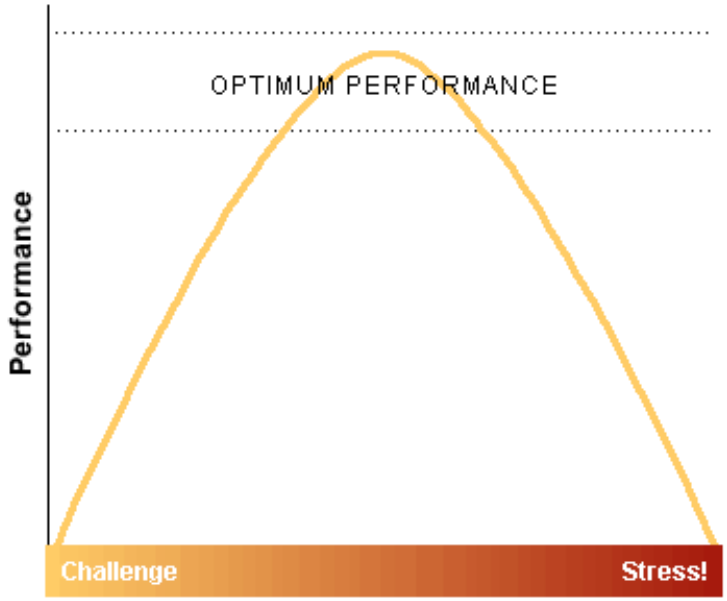
New gesture features to compute

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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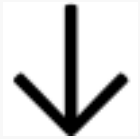

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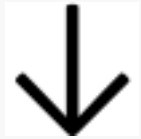

echo

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delta

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