Under **Pressure**

Sensing **Stress** of Computer Users

Javier Hernandez    javierhr@mit.edu
Pablo Paredes    pablo.paredes@berkeley.edu
Asta Roseway    astar@microsoft.com
Mary Czerwinski    marycz@microsoft.com
Depression  Anxiety  Fatigue
Insomnia  Headaches  Depression
Outline

• Stress Measurement
• Previous Work
• User Study
• Results
• Conclusions
Stress Measurement

**Hormones**
- Cortisol
- Adrenaline
- ...

**Self-reports**
- DSI
- PSS
- ...

**Physiology**
- EMG
- EDA
- ...

**Behaviors**
- Keyboard
- Mouse
- ...

- Intrusive
- Costly
- Slow

- Subjective
- Cognitive Attention
- Recall Problems

- Instrumentation
- Unfamiliar
- Caring

*(Zimmermann et al, 2003)*
Keyboard & Mouse

Pressure-sensitive Keyboard
(Dietz et al., 2009)

Capacitive Mouse
(Villar et al., 2009
Benko et al., 2010)
Keyboard & Mouse

Non-Pressure Dynamics
• Neutral/positive VS negative (Khanna et al, 2010)
  More typing mistakes and slower speeds
• 15 emotional states (Epp, 2011)
• Cognitive VS physical stress (Vizer et al, 2009)

Pressure Dynamics
• 6 emotions (Lv et al, 2008)

Non-Pressure Dynamics
• Increased speed and acceleration during high arousal (Maehr, 2008)
• Increased movement during stress (Rodriges et al, 2013)

Pressure Dynamics
• Increased pressure during stress (Wahlstrom et al 2012, Dennerlein et al, 2003)
Within-subject laboratory study

Three tasks:
- Expressive Writing
- Text Transcription
- Mouse Clicking

Two conditions

**Stressed VS Relaxed**
Physiological Stress

Affectiva Q™
Electrodermal Activity
(Galvanic Skin Response)

Self-reported Stress

How are you feeling right now?

Very unpleasant (negative)  ⬜  ⬜  ⬜  ⬜  ⬜  Very pleasant (positive)
Low energy (calm, low arousal)  ⬜  ⬜  ⬜  ⬜  ⬜  Very energetic (awake, high arousal)
Very stressed  ⬜  ⬜  ⬜  ⬜  ⬜  Not stressed at all

Submit
Task I: Text Transcription
• Transcribe short biographical text
• 3 minutes
• During the **stressed** condition:
  1. Type fast
  2. Internal competition
  3. Cursor blinks faster
  4. Random font style
  5. Timer
  6. Loud traffic noise  🎧
Task II: Expressive Writing

- Re-experience a relaxing or stressful memory and write about it
- Recommended time of 5 minutes
- Allowed to make spelling, grammar and sentence errors
Task III: Mouse Clicking

- After keyboard tasks
- Based on Fitts’ law task

90 times (3 dist. x 3 widths x 10 rep.)
**EW**: Expressive Writing  
**MC**: Mouse Clicking  
**TT**: Text Transcription

**Stressed** Condition  
**Relaxed** Condition

**24 participants**  
**Balanced gender**

**Study Design**  
**Stress Measurement**  
**Experimental Tasks**  
**Protocol**
Results
Did the tasks elicit the intended emotions?
Self-reports

Stress

Valence

Arousal

*The two distributions were significantly different (Wilcoxon Rank Sum test, p<0.05)
How is typing pressure affected by stress?
Transcription Task

22 out of 24 subjects (91.67%) show increased typing pressure under the stressed condition. The difference was computed from significantly different distributions (Wilcoxon Rank Sum test, p<0.05).
Expressive Writing

23 out of 24 subjects (95.83%) show increased typing pressure under the stressed condition. The difference was computed from significantly different distributions (Wilcoxon Rank Sum test, p<0.05)
How is mouse capacitance affected by stress?
Capacitive Mouse

13x15 Capacitive Pixels
Mouse Clicking

Start Task

End Task

Stressed condition
Relaxed condition

Mouse Task

Average

Time

Average

Relaxed
Stressed
18 out of 24 subjects (75%) show increased mouse contact under the stressed condition. The difference was computed from significantly different distributions (Wilcoxon Rank Sum test, p<0.05).
How much data is required to differentiate between the stressed and relaxed conditions at any point in time?
**Average**

# Participants with significantly more pressure/contact during the stressed condition

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**Text Transcription**

Expressive Memory

Mouse Clicking
Considerations

• Ill-defined ground truth
• Laboratory
• Many types of stress
• Direction of causality
• Individual differences
Conclusions

• Lab study to test effectiveness of pressure-sensitive keyboard and capacitive mouse to sense stress of computer users

• 3 tasks (expressive writing, text transcription, and mouse clicking) under 2 conditions (stressed and relaxed)

• Self-reports showed the effectiveness of tasks

• During the stressed condition:
  – >79% showed more forceful typing pressure
  – 75% showed greater amount of mouse contact

• Very small observation windows can be used to obtain similar results
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Microsoft Research

Javier Hernandez javierhr@mit.edu
Pablo Paredes pablo.paredes@berkeley.edu
Asta Roseway astar@microsoft.com
Mary Czerwinski marycz@microsoft.com