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Different Strokes for Different Folks
Individual Stress Response as Manifested in Typed Text

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Introduction
Given the relationship between cognitive processes needed to use technology and those impacted by cognitive stress, this research extends the prior literature by exploring keystroke and linguistic attributes of spontaneously typed text as a possible approach for monitoring cognitive changes.

Cognitive Stress
- High stress can lead to negative health consequences, and cause changes in cognitive function (Sparren et al., 2005).
- As stress or arousal increase, performance is enhanced to a certain threshold and declines thereafter, illustrated by an inverted U-shaped curve (Hei and Oechsler, 2000).
- Cognitive function is evaluated using neurophysiological measures, self-report questionnaires, and performance or behavioral measures (Laudenslager et al., 2006).
- Technology can be leveraged to solve the shortcomings of current assessment methods and help mitigate these negative health consequences.
- Insights from keystroke dynamics and linguistic analysis illustrate the possibility of leveraging everyday keyboard interactions for ubiquitous monitoring of cognitive function.

Keystroke and Text Analysis
- Keystroke dynamics studies show how a person types.
- Investigations of keystroke dynamics have included spontaneously generated, or free, text segments and more sophisticated classifiers (Vizer et al., 2005).
- Linguistic analyses of text examine what is typed.
- Salient features are extracted from the text and analyzed for purposes including deception detection (Henderson et al., 2003).

Methodology

Participants
20 young adults
Mean age = 24.4 (±3.9)

Features Extracted
Timing and Keystroke
- Input rate
- Adjusted input rate
- Pause rate
- Mean pause length
- Correction key rate
- Function key rate
- Other key rate

Linguistic
- Word count
- Long word rate
- Dictionary word rate
- Lexical diversity
- Cognitive operation rate
- Affect rate
- Sensory information rate
- Other reference rate
- Mean sentence length

Statistical Model
Binary Logistic Regression

Model Evaluation
Two-fold cross-validation (Table 1), McNemar's test (Table 3)

Results

Table 1: Selection of features associated with cognitive stress in individuals

<table>
<thead>
<tr>
<th>Feature</th>
<th>A2</th>
<th>D2</th>
<th>C2</th>
<th>B2</th>
<th>A1</th>
<th>D1</th>
<th>C1</th>
<th>B1</th>
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</thead>
<tbody>
<tr>
<td>Affect</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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<td>Complexity</td>
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<td>0.00</td>
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<td>0.00</td>
<td>1.00</td>
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<td>1.00</td>
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<tr>
<td>Diversity</td>
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<td>Language</td>
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<tr>
<td>Other rate</td>
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<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Sensation</td>
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<tr>
<td>Pressure</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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</tbody>
</table>

Table 2: Classification accuracies for different stress levels

<table>
<thead>
<tr>
<th>Stress Level</th>
<th>Accuracy (%)</th>
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</thead>
<tbody>
<tr>
<td>Low</td>
<td>85.0</td>
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<tr>
<td>Medium</td>
<td>78.7</td>
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<tr>
<td>High</td>
<td>69.6</td>
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</tbody>
</table>

Discussion

Changes in the models (Table 1) illustrate individual differences in the stress response. It also suggests that there may be a segment in the middle portion of the performance-annual curve where there is a mixed response to stress.

Future Work
- Longer-term study of individual responses to stress.
- Fine-tuning of the model building process to incorporate additional features and more sophisticated classifiers.
- Exploration of applications including home and workplace systems.
- Investigation of design of alert systems for stress mediation.
graduate second place

Juho Kim (MIT CASIL) "ToolScape: Enhancing the Learning Experience of How-to Videos"
Michael Crabb (U of Dundee)
"Human Cognitive Measurement as a Metric within Usability Studies"
undergraduate second place (A)
Joey Rafidi (MIT CSAIL)
"Real-time Trip Planning with the Crowd"
undergraduate second place (B)

Megan Torkildson (UW): "Visualizing Performance of Classification Algorithms with Additional Re-Annotated Data."
undergraduate first place

Bernd Huber (KAIST, Korea)
"Foot Pattern as Subconscious Expression at Public Displays"
student design competition
chairs

Thecla Schiphorst
Simon Fraser University
Vancouver, Canada

Carola Zwick
Studio 7.5
Berlin, Germany
jury

Steve Benford
United Kingdom

Elisa Giacardi
Delft University of Technology
The Netherlands

Lian Loke
University of Sydney
Sydney, Australia

Carman Neustaedter
Simon Fraser University
Canada
design problem

Empowering the Crowd

Changing Perspectives Through Collaboration
4th place

KAVA: The Virtual Experience of Urban Sharing

Nacim Fouad Amirouche
Marie-Christine Lafond
Josianne Lavigne
Marc-André Monette

Université Laval
Québec City, Quebec, Canada
3rd place

Maater: Crowdsourcing to Improve Online Journalism

Mark Baldwin
Stephanie Butler
Raymond Liaw
Ari Zilnik

Carnegie Melon University
Pittsburgh, PN, USA
2nd place

AME-C Raising Awareness for a Life Free of Gender Violence

Joscelin Rojas López
Stephanie López Hayna
Marvelia Gizé Jiménez Guzmán

Design Engineering
Universidad Tecnológica de la Mixteca
Oaxaca, México
1st place

Paléo: A Collaborative System for Social Conciliation

Tony Aubé
Hugo Savoie
Mathieu Thériault
Stéphanie Turgeon-Girard

Université Laval
Québec City, Quebec, Canada
student game competition
ATUM – Applying Multi-layer Game Design and Environmental Storytelling
Marta Clavero Jimenez
Thomas Buijtenweg
Squidge: An Integrated Game Controller
Thomas Smith