Emerging Methods and Measures for Detecting Stress and Deception: Thermal Imaging

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Major Points

- **Description** of thermography
- Data processing and algorithm development **issues** to be resolved
- Mock crime studies – Some **findings**
- Theoretical **discussion** and conclusions

**Description of Thermography**

Issues to be Resolved: Image Analysis

- Which data transformations and Filters should we use?
- How should head movement be tracked?
- How to determine rate of change (blood flow) in visual images?
- How best to standardize measurement locations, sampling rates, radiation detected?

Issues to be Resolved: “Deception” Algorithms

Some Problems:

1. Individual variability and subpopulations
   - Differences in physiology
   - No standardized test formats
2. Ill-defined psychological construct
3. Little understanding of the physiological process
   - Can’t develop theoretical framework
   - Can’t constrain the infinite number of transformations possible
4. Either Ground Truth Unknown or Little Jeopardy

Issues to be Resolved: Methodological Problems

1. Comparison Question Test Format (Pavlidis et al., 2002; Pollina & Ryan, 2002)
   - Head movement not adequately tracked/controlled
   - Stimulus presentation times variable
   - Algorithm sensitive to study conditions
2. Study 2. Concealed Information Test Format (Pollina et al., submitted)
   - Camera Sensitivity (.10 C) not adequate
   - Head movement not adequately tracked/controlled

Issues to be Resolved: Test Question Sets

New technology will have to be tested
- Mock Crime / Field Study
- Ground Truth
- Question Sets Used
Issues to be Resolved: What is the psychophysiological process?

Periorbital Region 1s after the presentation of a crime-relevant polygraph question.

Two broad categories

Core temperature ($T_C$).

Regulated temperature ($T_{REG}$).

Issues to be Resolved: Head Movement

Algorithm Types:
- General Purpose
- Specific Purpose

Head Movement:
1. In plane vertical
2. In plane horizontal
3. In plane rotational
4. Out of plane

Machine Vision:
Pattern Match Template
Early Thermal Imaging Studies: Overview

- Mock Crime: Murder
- 32 Participants, U.S. Army basic trainees
- Simultaneous polygraph and thermal imaging of the face

Grand Averages: Skin Temperature

- Ear
- Mouth
- Scalp
- Neck
- Nose
- Eye

Deceptive
Nondeceptive
Regions Sampled

**Mouth**
1. Buccinator.
2. Depressor labii inferioris.
3. Levator labii superioris.
4. Mentalis
5. Orbicularis oris.
6. Depressor anguli oris.
7. Zygomaticus major and minor.

**Ear**
8. Temporoparietalis.

**Scalp**

**Neck**

**Eye**
11. Corrugator supercilii
12. Orbicularis oculi.

**Nose**
13. Procerus.

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Mock Crime Study, ZCT: Grand Average Frame Means: Eye

<table>
<thead>
<tr>
<th>Temperature Difference</th>
<th>Frame Number</th>
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<tbody>
<tr>
<td>Deceptive</td>
<td>Nondeceptive</td>
</tr>
<tr>
<td>-10</td>
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</tr>
<tr>
<td>-8</td>
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</table>

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ZCT Data: Combining Polygraph and SST

Area Under the ROC Curve Derived from Binary Logistic Regression

<table>
<thead>
<tr>
<th>Regression Analysis</th>
<th>Predictor Variables</th>
<th>R² (Cox &amp; Snell)</th>
<th>ROC Area</th>
<th>Sig.*</th>
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</thead>
<tbody>
<tr>
<td>Polygraph Measures</td>
<td>BV, EDA, AR, TR</td>
<td>.41</td>
<td>.88</td>
<td>.002</td>
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<tr>
<td>SST Amplitude Measures</td>
<td>SST: Nose, Mouth, Eye, Scap, Neck, Ear</td>
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<td>.70</td>
<td>.09</td>
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<td>Polygraph and SST Amplitude: Nose</td>
<td>BV, EDA, AR, TR, SST: Nose</td>
<td>.49</td>
<td>.90</td>
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<tr>
<td>Polygraph and SST Amplitude: Eye</td>
<td>BV, EDA, AR, TR, Eye</td>
<td>.46</td>
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<tr>
<td>Polygraph and SST Amplitude: Eye, Nose</td>
<td>BV, EDA, AR, TR, SST: Eye, Nose</td>
<td>.52</td>
<td>.92</td>
<td>.001</td>
</tr>
</tbody>
</table>

*Null hypothesis: true area = .50

Irrelevant Items

CIT Results

Deceptive Group. Temperature change to critical item prior to verbal response.

Nondeceptive Group. Gradual increase in temperature throughout the response interval. Similar for critical and non-critical items.
Conclusions

- Thermal imaging shows some promise, especially when combined with traditional polygraph measures.
- Questions such as optimal measurement sites, sampling rates, transformation algorithms, and combination (with polygraph) strategies need to be developed and tested.
- The long range goal is to use these measures to determine the specific emotions experienced by examinees on-line, and to use this feedback as an aid in credibility assessment.