COMPUTATIONAL PHYSIOLOGY LAB

Perinasal Indicators of Deceptive Behavior

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Automatic Face and Gesture Recognition
FG2015

- **Introduction**
- Methodology
- Experimental Results
- Conclusion

Deception

- Deception
  - —“To purposely mislead”

Deception in Context

- Deception
  - —"To purposely mislead"
- Critical cases requiring deception analysis
  - —In matters concerning national security
    - Interrogating suspect terrorists
    - Screening people with security clearances
  - —Criminal justice system

Deception Detection Methods

Behavioral Observations

- Voice
- Gestures
- Facial Expressions

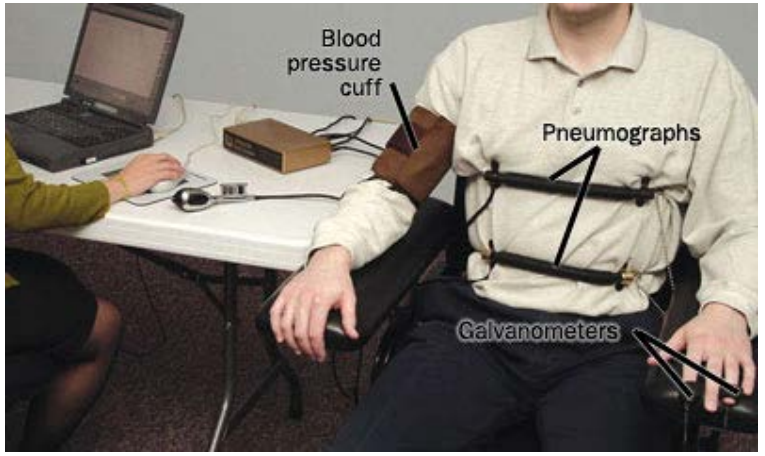
Physiological Measurements

•Adrenergic indicators

- Heart rate - Breathing rate

•Cholinergic indicators

- Electrodermal Activity



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i. More qualitative

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ii. Can be controlled to some degree ⊖

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ii. Difficult to control ⊕

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iii. Unobtrusive ⊕

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iii. Contact based methods ⊖

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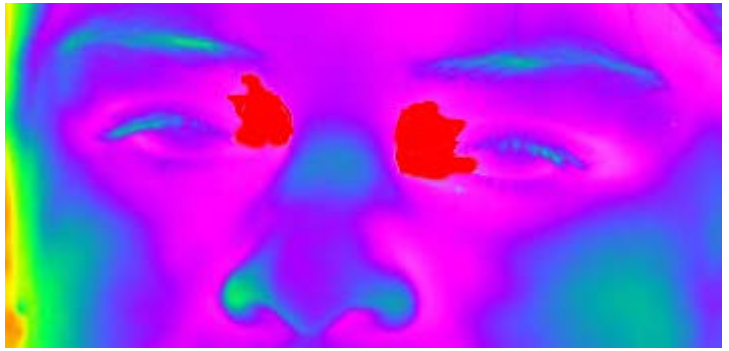
~~→ Thermal imaging~~

Perinasal Channel

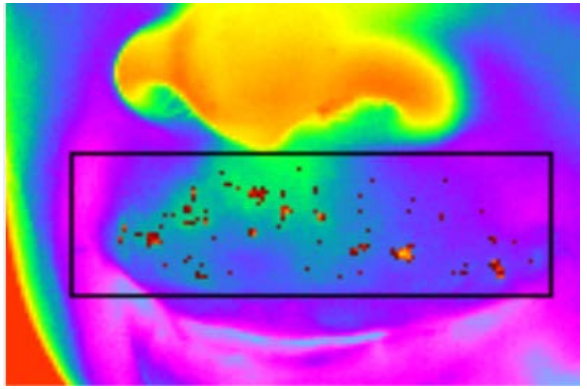
- Thermal Imaging – Periorbital Channel [1]



[1] I. Pavlidis, N.L. Eberhardt and J. Levine. Human behavior: Seeing through the face of deception, *Nature*, 415(6867) 35, 2002

Perinasal Channel

- Thermal Imaging – Periorbital Channel [1]
- Perinasal Channel
  - —Measures sympathetic arousal
  - —Perinasal perspiration has been linked to bouts of stress[2]
  - —Perinasal response is concomitant to finger response[2]



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[2] D. Shastri, A. Merla, P. Tsiamyrtzis and I. Pavlidis. Imaging facial signs of neurophysiological responses, *IEEE Transactions on Biomedical Engineering*, 56(2) 477-484, 2009

Perinasal Channel

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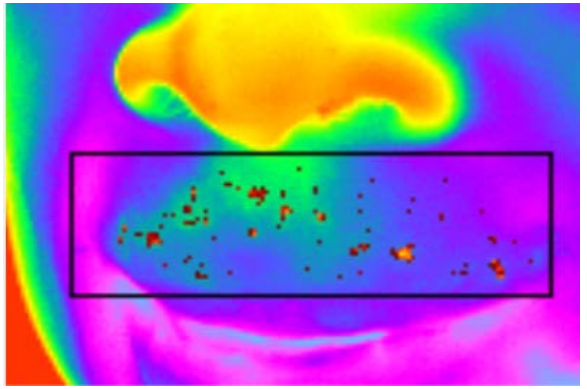
  - —Perinasal response is concomitant to finger response[2]
  - —Deceptive behavior under stakes causes stress
  - —Stress manifests through instantaneous perspiration
    - fingers & perinasal region



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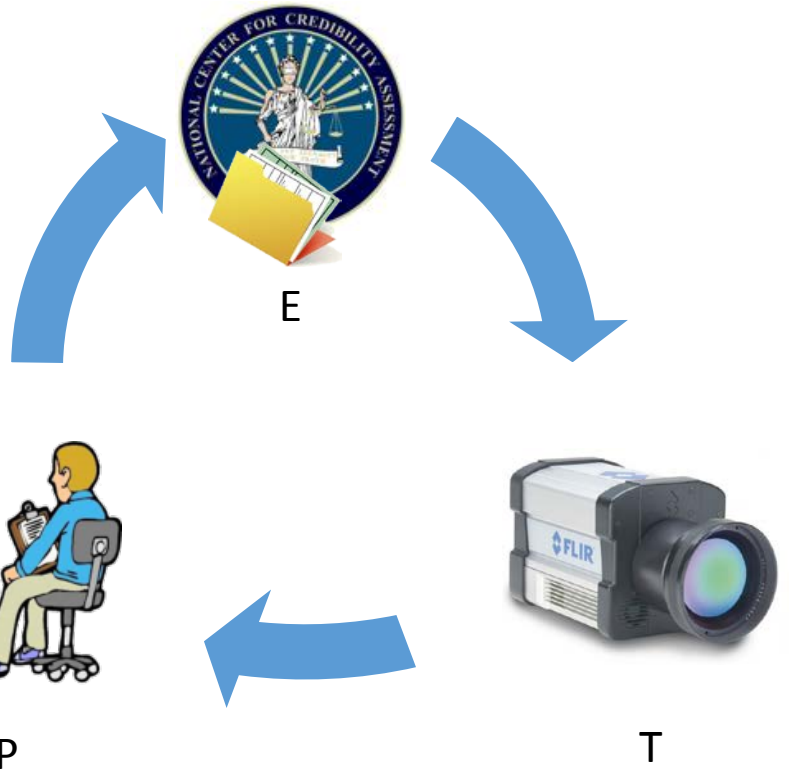
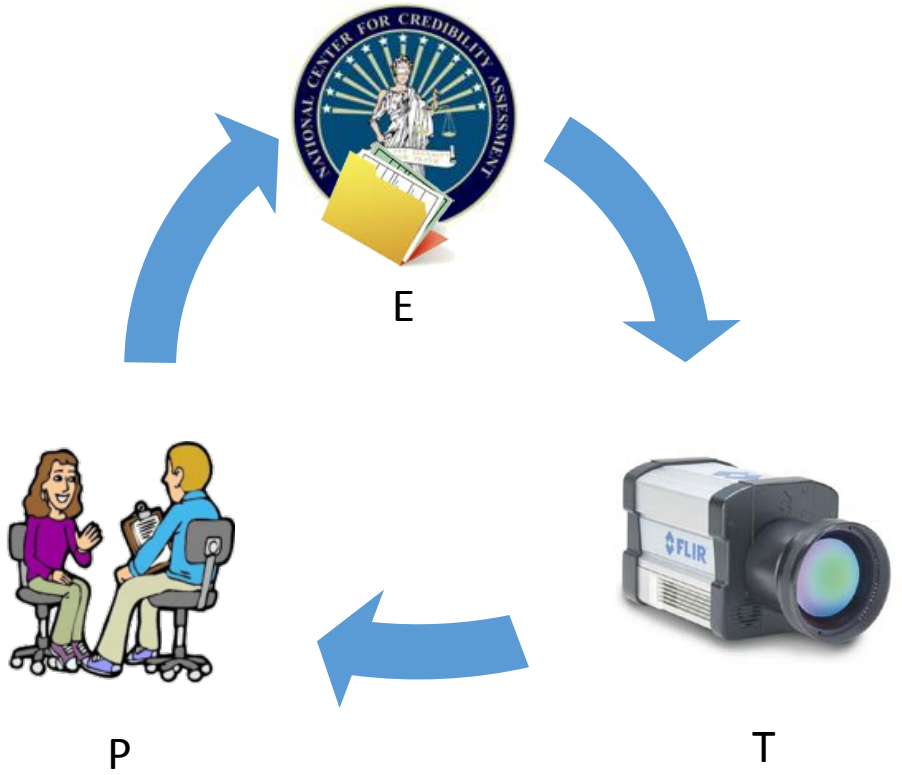
Experimental Design

- Collaborative effort
  - —Technology group
  - —Psychology group
  - —Evaluation group



Experimental Design

- Collaborative effort
  - —Technology group
  - —Psychology group
  - —Evaluation group
- Design Considerations
  - —Realism
  - —High stakes
  - —Motivation to perform



Experimental Design

Experiment Briefing

- Experiment: mock crime scenario – stealing a ring
- Subjects listen to prerecorded instructions
  - Programmed Truthful or Deceptive

Experimental Design

Experiment Briefing

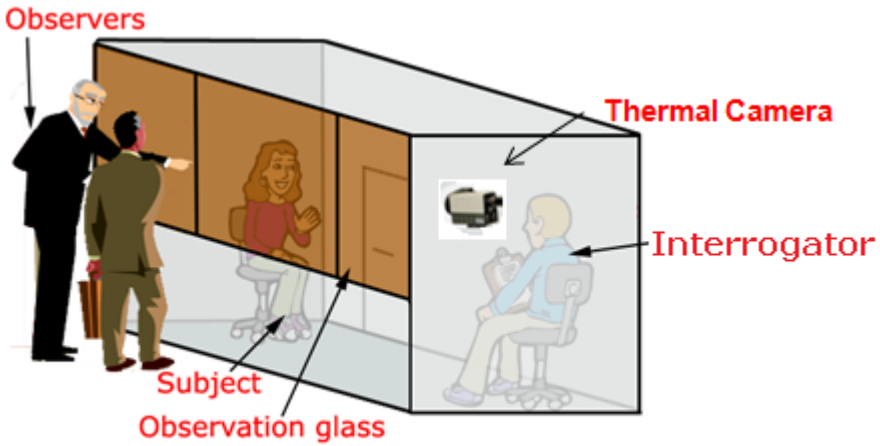
Chance to Steal The Ring

- Experiment: mock crime scenario – stealing a ring
- Subjects listen to prerecorded instructions
  - Programmed Truthful or Deceptive
- They go to a room – chance to commit crime

Experimental Design

Experiment Briefing	Chance to Steal The Ring	Interview

- Reid interview technique[4]
- Stressful and easy questions (Relevant and Irrelevant)



[4] J. Reid and J. Buckley, *Criminal interrogation and confessions*. Jones & Bartlett Publishers, 2011

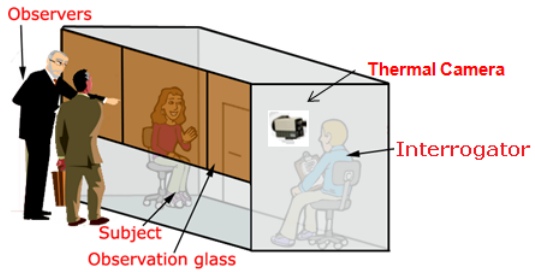
Experimental Design

Experiment Briefing 

Chance to Steal The Ring

Interview 

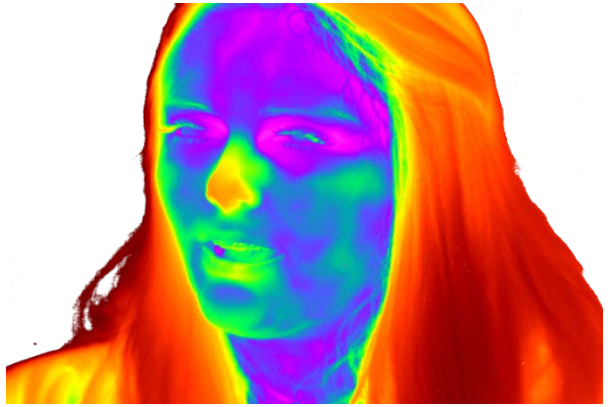
- Goal: Convince interviewer of their innocence



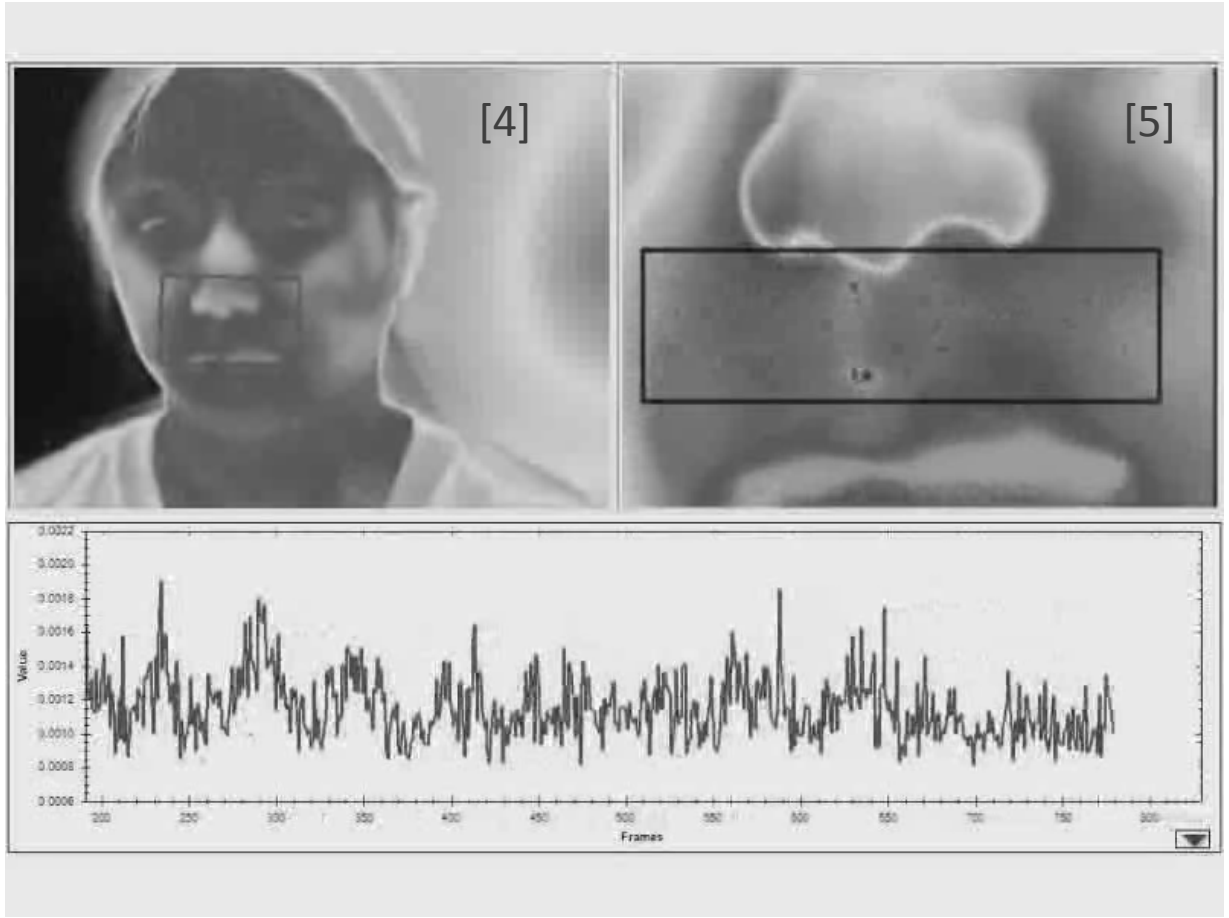
- Subject compensation : 
- If successful in convincing interviewer : $15 + $50
- If unsuccessful : Only $15

Experimental Setup

- ThermoVision SC6000 MWIR
  - —Temperature resolution: 0.025°C
  - —Spatial resolution: 640x480 pixels
  - —Lens: 100 mm
  - —Subject's distance from camera: 13 ft
  - —Recording speed: 25 fps



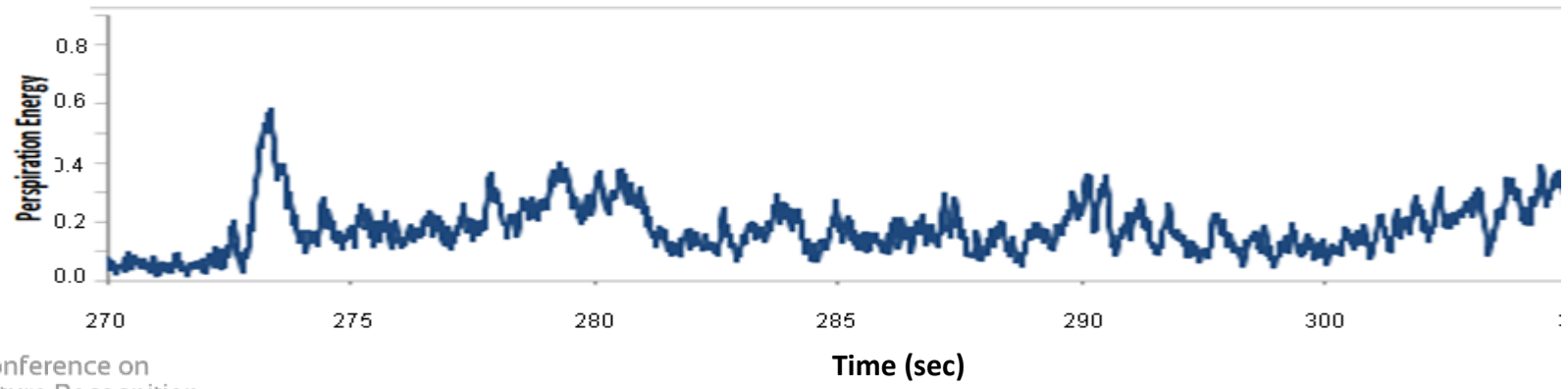
Step-1 Signal Extraction



[4] Y. Zhou, P. Tsiamyrtzis, M. Papadakis, P. Lindner, I. Timofeyev and I. Pavlidis. Spatiotemporal smoothing as a basis for facial tissue tracking in thermal imaging, *IEEE Transactions on Biomedical Engineering*, 60(5), 1280-89, 2013

[5] D. Shastri, M. Papadakis, P. Tsiamyrtzis, B. Bass and I. Pavlidis. Perinasal imaging of physiological stress and its affective potential, *IEEE Transactions on Affective Computing*, 3(3) 366-378, 2012

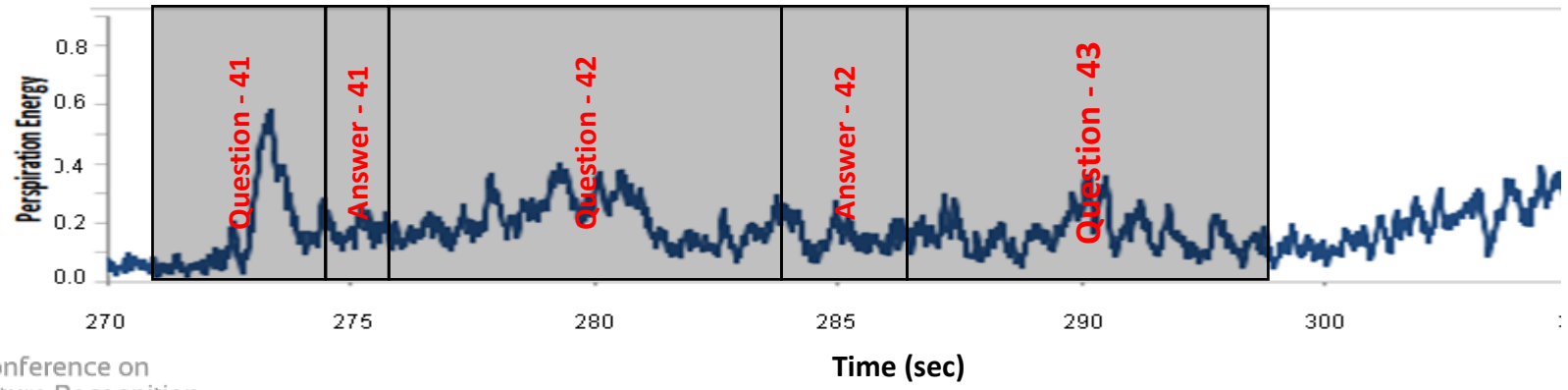
Step-2a: Audio Segmentation



Step-2a: Audio Segmentation

- Each question & answer pair is segmented

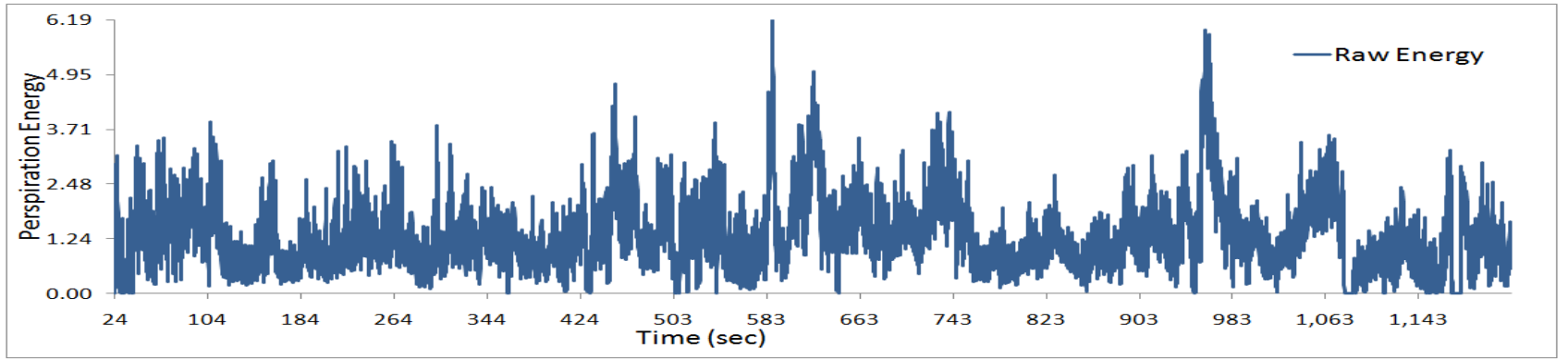
- Indexing question-answer pairs



Step-2b: Interview Segmentation

- Grouping of questions and answers based on similarity

Easy Questions → **IR1**
Difficult Questions → **R1**
Easy Questions → **IR2**
Difficult Questions → **R2**
Difficult Questions → **R3**
Difficult Questions → **R4**



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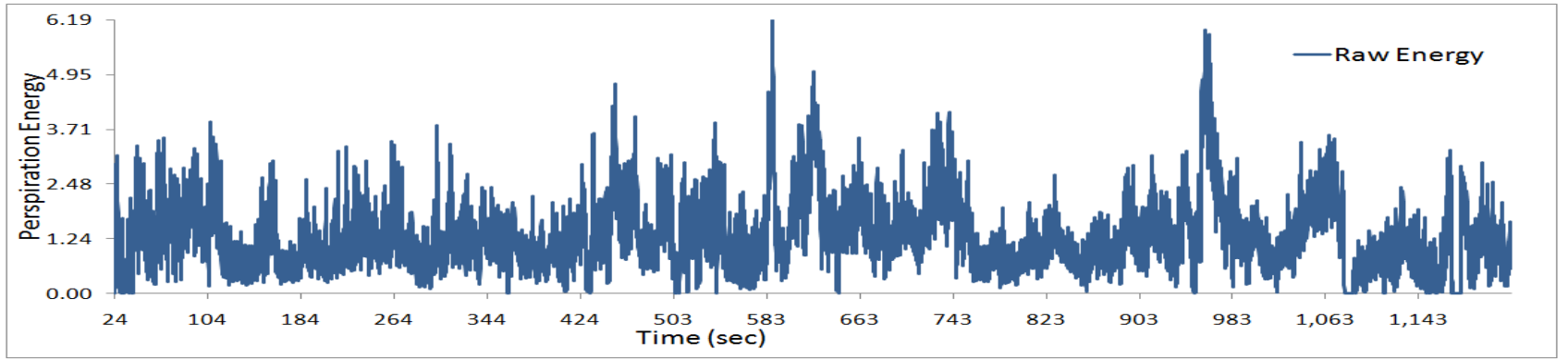

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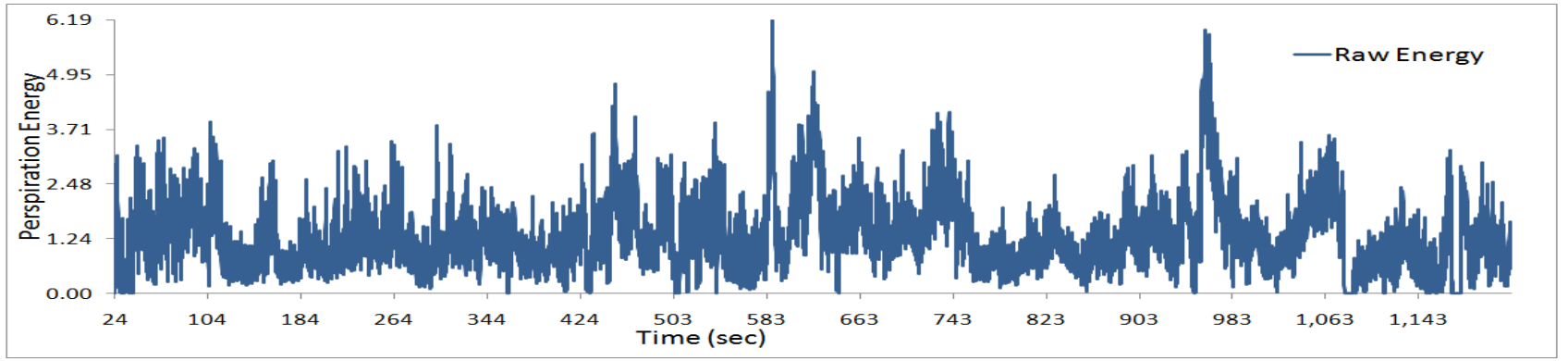
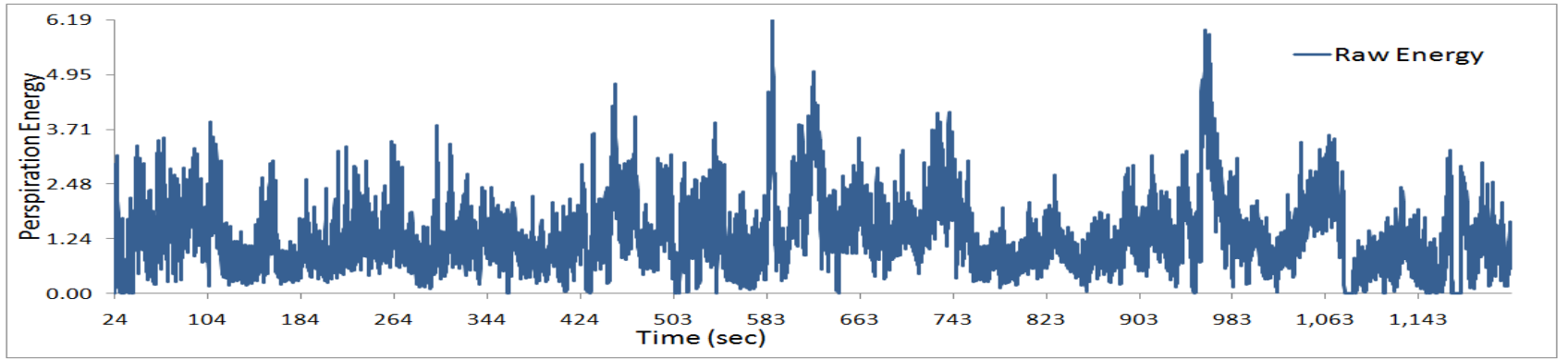


Step-2c: Signal Segmentation

- Indexing the perspiration signal via the audio segments

Easy Questions → **IR1**
Difficult Questions → **R1**
Easy Questions → **IR2**
Difficult Questions → **R2**
Difficult Questions → **R3**
Difficult Questions → **R4**

Six Segments



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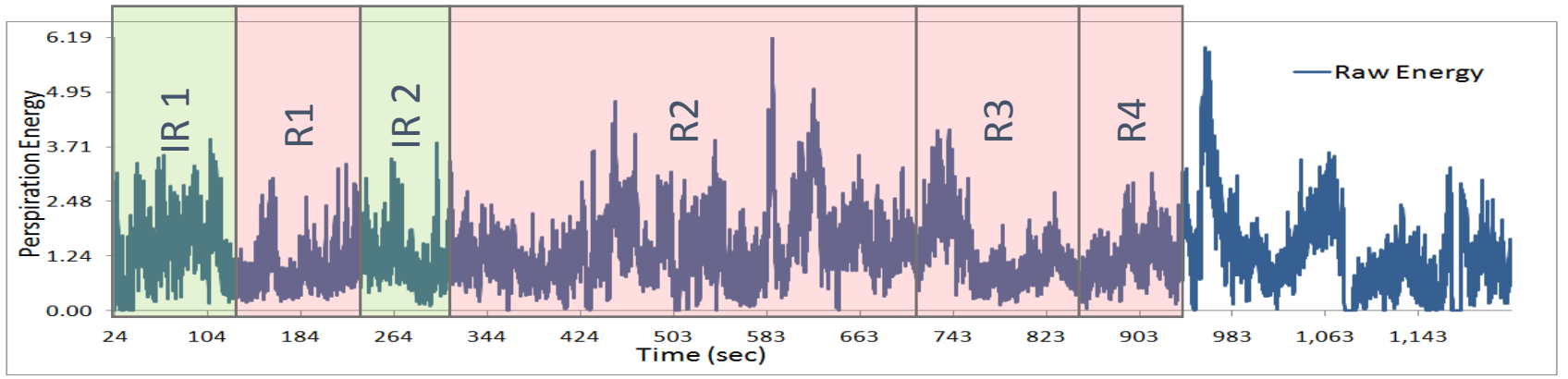
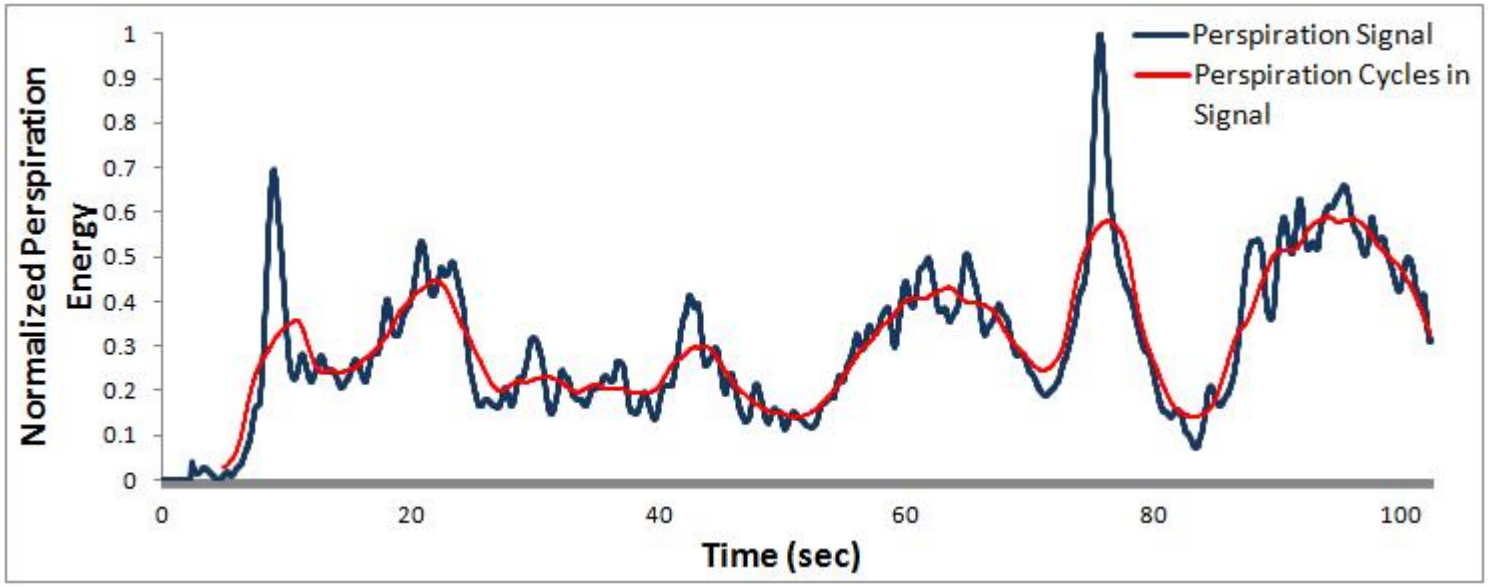


Feature Extraction

- Feature → rate of perspiration per segment



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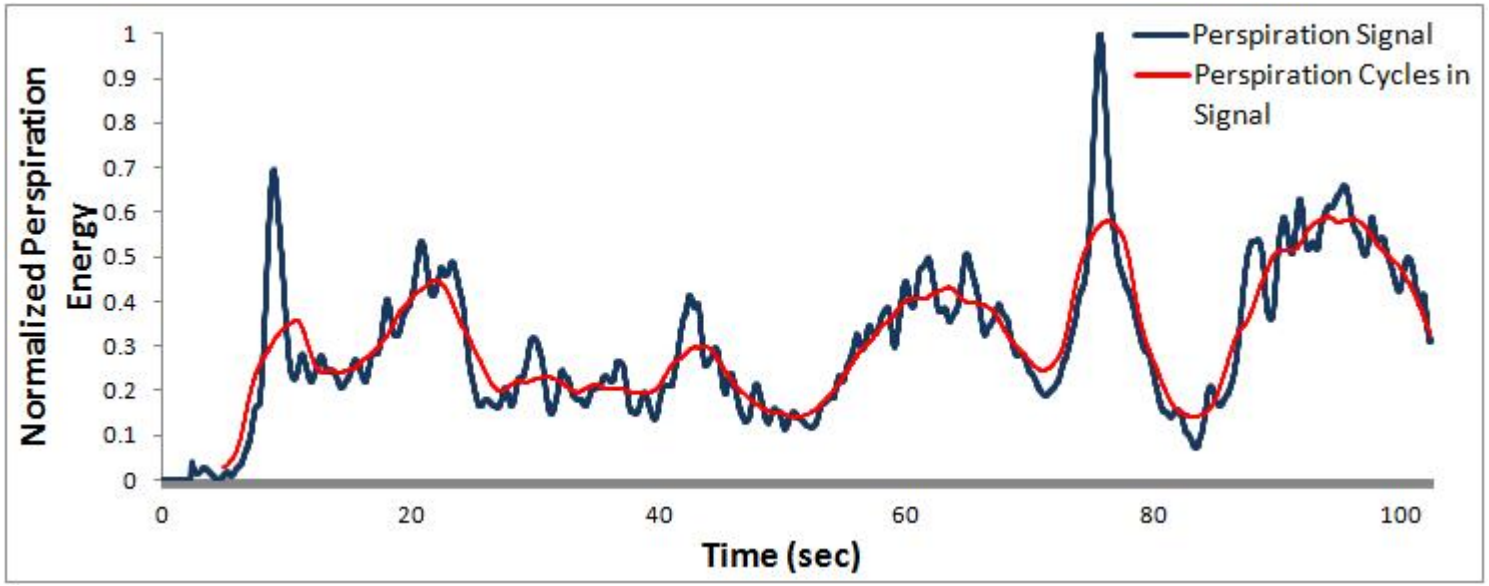

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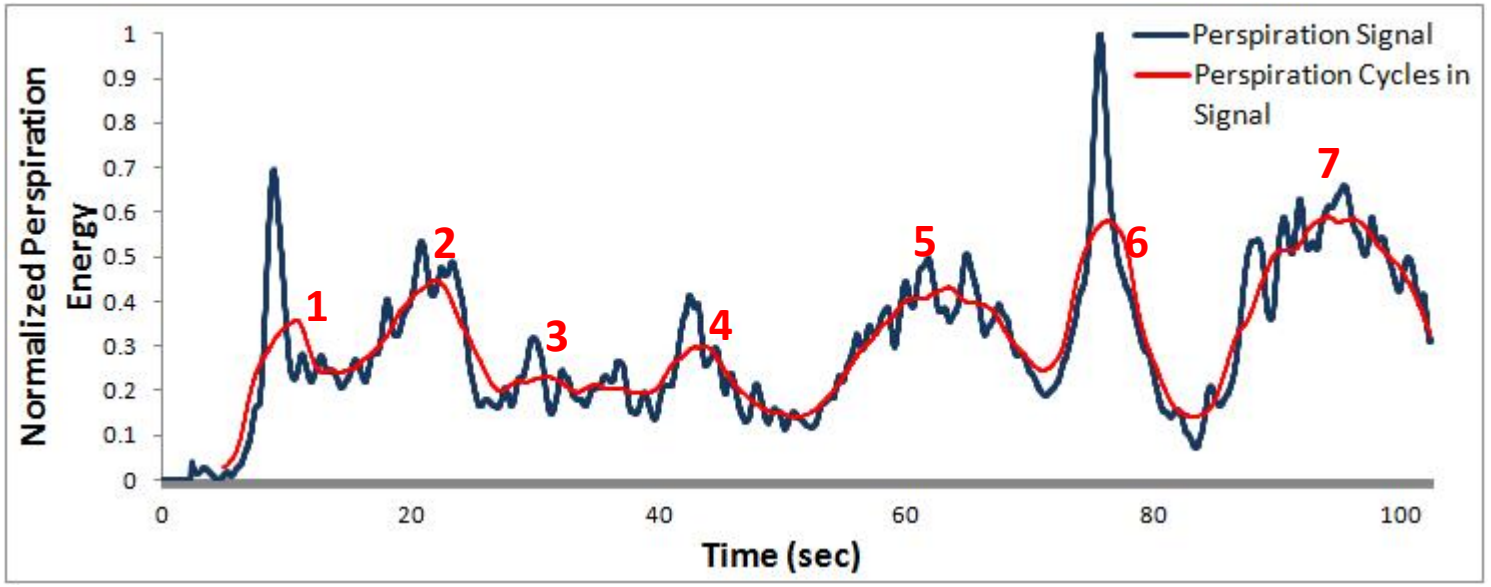

- Glands secrete in a pulsate manner[5]
- Use wavelet analysis to compute rate

[5] S. Nicolaidis, J. Sivadjian. High-frequency pulsatile discharge of human sweat: myoepithelial mechanism, *Journal of Applied Physiology*, 32, 86-90, 1972

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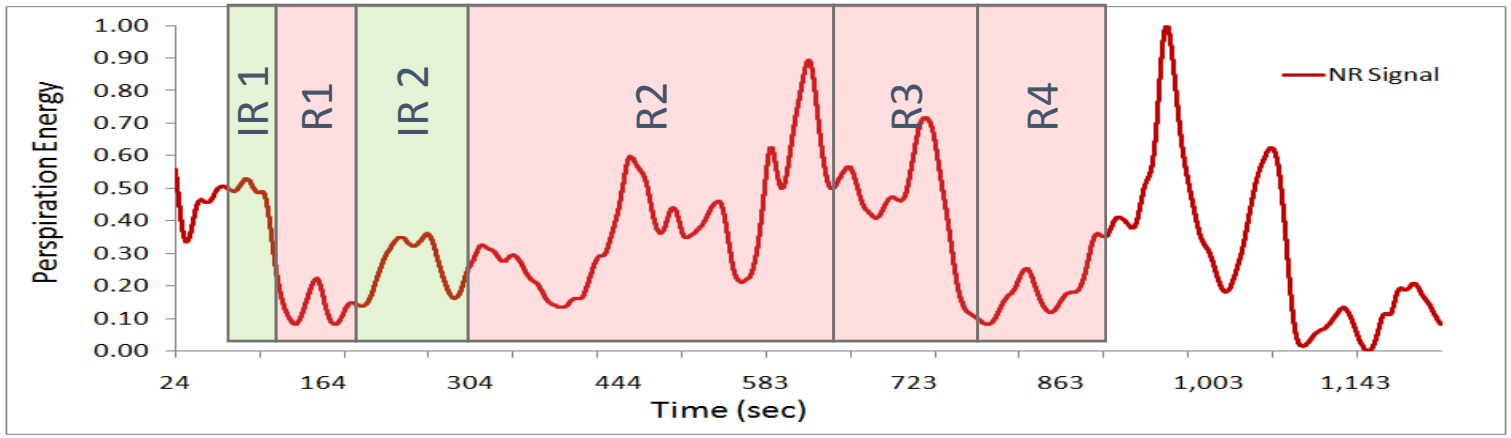
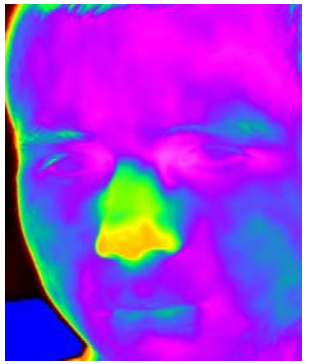


Features

Subject	IR1	R1	IR2	R2	R3	R4
D001	0.03385	0.09149	0.05836	0.04836	0.03627	0.07228
D004						
...	...	...	...	...	...	...

Hypothesis

•All participants experience some stress during the interview

	Irrelevant Questions	Relevant Questions
Truthful Subject		

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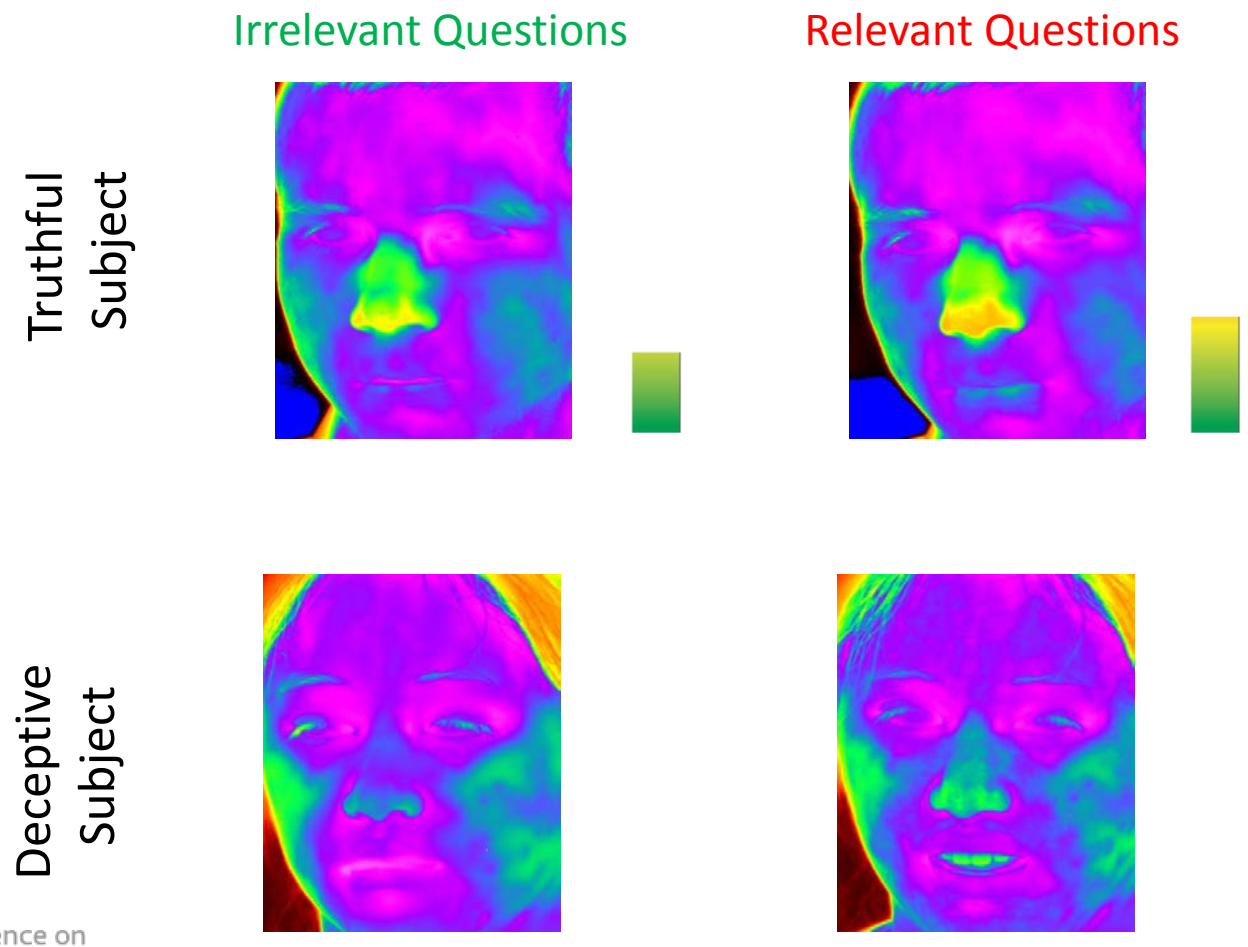

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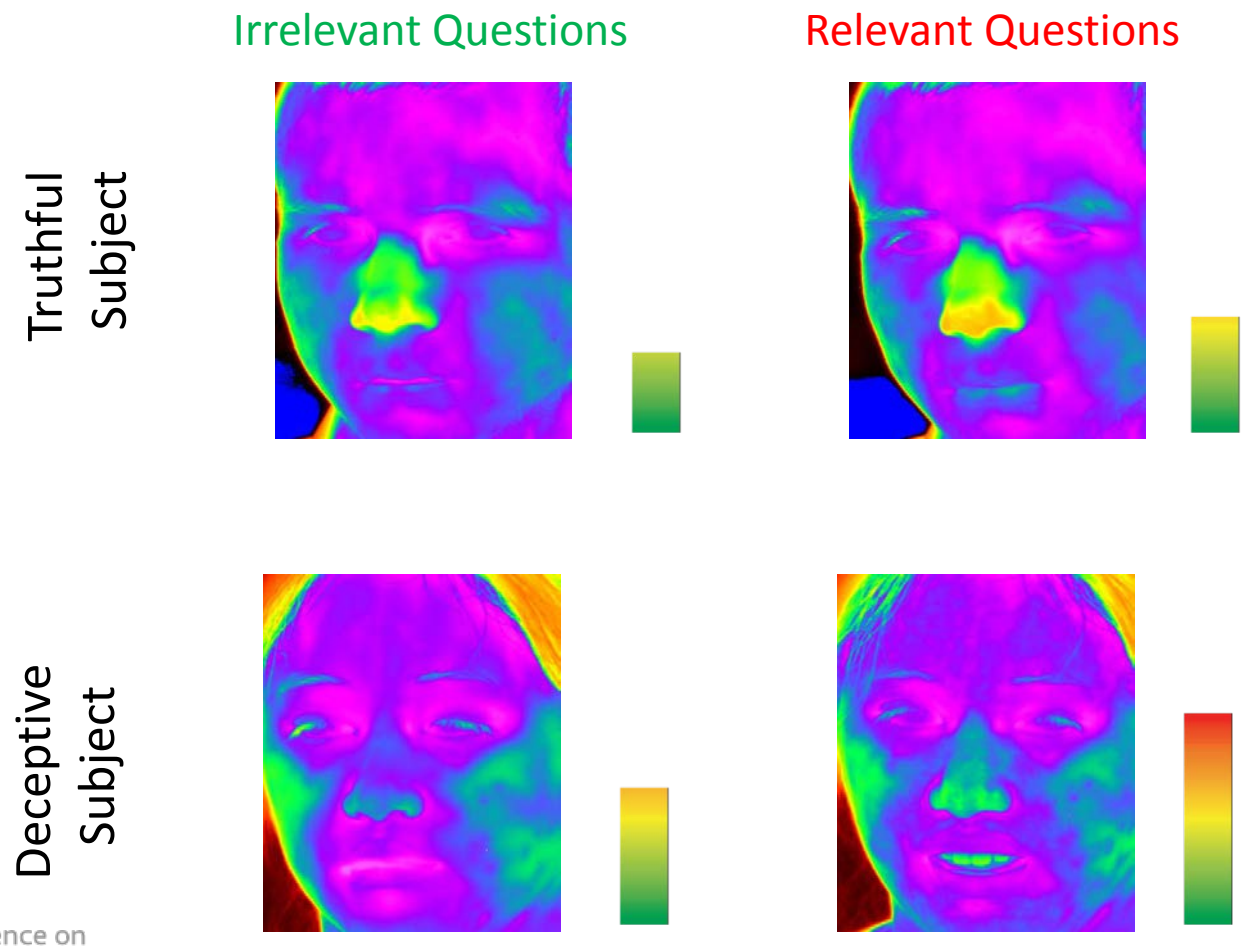

•Deceptive subjects experience higher stress during the relevant questions

Threshold Classifier

- Test the differential rate of perspiration between relevant and irrelevant question segments

$$f_R - f_{IR} \rightarrow \begin{cases} > 0 \text{ subject}(i) \text{ is D} \\ \leq 0 \text{ subject}(i) \text{ is T}, \end{cases}$$

where,

$$f_R = avg(f_{R1}(i), f_{R2}(i), f_{R3}(i)),$$
$$f_{IR} = avg(f_{IR1}(i), f_{IR2}(i)),$$

Machine Learning Approach

- Classifiers
  - —Decision Tree
  - —AdaBoost using Decision Stump
  - —AdaBoost using Naïve Bayes
  - —Multilayer Perceptron

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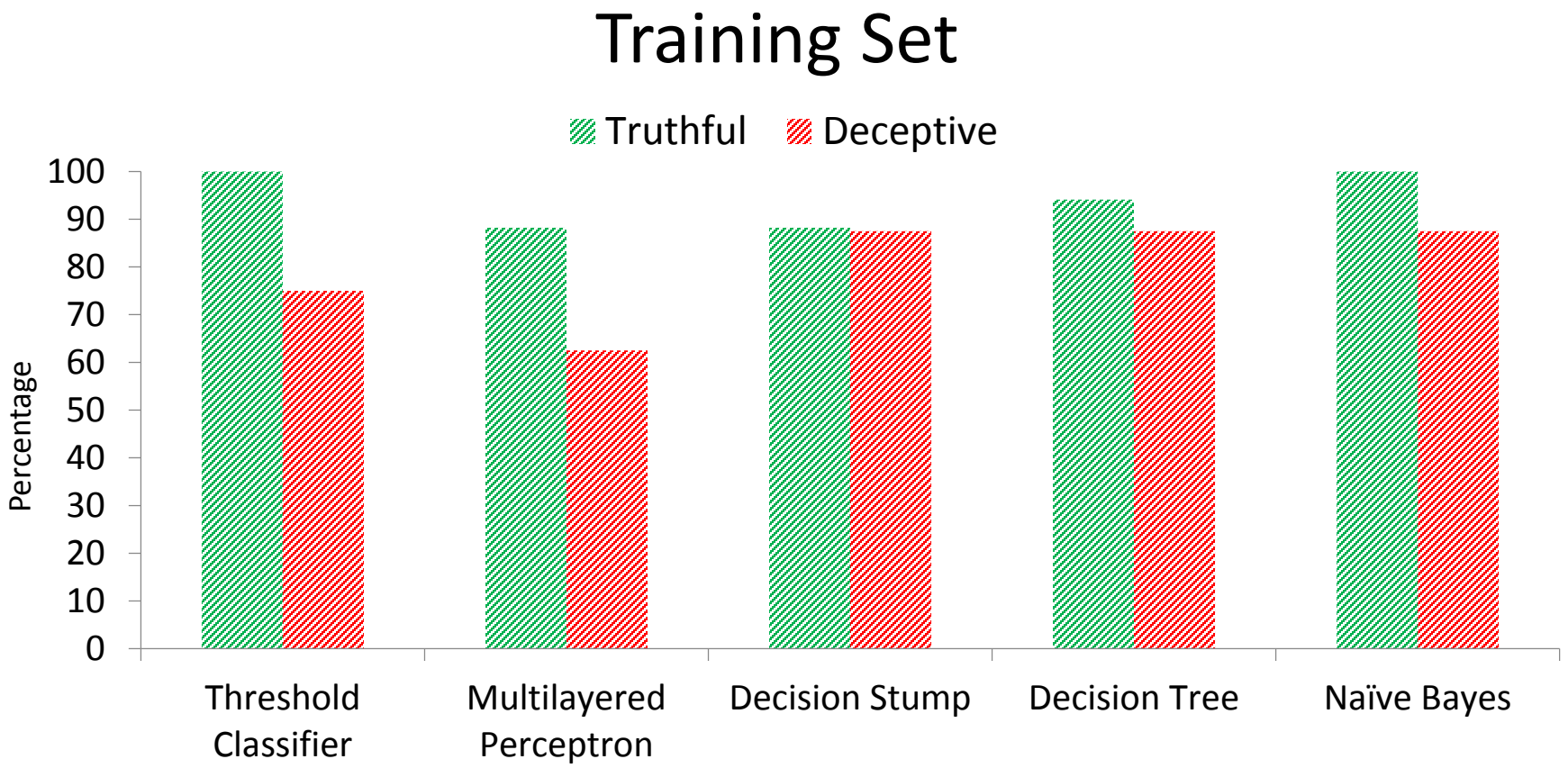
Model Validation

- Total of 40 subjects used in analysis (17 M, 23 F)
- Training set (25 subjects)
  - —Leave-one-out cross validation
- Test set (15 subjects – Blind prediction)

Classification Success Rates



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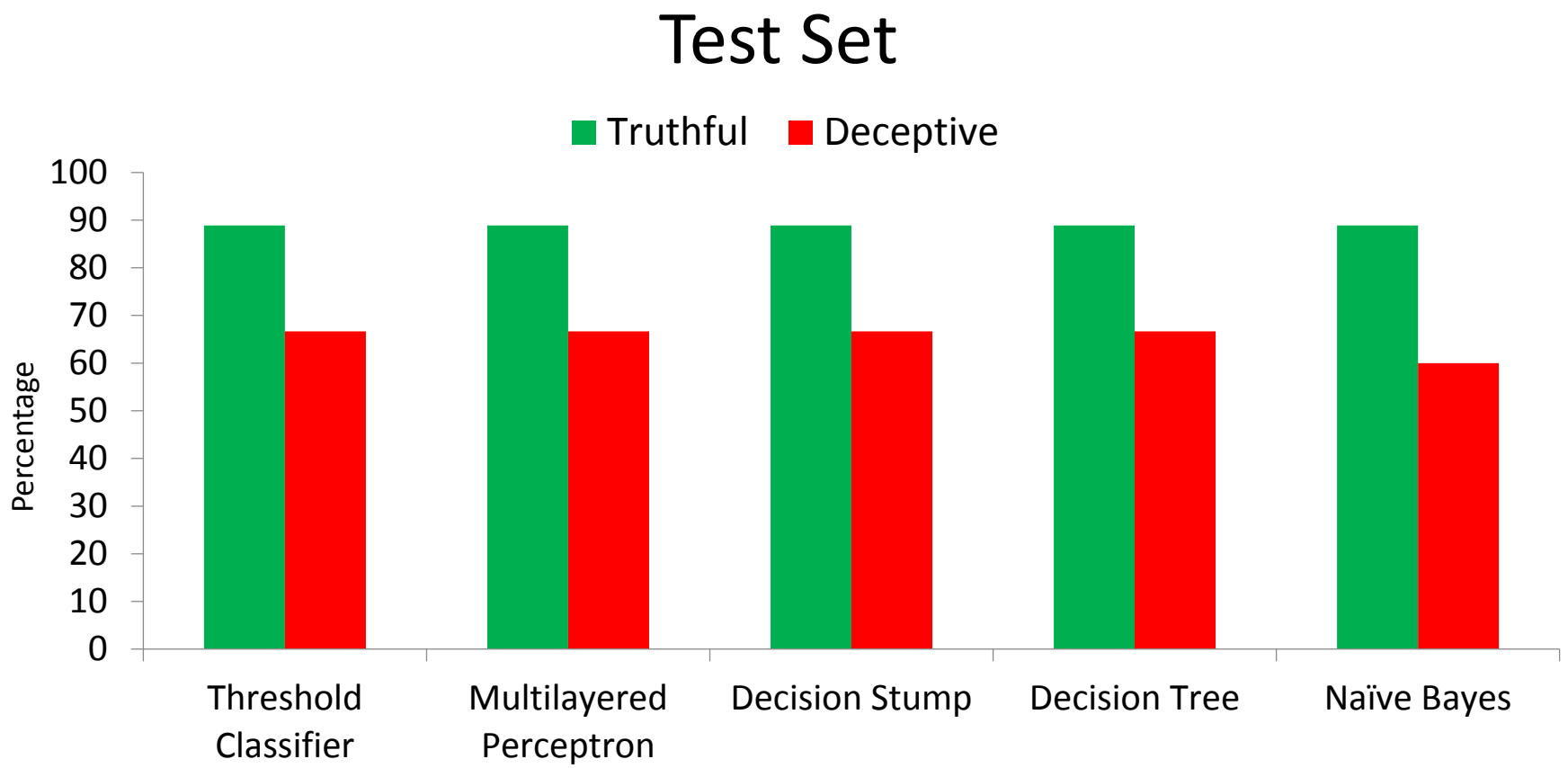

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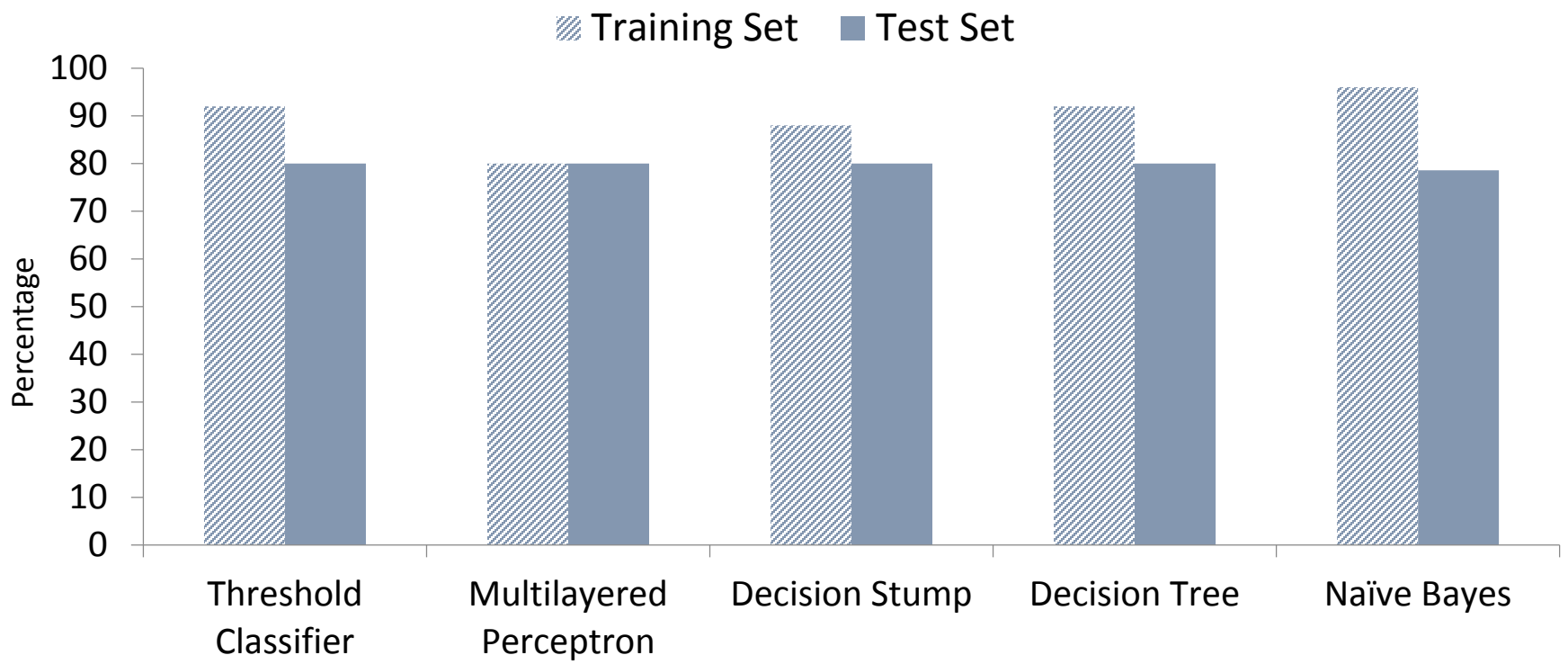

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Conclusion

- Perinasal perspiratory rate tracks deceptive behavior within an appropriate interrogation context

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- Good psychology theory +

  Good experimental practice +

  Good physiology theory +

  Good methods

Conclusion

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- Good psychology theory +
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- Performance scales up from training to test set

Acknowledgements

- This work was supported by the National Center for Credibility Assessment