CMI Center for the Management of Information

BORDERS™

A Department of Homeland Security Center of Excellence

THE UNIVERSITY OF ARIZONA

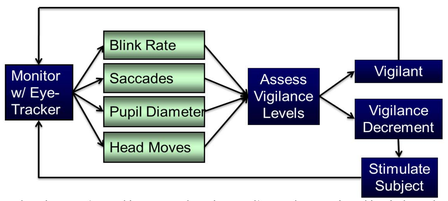
Using Eye and Head Based Psychophysiological Cues to Enhance Screener Vigilance

Brent T. Langhals, Judee K. Burgoon, Jay F. Nunamaker, Jr.

Center for the Management of Information, University of Arizona

Research Problem

- Problem
  - Adversaries conceal illegal items, thus security depends upon our ability maintain vigilance
  - Research has shown individual vigilance levels decrease in as little as 15—20 minutes
- Research Questions
  - Can we detect when vigilance decrement begins?
  - Can we effectively stimulate individuals to higher vigilance levels if we know when vigilance decrement begins?
  - Can we build a real-time feedback system for individual vigilance levels?
- Prototype Vigilance Feedback System
  - Monitors blinks, saccades, pupil diameter, and head movement
  - Algorithm to assess vigilance levels based upon changes in cue activity

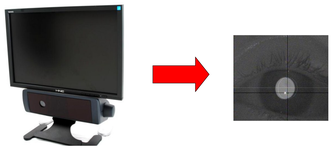


  - Provides stimulation (audio and visual) when individual is assessed as experiencing vigilance decrement

Materials and Methods

- 40 minute baggage screening task to detect illegal items
  - 600 slides with 32 slides containing illegal items

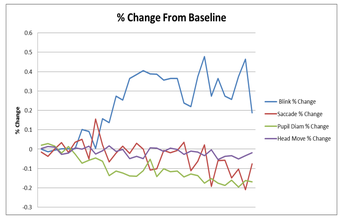
  - Use eye-tracker to detect eye and head based psychophysiological cues
  - Calculate ability to correctly detect presence of illegal items over time
- Applied Science Laboratories D6 Eyetracker
  - 60 frames per second; uses infrared light (bright eye) with head tracking to enable stable eye-tracking



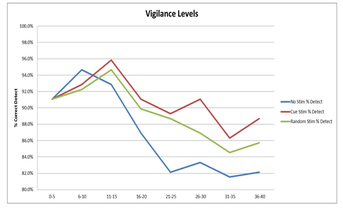
- Phase 1
  - Determine which (if any) psychophysiological cues are predictive of vigilance levels
  - Develop algorithm for assessing vigilance levels
- Phase 2
  - Create prototype vigilance feedback system based on results of phase 1
  - 3 Conditions: No stimuli, Cue-based stimuli, Randomly applied stimuli
  - Compare vigilance levels and false detects over 40 minute experiment

Results

- Phase 1
  - N=32
  - Blinks and saccades were most significant predictors
  - Classification models achieved over 91% accuracy



- Phase 2
  - N = 126
  - No significant difference in vigilance levels between random and cue-based conditions
  - Random and cue-based conditions were significantly higher ($p < .05$) than no stimuli condition after 20 minutes
  - Random condition had significantly more ($p < .05$) false detects after 20 minutes than both the cue-based and no stimuli conditions



Literature Cited

Mackworth, N. H, (1957). Some Factors Affecting Vigilance, *Advanced Science,* 53: 389-393.

Parasuraman R & Giambra L, (1991). Skill Development in Vigilance, *Psychology and Aging,* 6: 155-160.

For Further Information

For further information regarding this project please direct emails to brentl@email.arizona.edu or to reach the BORDERS Center of Excellence please send an email to rmcisaac@borders.arizona.edu.

Acknowledgements

This project was funded through the National Center of Excellence for Border Security and Immigration by a grant from the Department of Homeland Security, Science and Technology Directorate, Office of University Programs