Eye tracking in a human patient simulation environment: Data collection, coding, visualization, and analysis

Human Simulation and Patient Safety Center
Duke University Medical Center

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Human Simulation and Patient Safety Center

- The Human Simulation and Patient Safety Center is a unique, multidisciplinary unit within the Duke University Health System. The 1600 square foot facility maintains both rich educational and research activities.

- The HSPSC has multiple missions including:
  - Education
  - Research
  - Innovation
  - Service and process improvement
Facilities and Resources

- Simulation Room
  - Operating Room
  - Other hospital environments
- Observation Room
  - Computer controlled cameras
  - Audio/video capture and editing
  - Multimedia classroom
- Simulators
  - High fidelity patient simulation
  - METI, Laerdal
  - Physiological parameters
  - Breath and heart sounds
  - Pulses, and more
Benefits of Human Patient Simulators

- Train and practice without risk
- Practice uncommon but critical scenarios
- Allow errors to occur and reach their conclusion
- Evaluate and train interpersonal relationships
- Test limitations of human-machine interface
- Evaluate equipment and procedures without risk
Human Factors

- Designing systems to fit human capabilities and limitations
- Knowledge about the human capabilities and limitations
  - Perception
  - Cognition
  - Physical
- Knowledge of methods for studying humans in work environments
Anesthesia Practice and Patient Safety

- Anesthesia
  - Dynamic
  - Risky
  - Information-rich

- Anesthesia information sources
  - Written and oral communication with patient, providers, labs
  - Visual and auditory displays of monitored patient data
  - Direct observation of patient through sight, smell, hearing
  - Direct observation of environment -- surgical field, suction sounds, fluids

- Source of errors in anesthesia
  - From 54% to 82% of anesthesia mishaps due to “human error” (Weinger; JClinMonComp, 1999)
  - Or is it, “design induced error”? (Endsley et al., Designing for Situation Awareness, 2003)
Eye Tracking

- Evaluate menu scan behavior
- Compare novices and experts (e.g., aviation)
- Evaluate driver attention/distraction
- In anesthesia
  - For memory recall in task analysis (Seagull and Xiao, HFES Proceedings, 2001)
  - To verify check of ETCO2 in intubation (Via et al., IMMS, 2002)
- Equipment
  - Two cameras, scene & pupil, infrared lights, integrate data
  - Desktop, tethered wearable, non-tethered wearable
  - Automated coding, manual coding
Objective Measures of Performance in Simulated Anesthesia: A Comparison of Novices and Experts

- Funded by the Anesthesia Patient Safety Foundation and NIH
- Establish objective measures of provider performance
  - Identify methods that are sensitive to 1) provider experience, and 2) case difficulty
  - Situation awareness measures
  - Checklist measures
  - Eye tracking measures
- Identify key determinants of “expertise” in anesthesia
  - Indicators for assessment
  - Inform training
- Evaluate information access, scan patterns
  - Equipment redesign
Data Collection

- Non-tethered mobile eye tracker, manual coding
- Two anesthesia cases
  - One difficult - open fracture of jaw and leg, trauma, drug & alcohol use, CV complications, head injury
  - One moderate - knee arthroscopy, complications associated with obstructive sleep apnea, intraoperative complication
- 2nd year residents, anesthesiologists with 5 - 15 yrs experience
- Perform cases, with SA stops, eye tracking data collected for entire case
Eye Tracking Data Coding

- Manual
- 62 specific items available as visual “data”
  - Patient monitor, ventilator monitor, mannequin, anesthesia machine, other individual items
- Using Sportstec™ “StudioCode” video analysis software
- Watch video and press buttons for start of each item viewed
- Get: item viewed, start time, stop time, nth instance
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Eye Tracking Data Analysis

- **What do we want to know?**
  - Frequency
  - Dwell time
  - **Sequence**
  - Distribution/coverage
  - Expert vs. novice differences
  - Individual variation within expert or novice groups

- **When?**
  - E.g., immediately post induction
  - At the point of intra-operative event

- **Can we use eye tracking to measure performance?**
Frequency for one subject
How do we get where we need to go?

- Node-link diagrams
- Fading comet representation of time
- Other alternatives?
- Identify key areas of interest
- Statistical analysis of the data
- Comments, suggestions, questions…