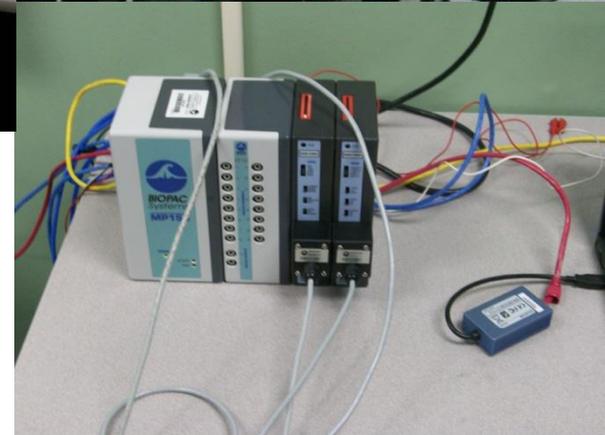
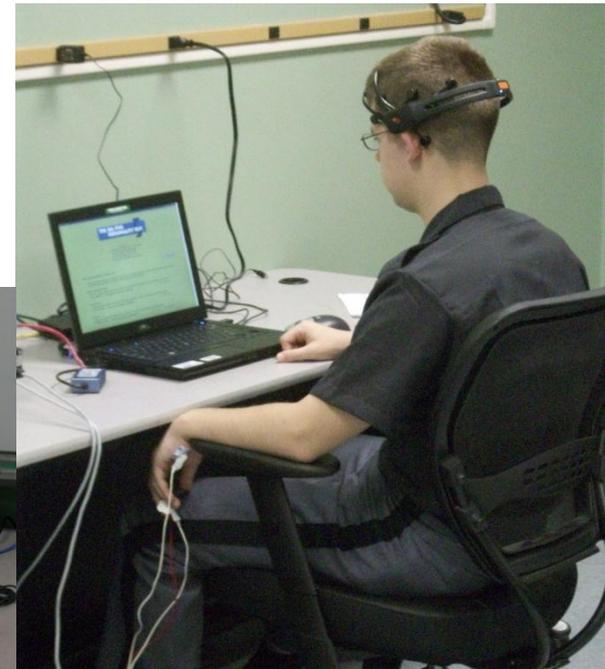


- Objectives
 - Purpose
 - Research Questions
- Background
 - Engagement and Learning
- Methodology
 - Apparatus
 - Hypotheses
 - Analysis Approach
- Results
- Conclusions
- Future Work



- **Aim**

- **Assess impact of manipulations on states of interest in Cultural Meeting Trainer (CMT)**
- **Identify sensors for tracking physiological metrics:**
 - **Can be tracked in real-time for informing system adaptations**
 - **Linked to cognitive and affective states associated with learning**
 - **Level of Attention (Cognitive Engagement)**
 - **Frustration/Excitement/Boredom (Arousal)**

- **Purpose**

- **Make Computer-Based Tutoring Systems (CBTSs) adaptive to cognitive and affective states found to impact training outcomes**
- **Evaluate tailoring approach for training mediation**



- **Engagement**

- Linked with information gathering, and periods of sustained attentional focus (Berka et al., 2007; Dorneich et al., 2004)
- Disengagement and fatigue negatively impact training performance (Small et al., 1996)
- Lack of engagement decreases learning (Baker, et al., 2004)

- **Arousal**

- Correlated with retention in learning periods (Levonian, 1972)
- Low arousal associated with rapid forgetting (Kleinsmith & Kaplan, 1963)
- High arousal results in better memory performance central to the arousing event (Bradley et al., 1992)

- **Boredom**

- Negatively correlated with learning gains (Craig, et al., 2004)
- Negatively correlated with high retention (Small, et al., 1996)



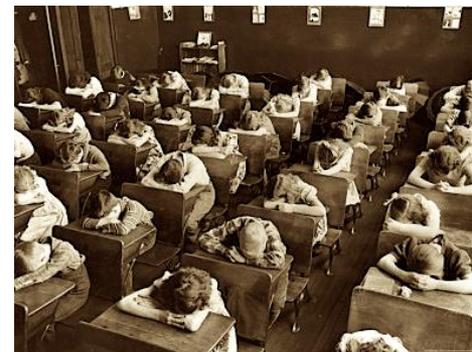
- **Engagement**
cognitive state



- **Arousal**
affective state



- **Boredom**
affective state



EEG can measure

- Attention
- **Engagement**
- Workload

GSR can measure

- Anxiety
- **Arousal**
- **Boredom**
- Frustration
- Stress

ECG can measure

- Anger
- **Arousal**
- Attention
- **Boredom**
- Fear
- Stress

- **Emotiv EPOC Neuro-Headset**
 - 14-Channel Electroencephalogram (EEG) headset
 - Proprietary metrics used for purpose of maintaining low cost (Three Detection States):
 - Engagement
 - Short-Term Excitement
 - Long-Term Excitement

- **BIOPAC's MP150 System**
 - Collected both ECG and GSR data
 - 500Hz sampling rate

- **Self-Report Measures**
 - Mood via Self-Assessment Manikin
 - Self-Reported Engagement via ITC-SOPI

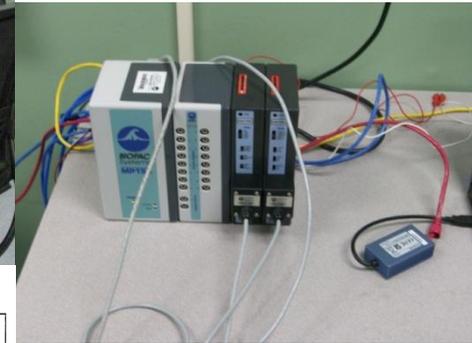
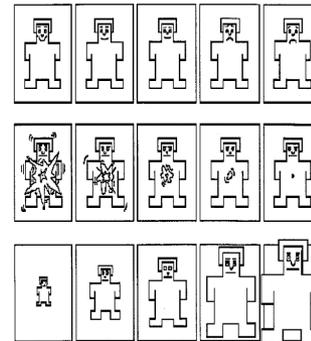


FIGURE 1
SAM The Self-Assessment Manikin

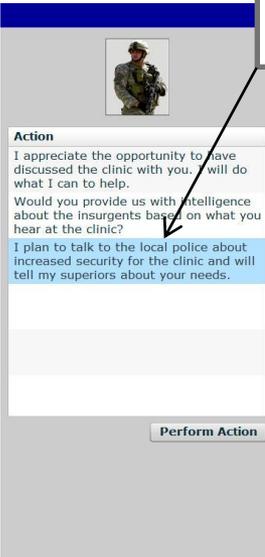


Cultural Meeting Trainer (CMT)

- Web-based flash system prototype applied for cross-cultural interaction training
- Specifically designed for training cross-cultural norms and customs associated with phases of negotiation

CMT Designed Scenarios

- Well-Defined No Interruption (WDNI)
- Ill-Defined No Interruption (IDNI)
- Ill-Defined Interruption (IDI)



Action
I appreciate the opportunity to have discussed the clinic with you. I will do what I can to help.
Would you provide us with intelligence about the insurgents based on what you hear at the clinic?
I plan to talk to the local police about increased security for the clinic and will tell my superiors about your needs.

Perform Action

Trainee Action Selections

Dr. Alsafi: It's about time someone from the U.S. came here. The situation is bad, very bad. I try everything to make someone pay attention, but too many times I hear only empty promises or help that never comes.

You: I could ask about some humanitarian aid for this area and the clinic.

Dr. Alsafi: Your promises mean nothing. If you want to help the clinic, then make it safe enough for us to receive our own supplies regularly.

You: Tell me more about how we can make you feel safer.

Dr. Alsafi: It is like I have been saying. Too many doctors are kidnapped or killed and it scares the rest away. It is crazy that I have to make threats before anyone decides to do anything about the fact that we are running out of people who can heal. We need more protection.

You: I want to help the clinic. I know you have been frustrated with us in the past, but I want to help you.

Dr. Alsafi: Can you offer me anything other than promises? Others have said they wished to help as well.

You: We do not have the resources to provide bodyguards for your doctors. Would it help to talk with the local police?

Dr. Alsafi: Yes, that might work. We would be willing to continue the clinic to give you some time to work this out with them.

You: What can you tell me about the insurgent attack two nights ago?

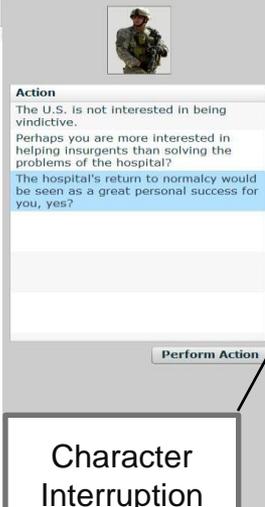
Dr. Alsafi: It was terrible! These people are barbarous. That, I suspect, you already know.

You: Other than improved security, what would you suggest you most need for the clinic?

Dr. Alsafi: The hospital in general needs supplies and medicine. The clinic especially needs antibiotics for the children.



Dr. Alsafi
Attending/Head of Community Clinic



Action
The U.S. is not interested in being vindictive.
Perhaps you are more interested in helping insurgents than solving the problems of the hospital?
The hospital's return to normalcy would be seen as a great personal success for you, yes?

Perform Action

exist.

You: Do you think we should consider reducing US presence in the area?

Dr. Mahdi: I do not know what good it would truly do, but I am sure that many would be grateful. It's the long term solution I have no doubt, and I appreciate the desire to respond to the public's desires.

You: We have every intention of helping you improve the situation at the hospital.

Dr. Mahdi: Your eagerness to help would be proven by some additional support for the hospital.

You: I have influence with my commanders and can get you the help you need.

Dr. Mahdi: And what could this influence mean for us? I do not know what you would want in exchange.

You: ...

Dr. Mahdi: Listen, my friend. May I trust you? Do you have the authority necessary to address our needs at the hospital?

You: I must check with my superiors before making any definite promises for expensive supplies.

Dr. Mahdi: I know that you have procedures, but people will die if they have to wait much longer.

You: Who should I speak with to learn more about the supply theft?

Dr. Mahdi: I do not know. Perhaps the thief? I will share any information I come across after you leave, and I ask you to do the same.

You: Tell me, specifically, what you need for the hospital to return to normalcy?

Dr. Mahdi: To return to normal, we need normal access to the Diyala bridge and our normal shipments of supplies. This last is key. Thank you for your interest in helping us!



Dr. Mahdi
Hospital Administrator

Character Interruption

Continue



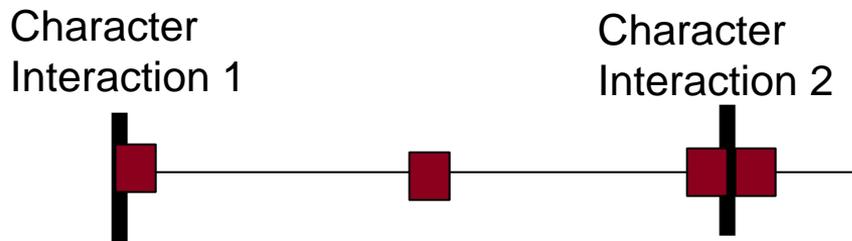
- **Participants**
 - 19 Cadets with BIOPAC GSR/ECG data
- **Counter-Balanced Within Subject Design (IV's)**
 - Clarity of Task Execution (Well-Defined vs. Ill-Defined)
 - Presence or Absence of Character Interruptions
- **Procedure (Scenario Conditions Presented in Random Order Across Participants)**
 - Introductory Conversation →
Rest → Scenario1 → Survey →
Rest → Scenario2 → Survey →
Rest → Scenario3 → Survey



- **Exploratory Hypotheses**

- **H₁**: An interruption in expected task flow will produce a noticeable response in physiological metrics reliably across participants
- **H₂**: Physiological and self-reported metrics will produce reliably different outputs between well-defined and ill-defined task objectives
- **H₃**: Physiological data will correlate with self-reported levels of engagement and mood

- **Post-Processing of BIOPAC Data :**
 - ECG Signal Processed for Real-Time Heartbeat Detection
 - GSR Features Extracted: Mean; Standard Deviation; and Signal Energy
 - Each metric is Processed for Defined Areas of Interest
 - 16 Second Samples Before, After, and Halfway Between System Interactions



- 2nd order band-pass, derivative, squared, integrated, thresholded

- Filter Response: $\frac{s \cdot w_0}{s^2 + s \cdot \frac{w_0}{Q} + w_0^2}$ (with a center frequency of 5 and a Q value of 4)

- $\frac{d}{dx} = y(nT) = \frac{1}{8} * T[-x(nT - 2T) - 2x(nT - T) + 2x(nT + T) + x(nT + 2T)]$

- Squaring: $y(nT) = [x(nT)]^2$

- MWI: $y(nT) = \left(\frac{1}{N}\right) * [x(nT - (n - 1)T) + x(nT - (N - 2)T) + \dots + x(nT)]$
(N is 30 samples, or a 3.6 millisecond delay for this work)

Pan, J., Tompkins, W.J.: A real-time QRS detection algorithm. IEEE Trans. Biomed. Eng. BME, 32(3): 230-236 (1985)



- Smoothing
$$y[n] = \frac{1}{\tau} x(n) + \frac{\tau-1}{\tau} y(n-1)$$
- Normalization
$$s(t) = \frac{s(t) - \mu_s(t)}{\sigma_s(t)}$$
- Second Difference Energy
$$\sqrt{\int_t \frac{d^2}{dt^2} (s(t))}$$

Kapoor, A., Burleson, W., & Picard, R. W. Automatic prediction of frustration.
International Journal of Human-Computer Studies, 65, p. 724-736 (2007)

- Analysis showed ECG data to display minimal variance over time and across scenarios, including the IDNI scenario.
 - This can be seen when looking at the correlations between ECG metrics
- Significant differences were found for all GSR metrics (Mean, SD, and Signal Energy) when examining the effect of task clarity (Ill- vs. Well-Defined):
 - IDI against WDNI: [Mean, $t(18) = -2.643$, $p < .025$; SD, $t(18) = -2.323$, $p < .05$; and Signal Energy, $t(18) = 2.414$, $p < .05$]
 - IDNI against WDNI: [Mean, n/a; SD: $t(18) = -2.472$, $p < .025$; and Signal Energy, $t(18) = 2.965$, $p < .01$]
- No correlations present between BIOPAC metrics and self-report scores (Mood and Presence)
- Interruption in scenario interaction had no noticeable impact on BIOPAC data (H_3)

- Interaction scenarios without clear goals, such as in the ill-defined interaction context, are likely to produce lower levels of arousal (GSR) (H_2)
 - Supported by work examining the relation between performance and stress through compensatory control of one's attention and effort (Hockey, 1986)
 - Interaction scenarios with unclear goals produce greater variability (as seen by Signal Energy) in GSR outputs across time.
- There were no reportable differences in dependent variables between the IDI and IDNI scenarios (H_1)
 - This is an indication that the instructional event of interrupting users had no effect on their arousal levels.
- No variability among cadets in self-report or engagement surveys

- Additional research is required to:
 - Assess the effect varying methods of task intervention has on cognitive engagement across multiple computer-based platforms
- Future work to assess real-time changes in trainee affect is motivated by the ability of the GSR signal to detect significant differences among experiences
- Models of student affect need be constructed and utilized in real time in order to be practical. Metrics developed here will further this work



Questions?

