Methodology for Study of Human-Robot Social Interaction in Dangerous Situations

David J. Atkinson and Micah H. Clark
Institute for Human and Machine Cognition

Presented at 2nd International Conference on Human-Agent Interaction
Tsukuba, Japan   *31 October 2014*

Topics

- Context – About This Study

- What is the Methodological Problem?

  o Dangerous Situations & Unique Psychological Factors

- Requirements for a Solution

- Our Approach: Use of Immersive VR/Online "World"

  o Situational and Psychological Fidelity

  o Components Related to Evoking Perceived Danger

- Current Status

- Next Steps

Context: Current Study

- Will people believe a robot is "benevolent" in conditions where they perceive personal danger?

- What beliefs are important to benevolence?
  - Agency (Choice), Competence, Predictability, Nothing to Gain…

- Does perceived benevolence of a robot increase cooperation and compliance with an offer of help?

→ **Results will be reported next year!**
  Today: The methodology challenge

The Challenge

- Scientific study of HRI in dangerous domains (e.g. USR) is difficult because **... it's dangerous!**

- "Real life" disasters:
  - Rare, Uncontrolled, Not Replicable, **Unsafe**
  - Can study HRI with *Operators* but not **Victims**

- Scientific studies require:
  - Participant Safety
  - Sufficient Experimental Controls
  - Precise Measurement and Replication
  - ***Situational and Psychological Fidelity***
  - ***Ability to Evoke Perceived* Danger**

Psychological Factors of Danger

- Unique stimuli evoke *reflexive* physiological and psychological reactions
    - Fear-Potentiated Startle
    - Anxiety
    - Stress
    - Panic
    - Hyper-Vigilance
    - Sensitivity to Environmental Cues
    - Reduced Compliance with Social Norms
    - Avoidance Behavior

Rescue Interaction

- First Responders are trained for "victim psychology" **– some people resist rescue**.

- If human interpersonal behavior is so profoundly affected when danger is present,

  → **Why would it be any different for human-robot interaction?**

"Rescue robots" are being developed and fielded *but we don't really know how victims will react!*

Key Requirements for Studies

- Behavioral Realism ✦

- Evoke "Danger" Psychology ✦

- Robots with Sufficient Behavioral Fidelity

- Experimental Control and Measurement

Immersive Virtual Reality/Online World Provides Useful Affordances

Behavioral Realism

Behavior in VR must be <u>sufficiently</u> similar to RW

Virtual
Reality

Real
World

- **Social Presence**

- **Immersive Feeling of Embodiment**

- **Identification with their In-World Avatar**
  - o SecondLife ™ is an online world with 100,000's "trained" users

- Important to allow time for acclimation to the environment to occur ➔ *immersion will follow*

- Specific features of the virtual environment promote immersion and behavioral realism

Task Scenario

- **Seek & Find:** Study participants are told to locate and retrieve a briefcase inside a warehouse.

- **Robot Encounter**: Participants are told they may encounter a robot.
  The details vary by type of trial.

- **Task is Really a Manipulation:** After an acclimation period, a *disaster* occurs!

Warehouse: Initial Condition

Visual Complexity

Ambient Sounds

Large: 80m x200m

Situation-Appropriate Artifacts

Feature Rich: Attributes Promote Immersion

Evoking Sense of Danger

Potentiate fear of "predatory" attack
Lighting creates dark shadowed areas
Atmospheric diffusion limits distance clarity
Visibility lines are obstructed

Potentiate perception of danger with risk stimuli
Worn out appearance, messy, signs of incivility (trash, graffiti)
Presence of drums with warning signs of hazardous chemicals
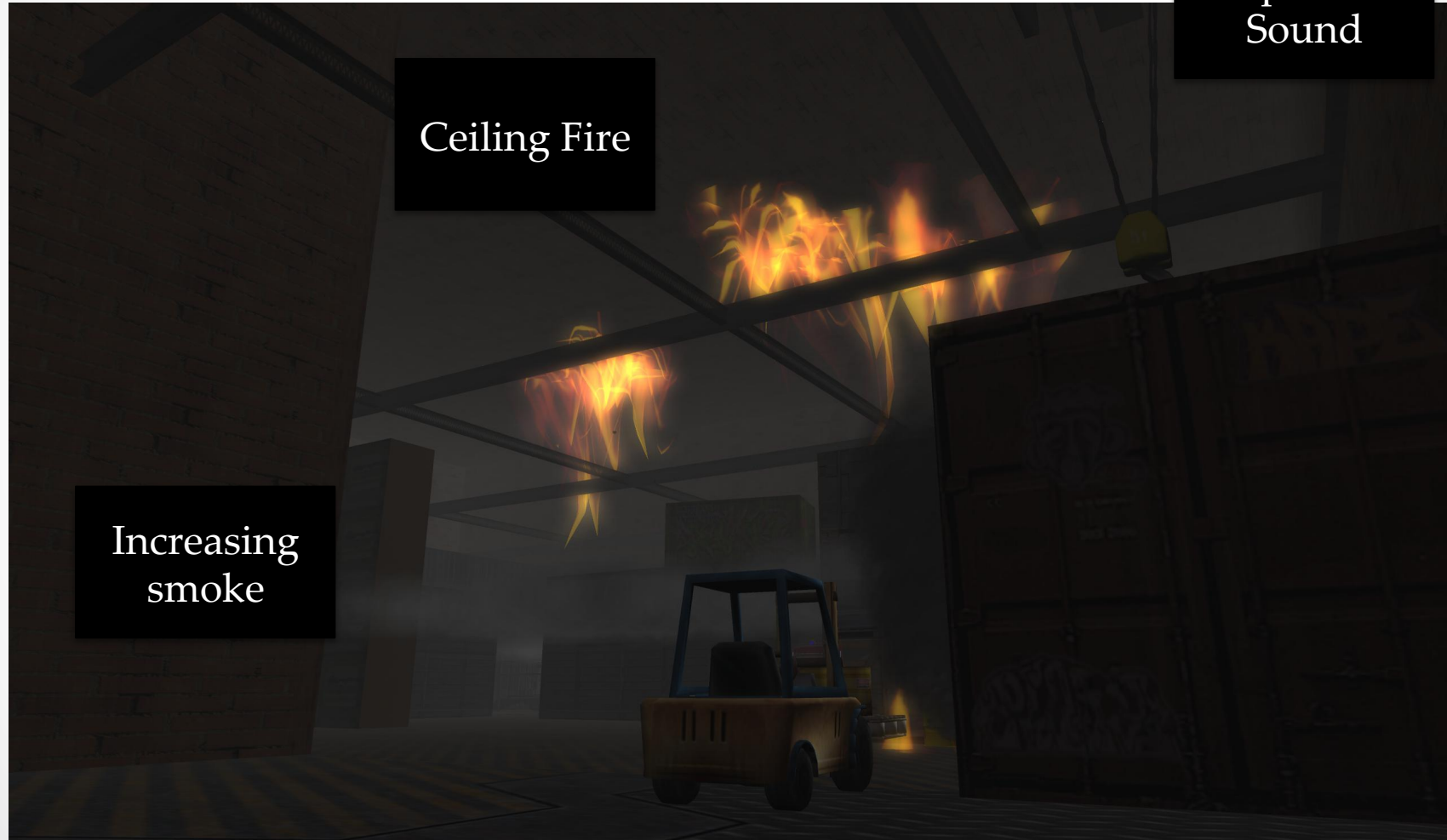Prominent warning signs and fire alarms

Acclimation Period Allows Attention to Cues

Explosion

Explosion
Sound

Ceiling Fire

Increasing
smoke

Participant POV

Thick Smoke

Fire Sounds

Fire Spreads to Floor

Visually Startling

It Gets Worse!

Loud Fire Alarm & Evacuation Alert

Debris and Fire Block Original Entrance

...the robot appears

Status & Next Steps

- Warehouse, robots, disaster effects, automated data collection, … all are complete

- All open source.

- Experimental trials are underway (260 minimum)

Future Work

- Increase **immersion** – CAVE / Oculus Rift / 3D audio

- Collect **physiological data** to verify "DANGER"

- Increase **range and fidelity of robot social signals** related to trustworthiness

Thank You!