Understanding the Effects of Non-Lethal Technologies and Tactics Through Modeling and Simulation

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Conclusion

- **Modeling the human element is essential for being able to predict the effectiveness of non-lethal technologies or tactics to a situation.**
- **The human behavior models we are developing could be applied to modeling crowd behavior and crowd dynamics.**

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Conclusion (cont'd)

Our goal is realistic simulation of human decision processes. To achieve this realism our computational framework models cognitive processes and can also accommodate the effects of a variety of organic factors such as:

- **emotion**
- **arousal**
- **stress**
- **culture**
- **individual variability**

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Program Objectives

Objective: collection of projects focused on development of a framework for the comprehensive modeling of factors that shape human decision processes in naturalistic settings

Technical Challenge: realistically model decision making processes in a manner that is comprehensive, defensible, extensible and doable.

Problem Space: (1) Synthetic humans for training and analytic tools; (2) Intelligent machines; and (3) Core technology for augmented cognition solutions

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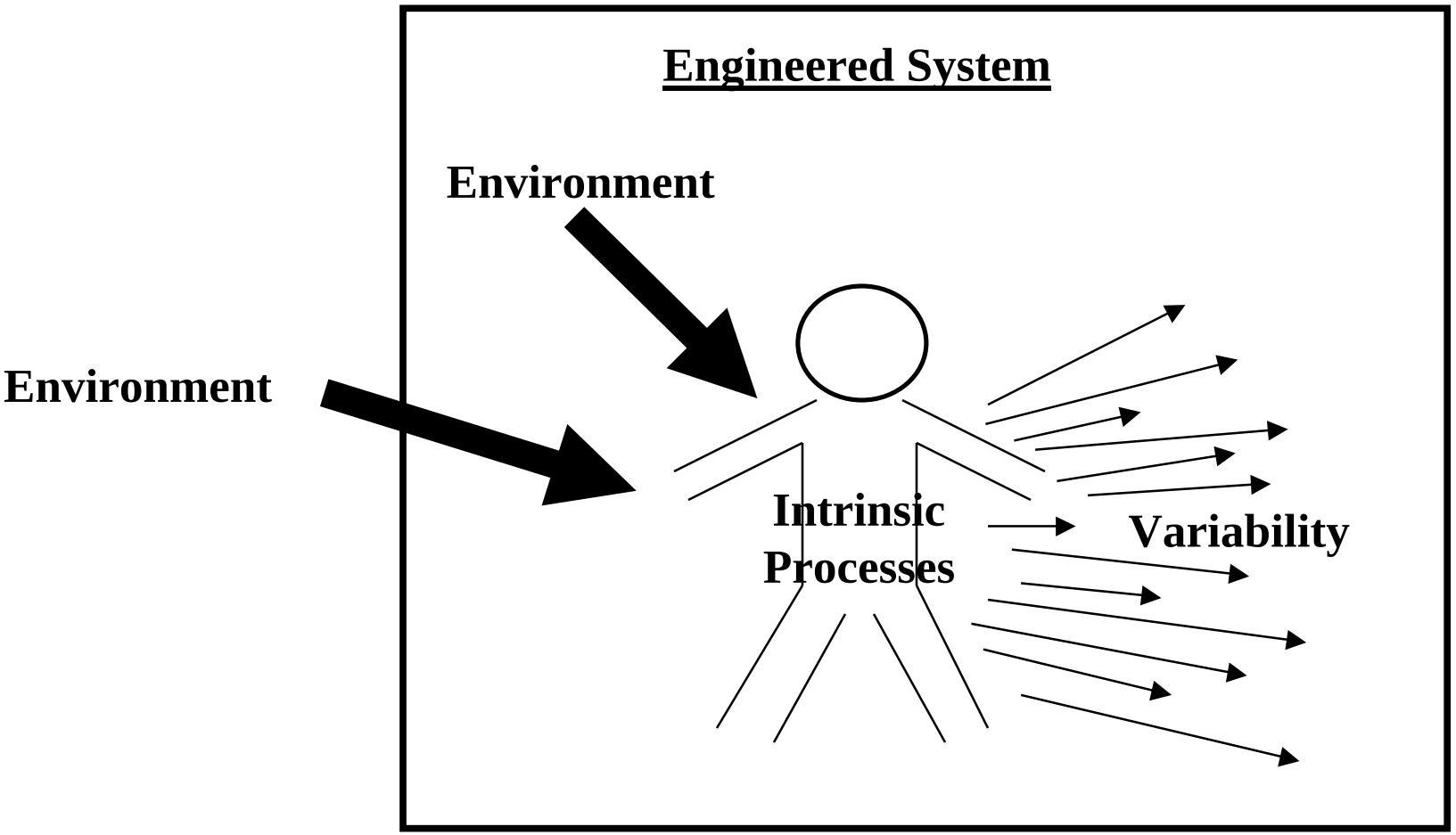
The Organic Model

Humans are organic systems (i.e., living organisms) and once they are inserted into a system that otherwise, could be understood using properties from the physical sciences, that system begins to exhibit properties of an organic (i.e., biological) system.

Organic Model in Perspective



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Critical Requirements for Realism of Synthetic Entities

- **Representation of emotional processes including the interaction between emotions, arousal and cognitive processes**
- **Representations of knowledge that provide a broad range of relevant, and also, irrelevant behavioral responses**
- **Mechanisms to address variations in knowledge and emotional associations attributable to cultural differences**
- **Mechanisms that enable non-linear patterns of behavior and reasonably realistic reactions to non-linear behavioral responses**

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Placement in World of Cognitive Modeling

Whereas emphasis has focused primarily on normative models of human performance, workload, etc., our goal has been to address the range of variability in behavior

- **Low likelihood – High Consequence Events**
- **Cultural Models**
- **Individualized Models**
- **Non-Optimal Conditions**
- **Psychopathologies**
- **Non-linear or Emergent Behavior**
- **Asymmetric Threats**
- **Effects-Based Operations**
- **Complex Systems**
- **Aberrant Behavior**

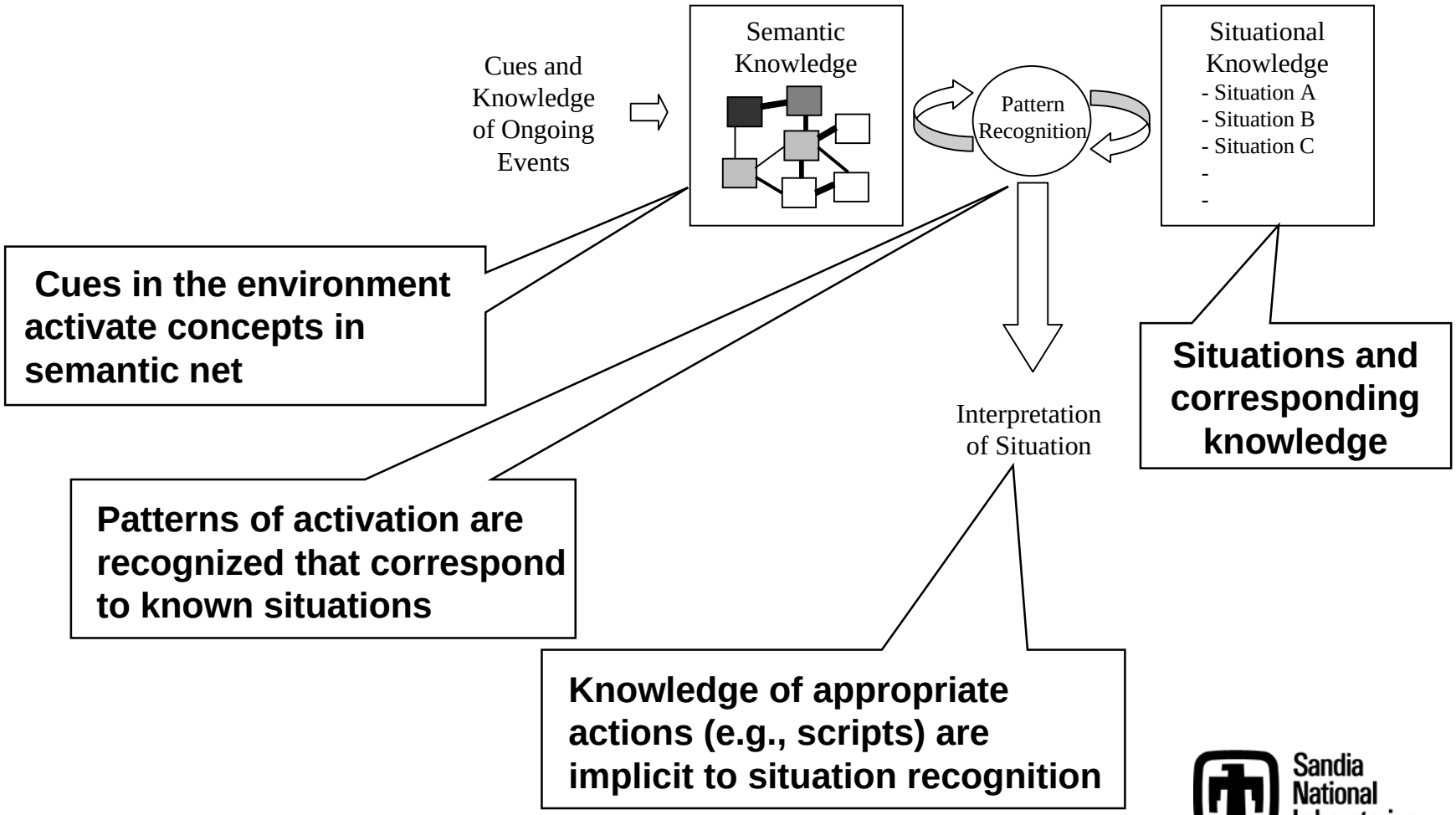
Recognition Primed Decision Making

Theory of human decision making advanced by Klein, and others, based on observed behavior of expert decision makers in real-life situations

Basic tenets:

- **Experts commit resources to understanding cues and other factors in a situation, not evaluation of alternative courses of action**
- **Once a pattern emerges, there is recognition of the situation with the appropriate course of action being implicit in this recognition**
- **Diagnosis and mental simulation applied in contexts where patterns are not immediately apparent**

Modeling Recognition Primed Decision Making



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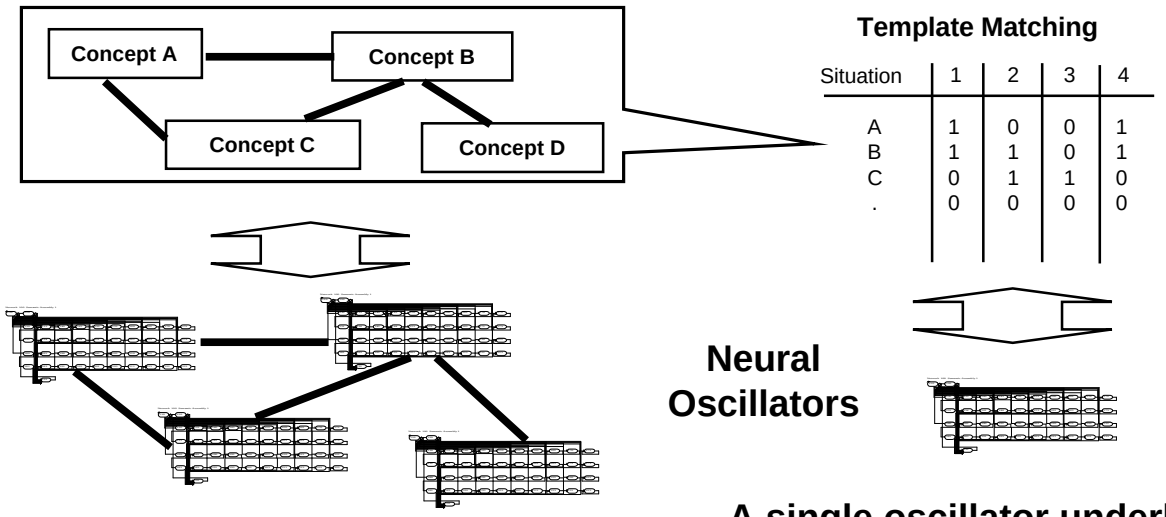
Physiology-Based Engine: Foundation in Oscillating Systems Theory



Oscillators represent each node in the network. In operation, the activity of these oscillators may vary in frequency and amplitude.

A single oscillator underlies the pattern recognition process. Operating at a lower frequency (10-13 Hz for semantic processes versus 4-7 Hz for recognition) it provides a relatively broad window for recognition of patterns in the activation of the semantic network.

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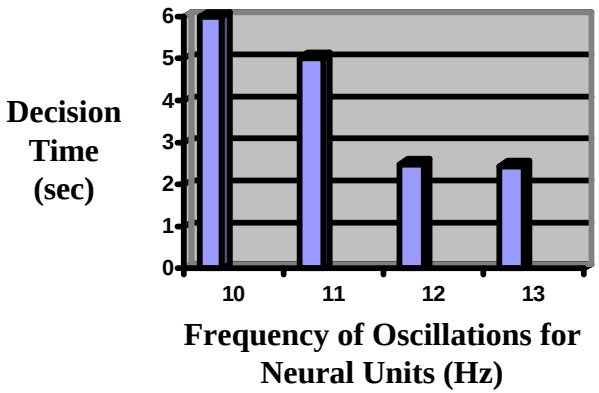
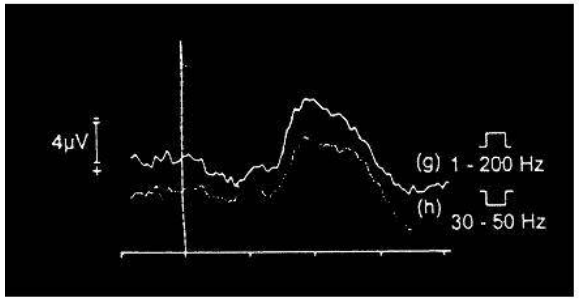
Properties of Semantic Processes: Reverse Engineering and First Steps Toward V&V

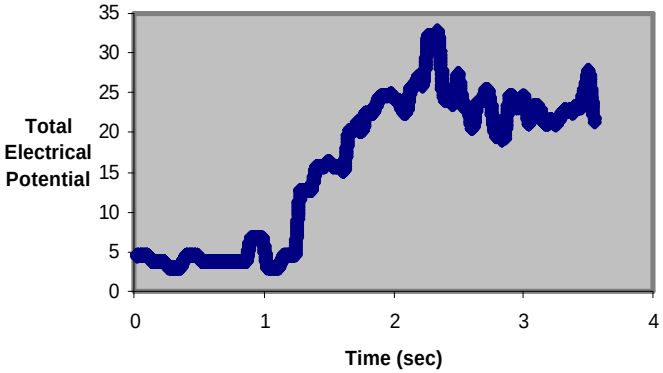
<u>Example of Specification</u>:
The rate of information processing corresponds to the dominant frequency in the 10-13 Hz Bandwidth
(Klimesch 1996)



Actual Event-Related Potential



Simulated Event-Related Potential



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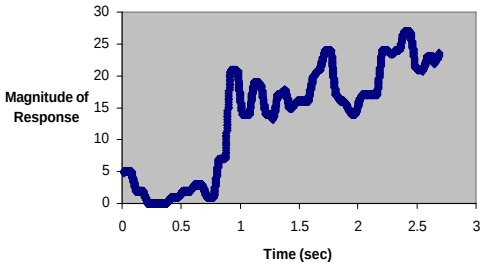
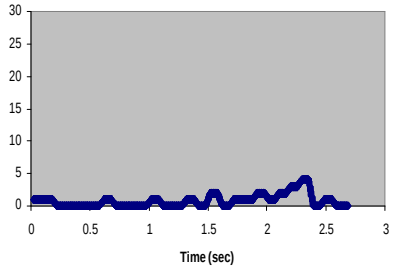
Emotions: Fear

Emotion leads to increased activation of neural assemblies corresponding to the stimulus event or situation associated with emotional reaction, and active inhibition otherwise (LeDoux 1998)



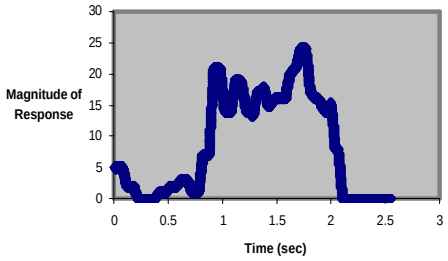
No association



Association

Activation Observed in the Absence of Fear-Inducing Stimulus

Activation Observed with Fear-Inducing Stimulus Presented at Approximately 2 Seconds.



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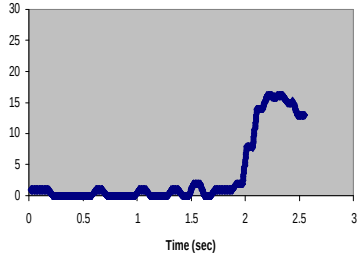

Association

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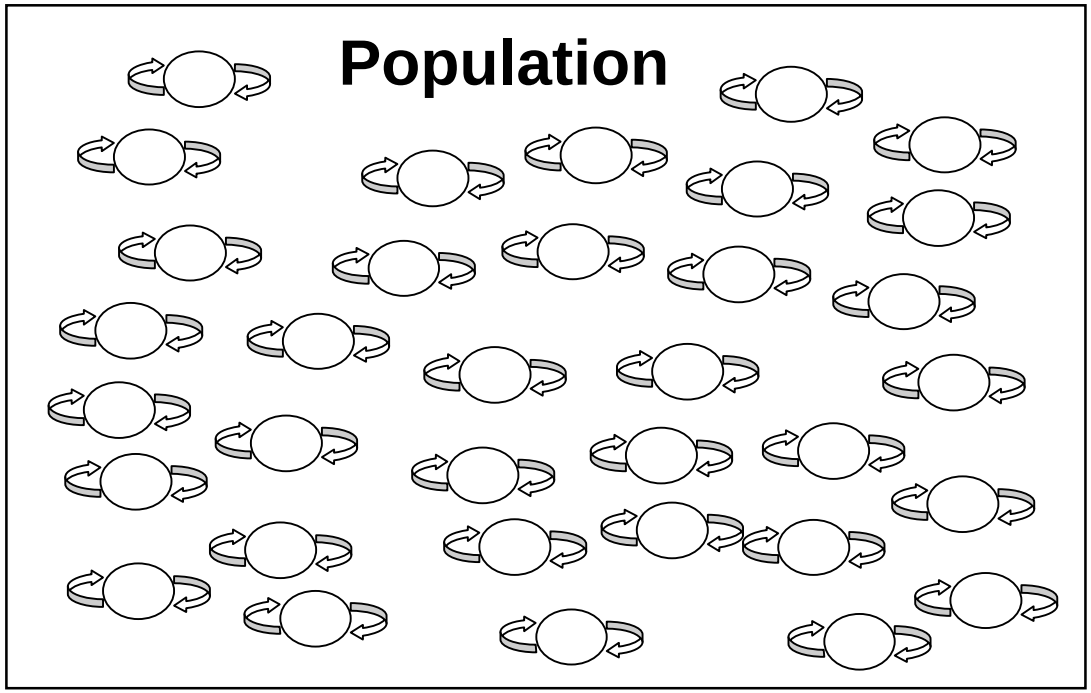
Population Models

Exploring concepts in which populations of distinctly different cognitive models interact



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Details, Characterization and Validation

Numerous assumptions underlie model, numerous parameters require characterization, and a methodology is required for validation

- differential contribution of cues
- additive and inhibitory influences of cues
- redundancy of cues
- differential saliency of cues
- facilitory priming of cues
- inhibitory priming of cues
- differential sequencing of cues
- top-down facilitation by preceding situation(s)
- top-down inhibition by preceding situation(s)
- situation release and situation nesting

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