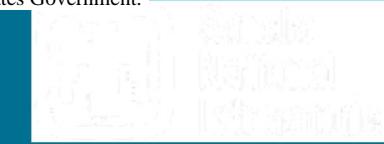


A Method to Assess Sociocultural and Geopolitical Responses to Concurrent Infrastructure, Information & Economic Attacks

DYMATICA

Dynamic Multi-scale Assessment Tool for Integrated Cognitive-behavioral Actions

Modeling, Assessment, and Training

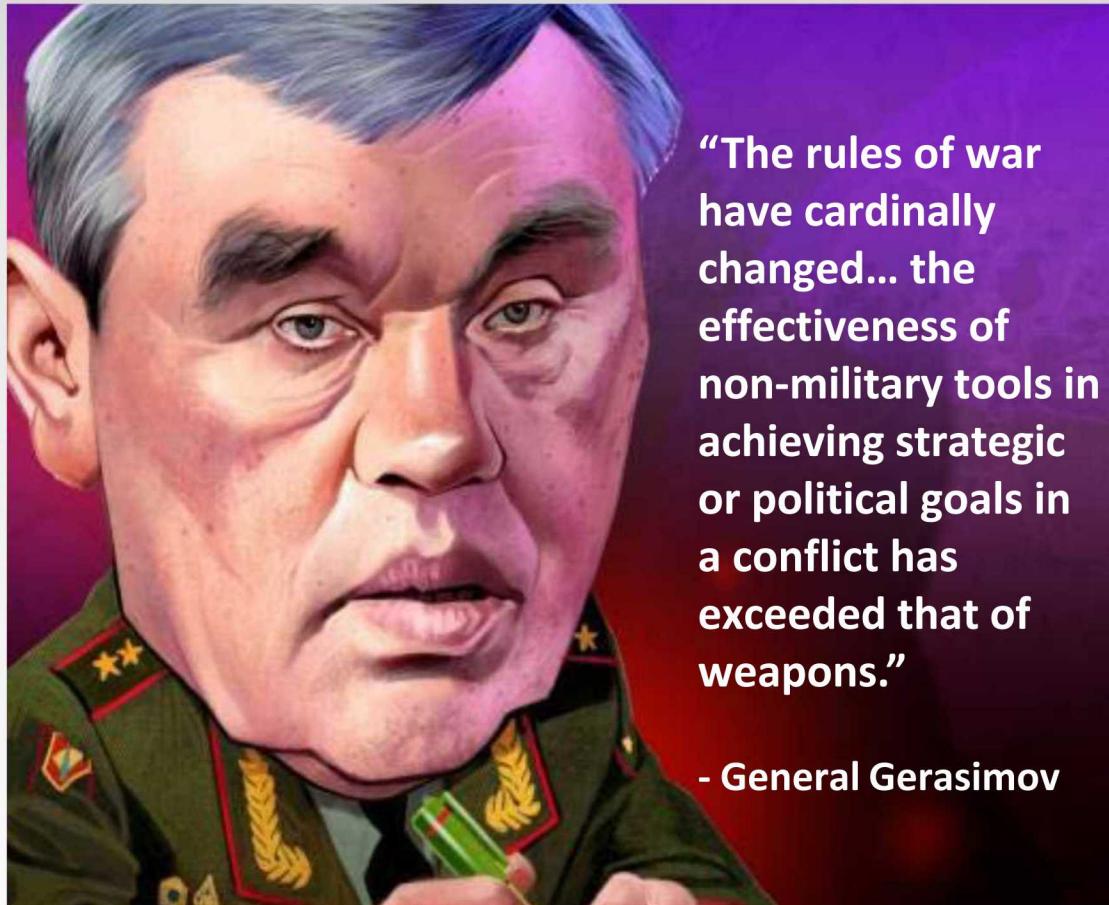


Sandia National Laboratories
Department of Energy

PRESENTED BY

Casey Doyle, PhD
Systems Research and Analysis

Geopolitical Gamesmanship, Social & State Stability, Extremist Movements...



“The rules of war have cardinally changed... the effectiveness of non-military tools in achieving strategic or political goals in a conflict has exceeded that of weapons.”

- General Gerasimov



“TERRORISM IS A PSYCHOLOGICAL WARFARE. TERRORISTS TRY TO MANIPULATE US AND CHANGE OUR BEHAVIOR BY CREATING FEAR, UNCERTAINTY, AND DIVISION IN SOCIETY.”

- PATRICK J. KENNEDY

Common Practices

- At least one expert with a specific domain expertise
- Group discussions, role playing, brain storming techniques

Current Limitations

- Not reproducible
- Typically focus on 1st-ordered interaction effects
- Typical ability to understand dynamic structure and behavior is very limited
- Typically does not consider decision/social theories
- Typically incorporates limited range of information/data
- Often personality driven

Yet...

In this area **human behavior** is important to consider

If we ignore human behavior, we are assuming it does not affect the system (setting it to zero)



Dynamic Multi-Scale Assessment Tool for Integrated Cognitive-Behavioral Actions

Informs High Consequence Decisions

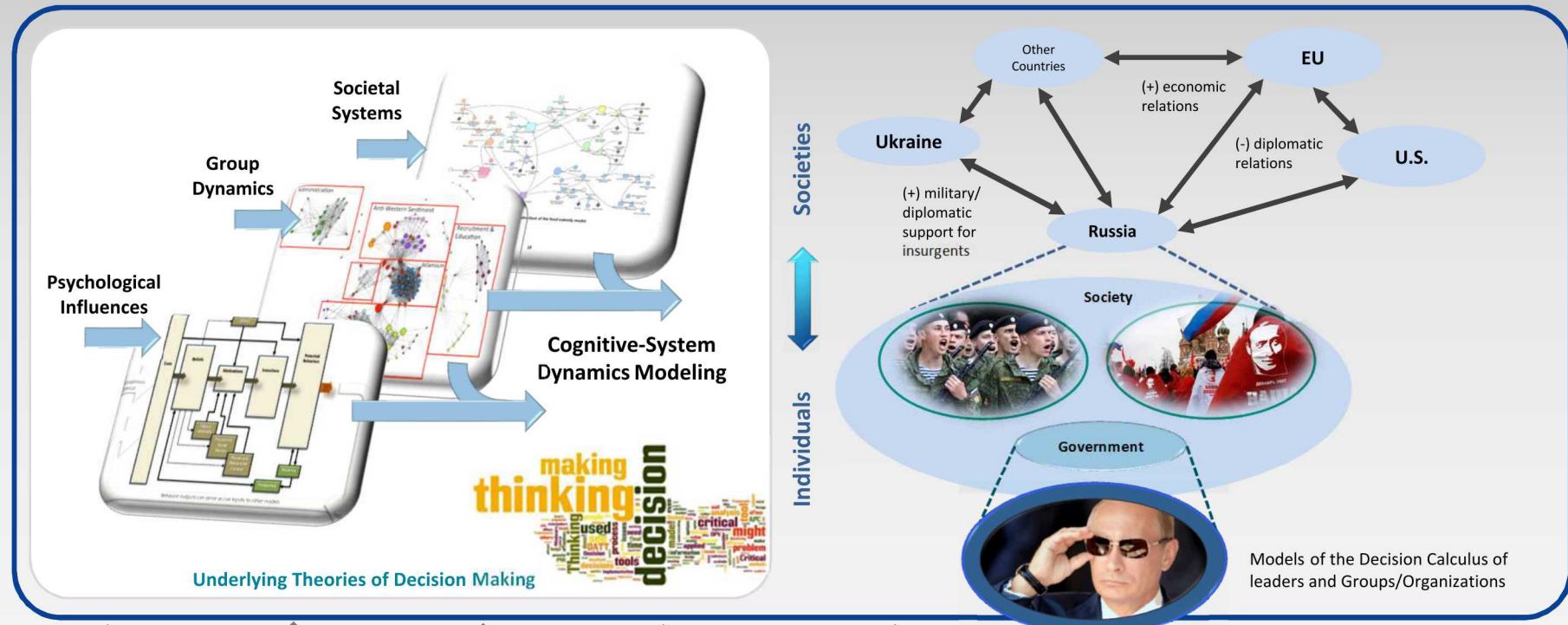
- Minimize the likelihood of decisions that lead to undesirable consequences by providing a more systematic analysis of group and individual decisions within state and non-state entities

Impact

- Enable analysts to assess higher-order (cascading) influences and reactions to events, as well as determine the uncertainty that the event will produce the desired results over time

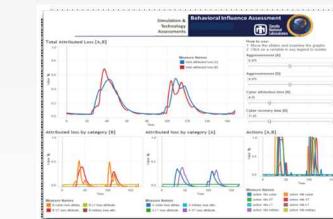
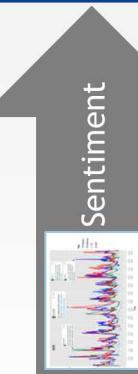
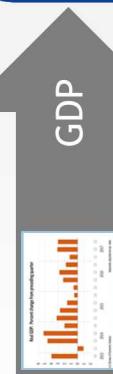


Russia Example

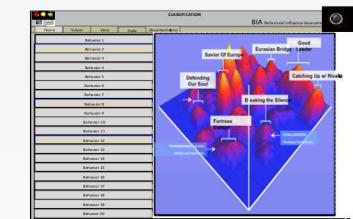


Multi-INT Data/Info

Current data to update model outputs



Descriptive & Prescriptive Analytics

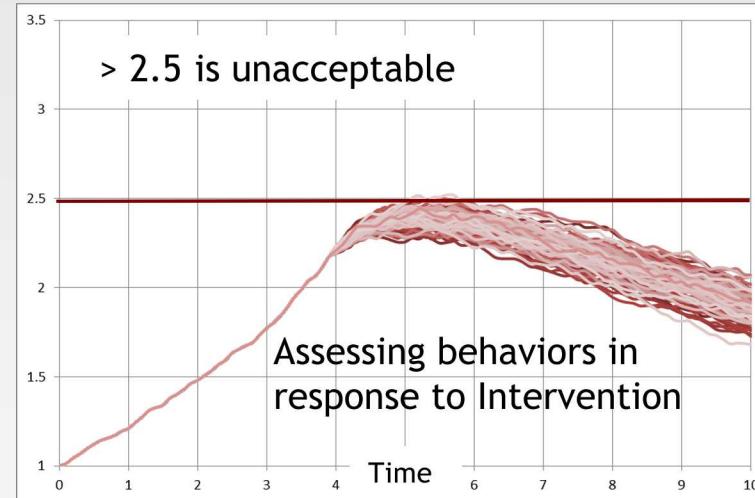
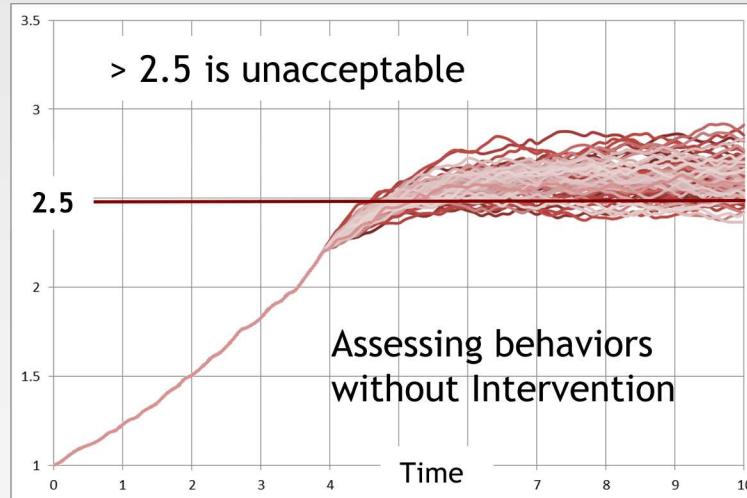


Hybrid Warfare Exercises and Future Operations

DYMATICA can assess the full range of behavioral patterns across time

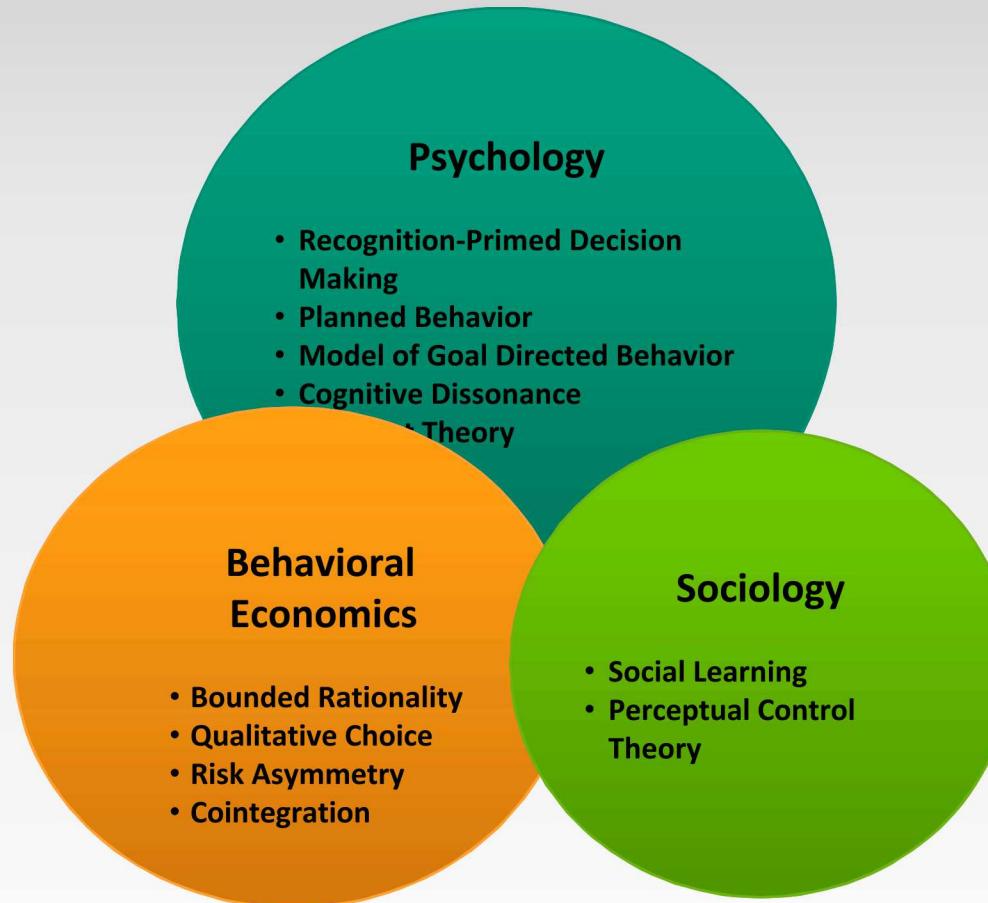
Given uncertainty, what interventions will most likely avoid unacceptable outcomes (including unintended consequences)?

- Example: Figures below shows likely behavioral paths across time. What is most important is to keep or move the range of behaviors to a level that is acceptable.



“River of Blood”: A now ‘formal’ term derived from the Bank of England Annual Report on economic forecasts and their uncertainty. Because of temporal volatility, DYMATICA extends the logic beyond the simplistic use of “variance” confidence intervals

Incorporates a Set of Theories Across Domains



Theory Descriptions (Examples)

Perceptual control theory

- Model of behavior based on the principles of negative feedback, but differing in important respects from engineering control theory

Prospect theory

- People make decisions based on the potential value of losses and gains rather than the final outcome, and that the losses and gains are evaluated using certain heuristics

Recognition-primed decision making

- Model of how people make quick, effective decisions when faced with complex situations

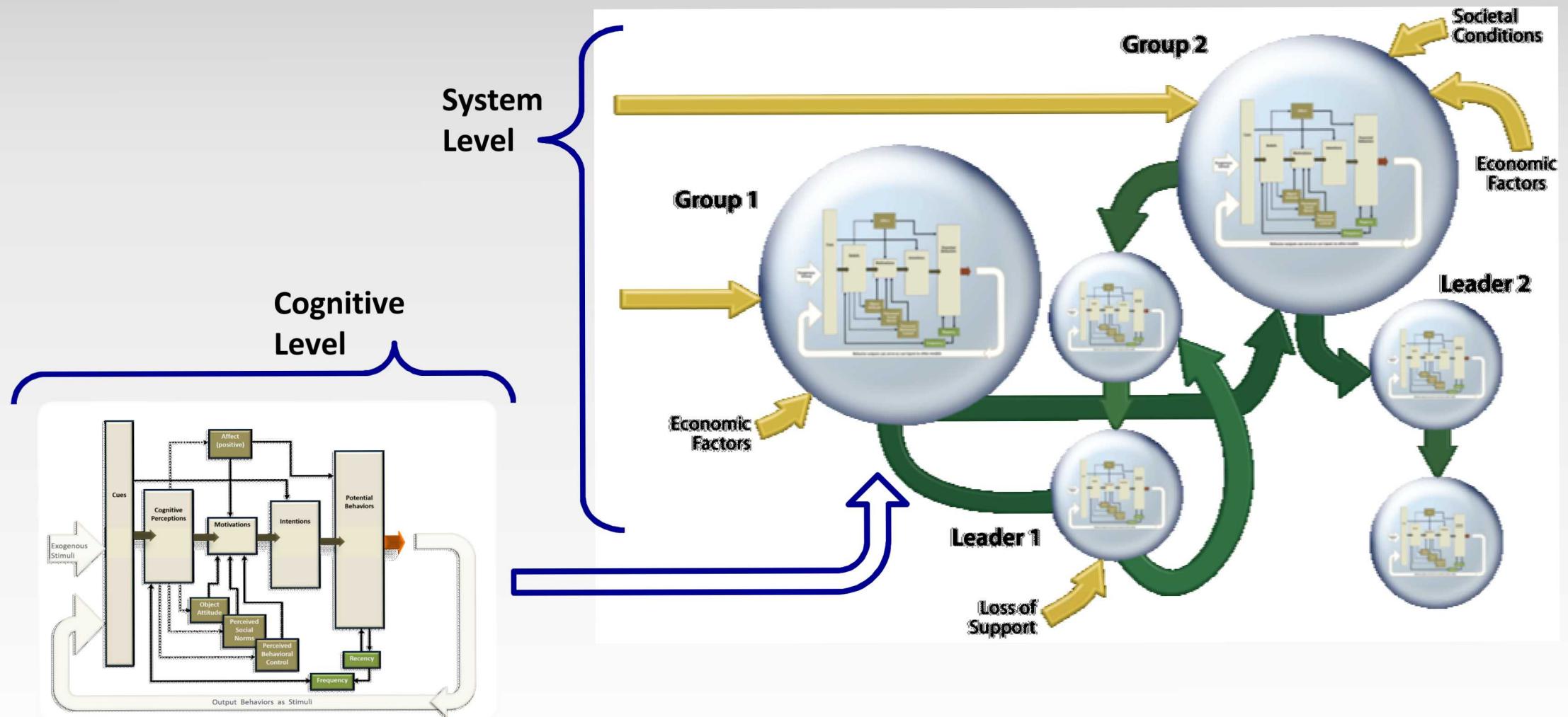
Qualitative choice theory

- *Daniel McFadden: 2000 Nobel Prize*
- Social responses are dominated by uncertain decision logic, parameters, and information processing

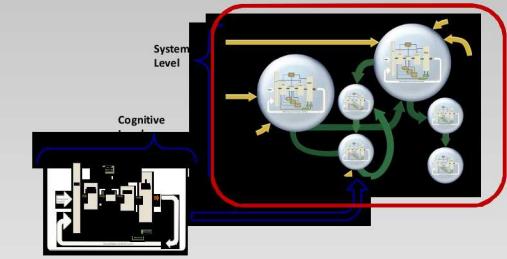
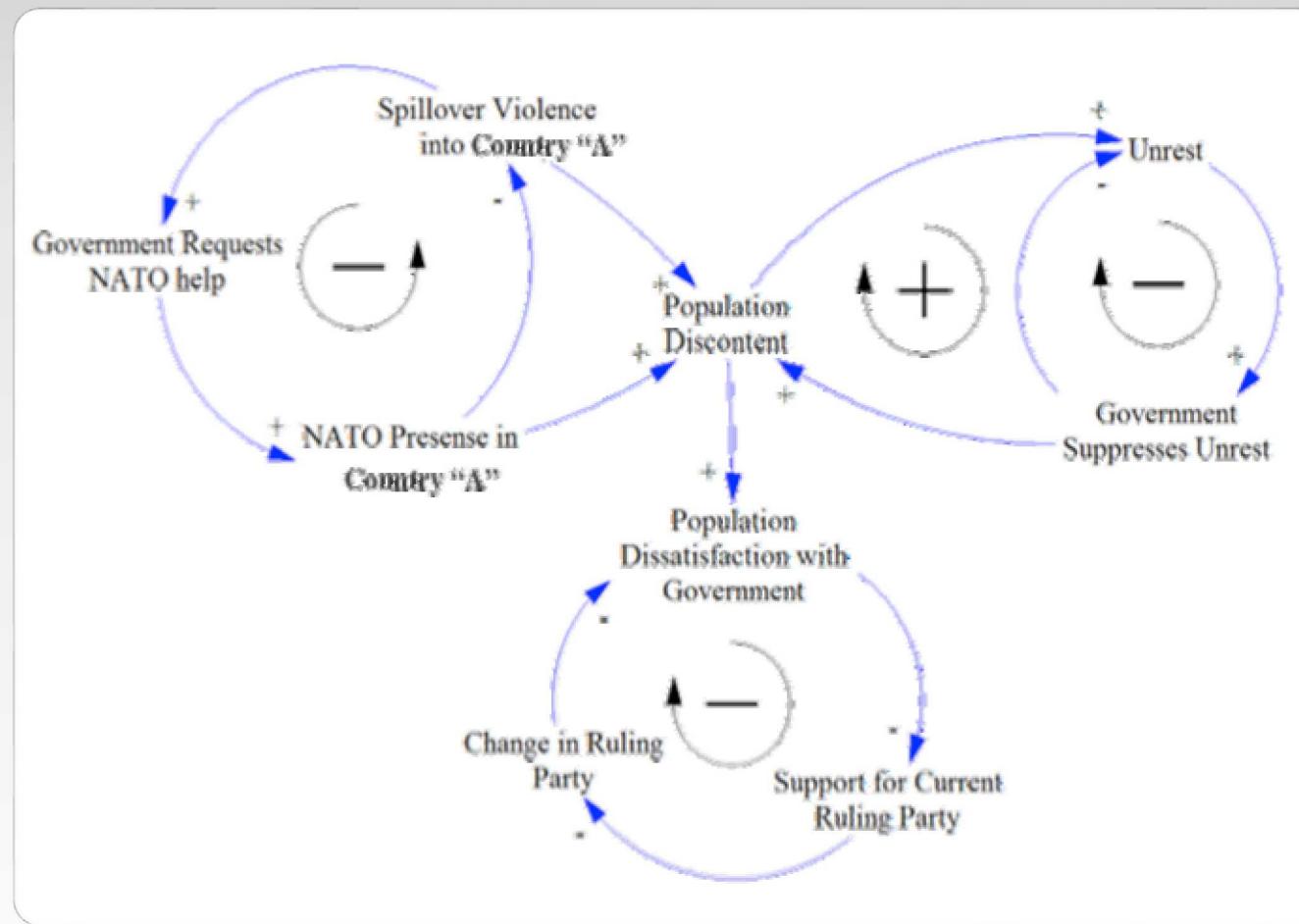
Social learning theory

- Individual's behavior is influenced by the environment and characteristics of the person

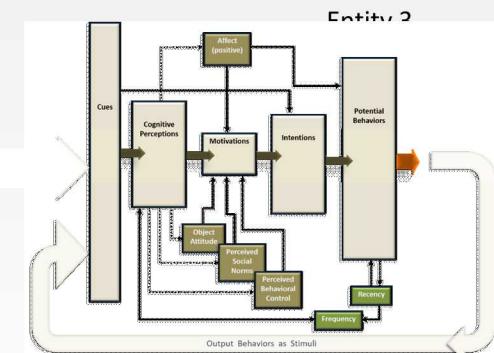
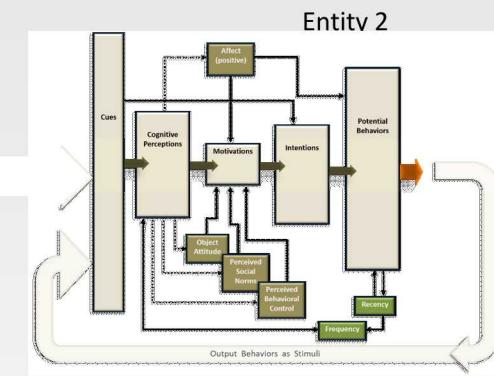
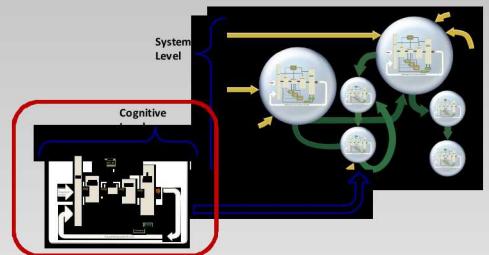
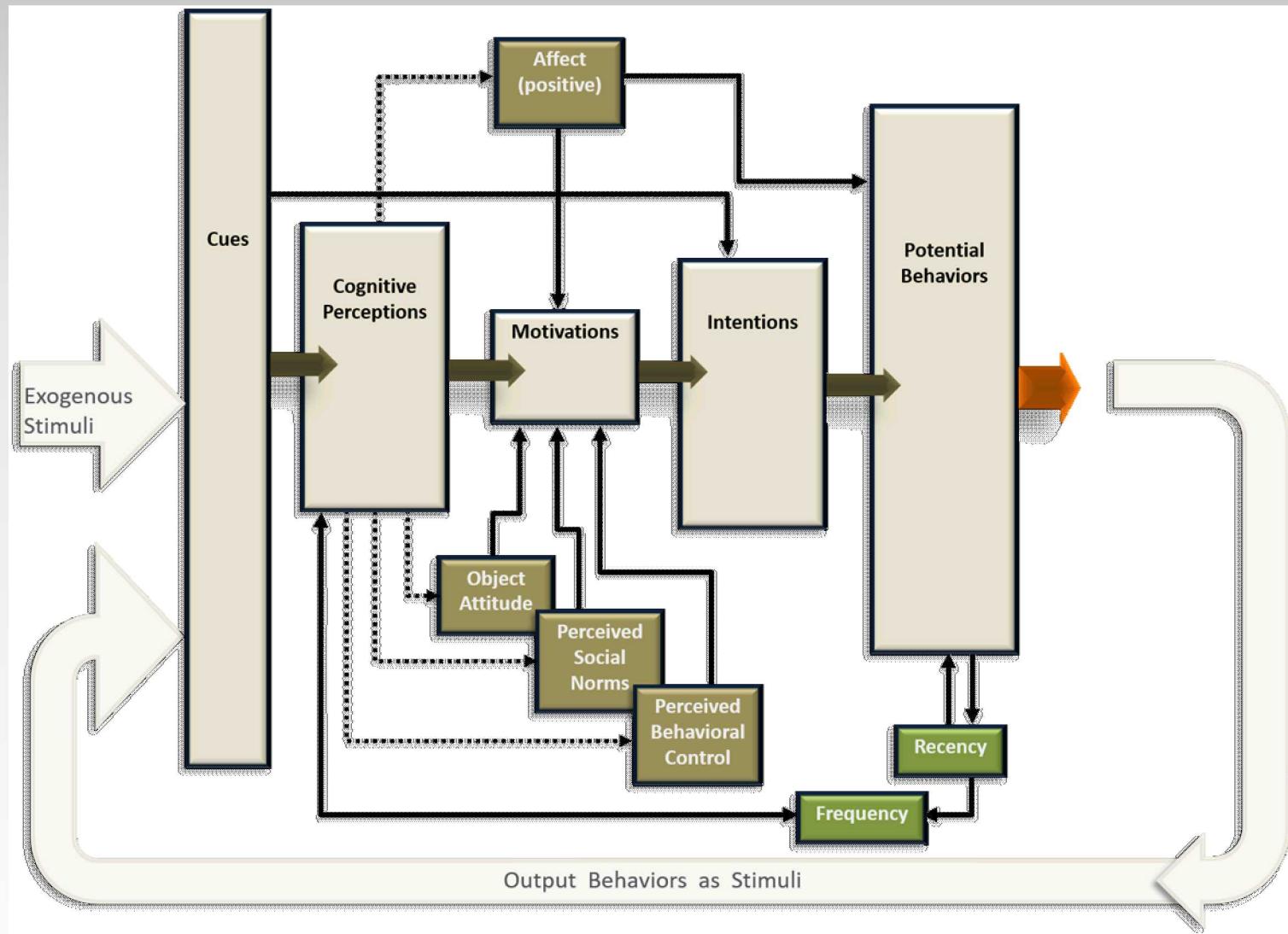
Integration of Cognitive and System Models



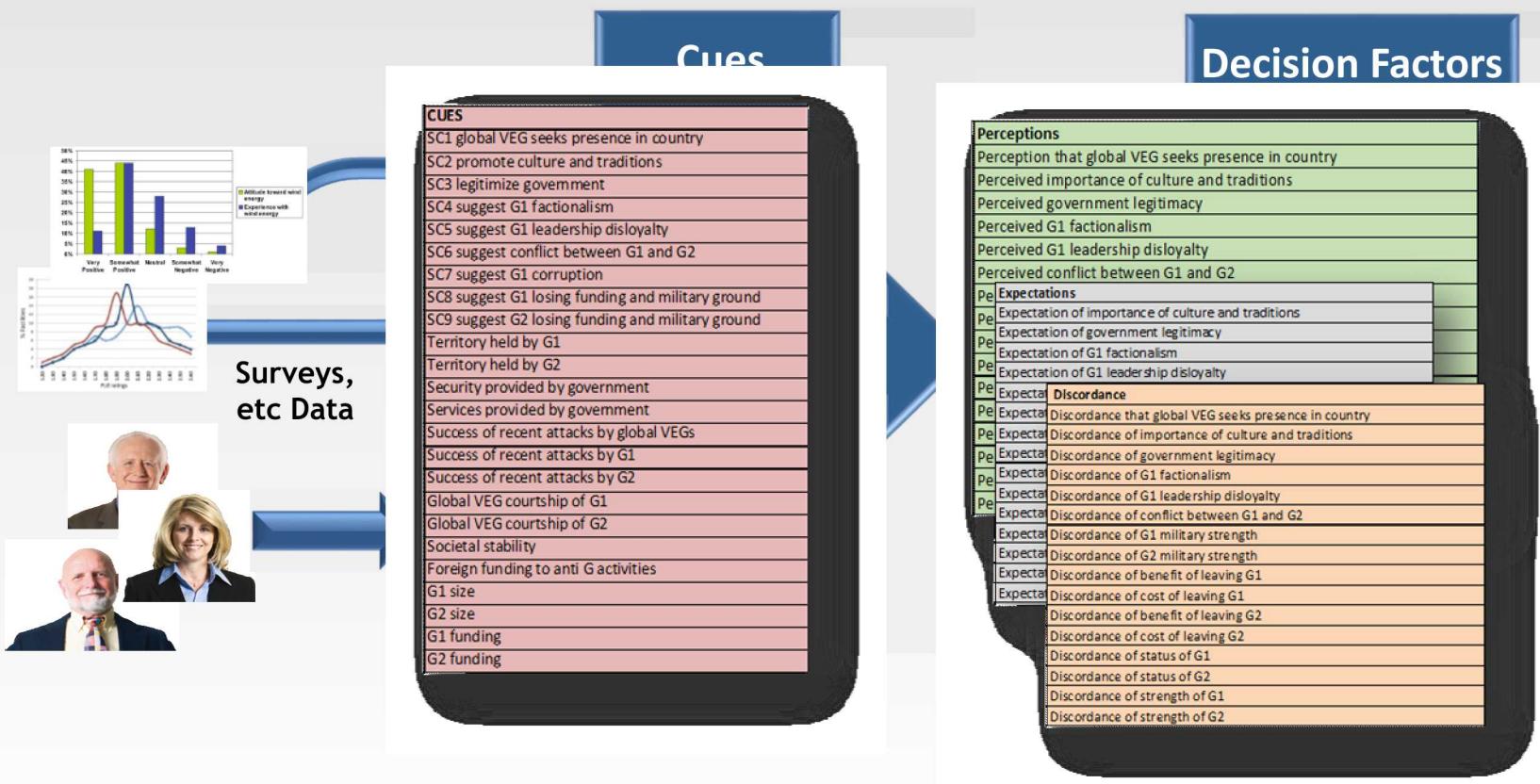
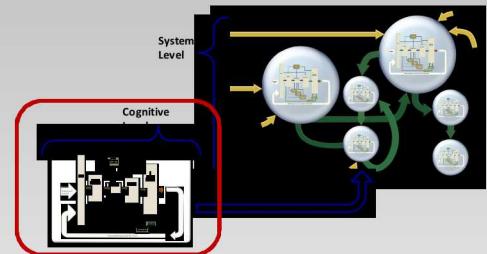
Broad-Level Societal System (Example)



Core Psychosocial Architecture

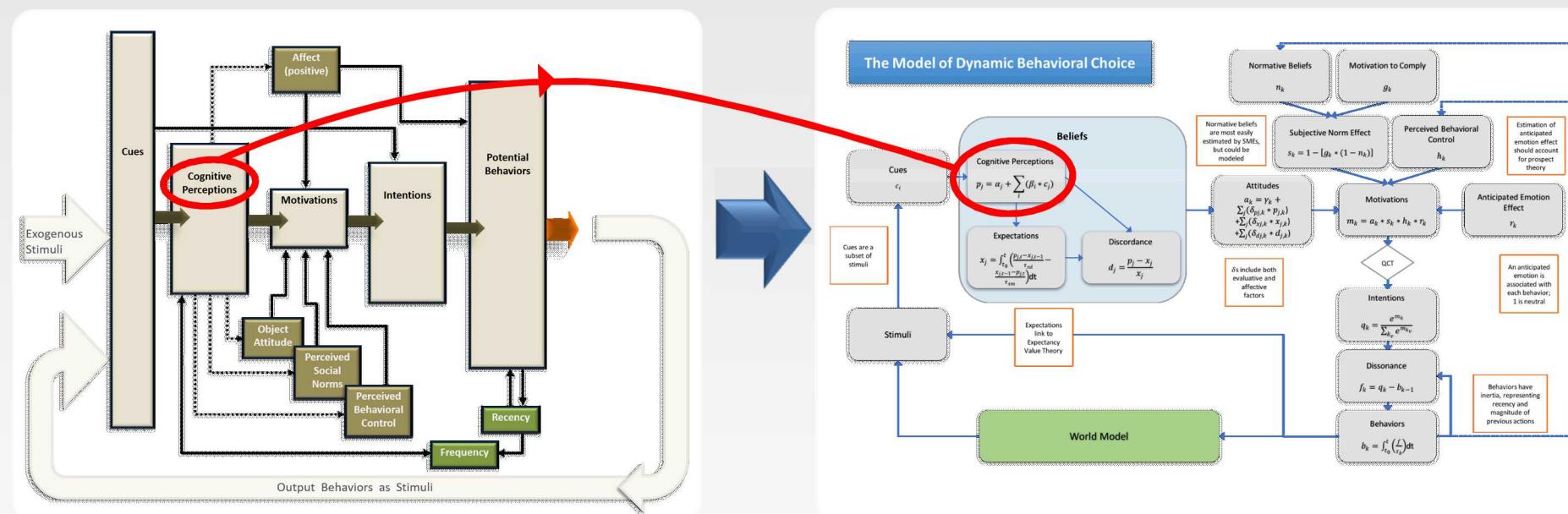


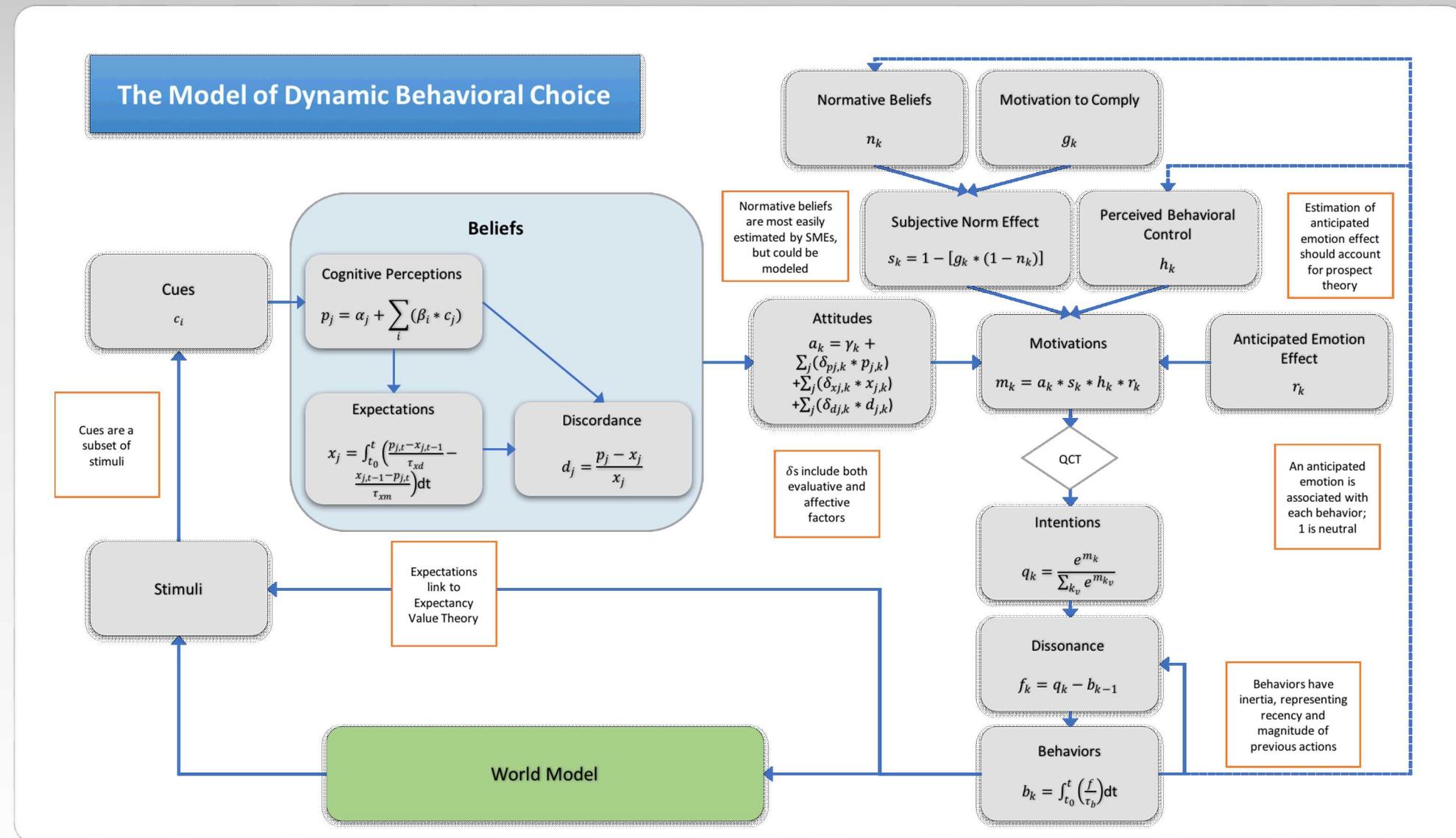
Examples of SME information, data, and report information that populate DYNAMICA models



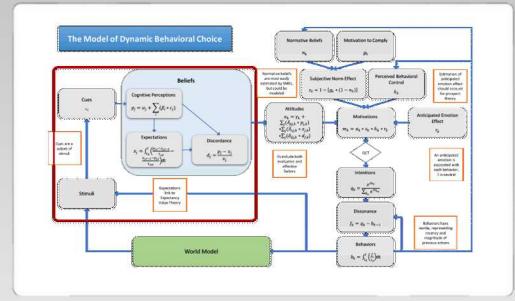
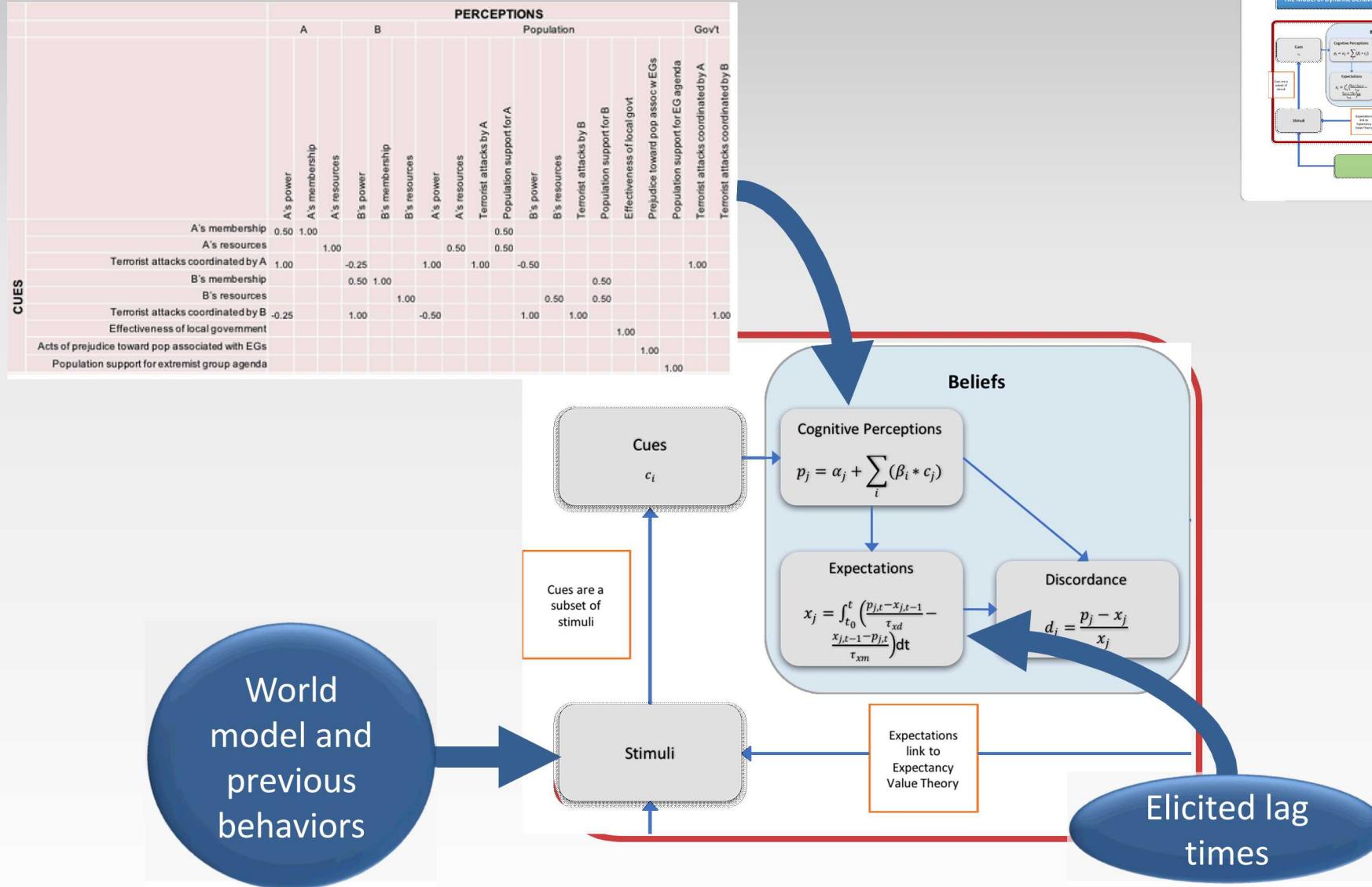
One-to-one Mapping of Conceptual Model to Mathematical Implementation

How to translate and incorporate SME opinion into computational, decision models of specific groups/individuals?

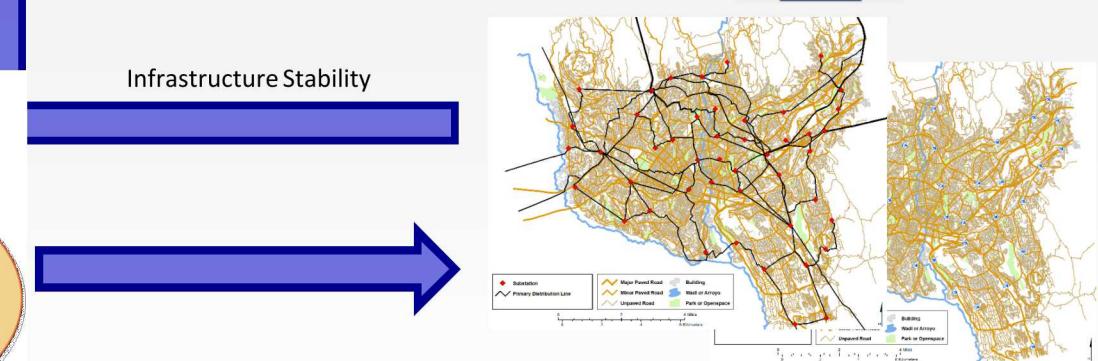
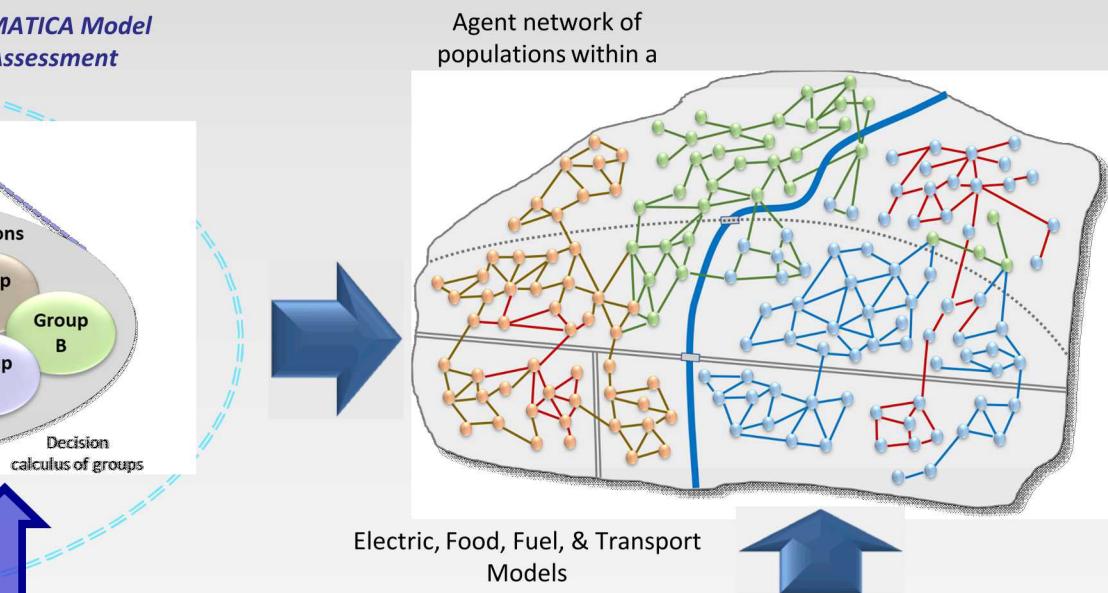
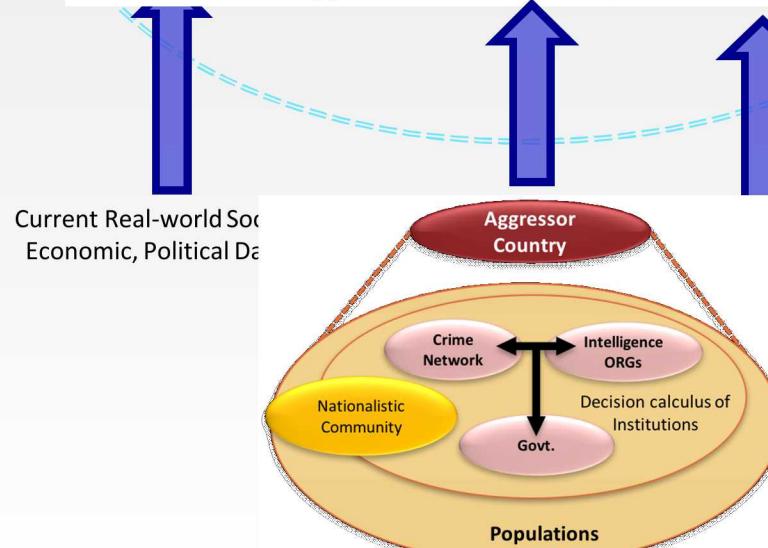
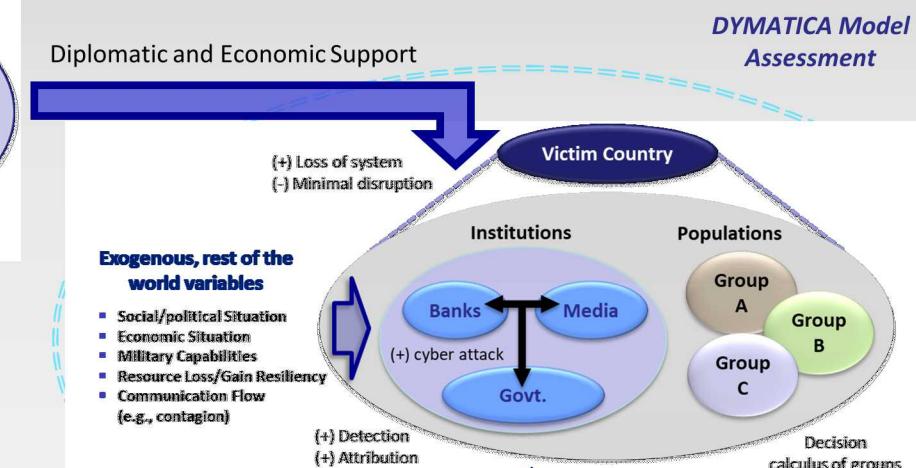
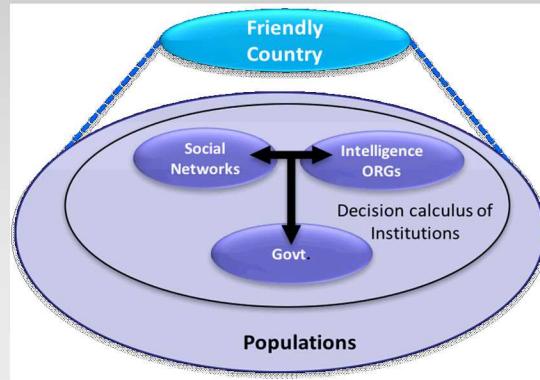




Mathematical Implementation Example



Hybrid Warfare Simulations for Assessment Tools



Projected Developments

Year One (FY18-19)

- The ability to model and simulate how certain infrastructure disruptions and co-occurring geopolitical, economic, and sociocultural events affect the resiliency of governments, as well as various aspects of society.
 - *Coupling of DYMATICA with Infrastructure and economic models*

Year Two (FY19-20)

- The modeling and simulation of multiple adversary messaging/propaganda, economic warfare, infrastructure disruptions/special operations, along with friendly country assistance as it affects the behaviors of multiple government institutions, societal groups and non-governmental organizations across time.
 - *Coupling of DYMATICA with Infrastructure and economic models*
- The ability to ingest government data and social media information to update and calibrate the model over time.

Assessing Data Within Models

- ***Quantifying uncertainty:***

- Assess how uncertainty in model inputs propagates through the model to affect results
- Characterize uncertainty in model inputs
- Helps the analyst to understand potential outcomes given that some assumptions and conditions are uncertain
- Run the model with different combinations of inputs to characterize uncertainty in outputs
- Likely to use Dakota software - Sandia-developed, Publicly available

- ***Sensitivity analysis:***

- Assess which COAs have the largest effects, i.e., where intervention would be most effective
- Can use to learn
- Best places to focus data collection resources
- Whether the model can be simplified

- ***Verification:***

- Extreme value tests - to assess implausible behavior caused by certain ranges of values
- Benchmark problems - to test the accuracy of the code used for numerical integration

- ***Validation (Confidence Management):***

- Face validation - assess model for reasonableness; Diagrams of model structure
- Cross validation - assess a subset of historical data, compare results to remaining data

DYMATICA Modeling & Assessment

Current Work and Capabilities

DYMATICA

Dynamic Multi-scale Assessment Tool for
Integrated Cognitive-behavioral Actions

Modeling, Assessment, and Training

Sandia National Laboratories
Department of Energy

PRESENTED BY

Michael Bernard, PhD
Applied Cognitive Science Dept.

