



DYMATICA Modeling & Assessment

Current Work and Capabilities

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Our Focus

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

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.

“THE RUSSIAN VIEW OF MODERN WARFARE IS BASED ON THE IDEA THAT THE MAIN BATTLESPACE IS THE MIND.”

— NATIONAL DEFENCE ACADEMY OF LATVIA POLICY PAPER



“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 Assessment Methods

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

Current limitations

- Human ability to understand dynamic structure and behavior is very limited
- Typically does not consider decision/social theories
- Typically incorporates limited data
- Focus on 1st-ordered interaction effects
- 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)

R&D Challenge 1:

More rigorously assess sociocultural/
geopolitical responses to actions and events

Develop and implement assessment
capabilities that can effectively do this

Informs High Consequence Decisions

- Better understand and anticipate the interplay between specific individuals, political/social military organizations, and general society in response to potential courses of actions or events

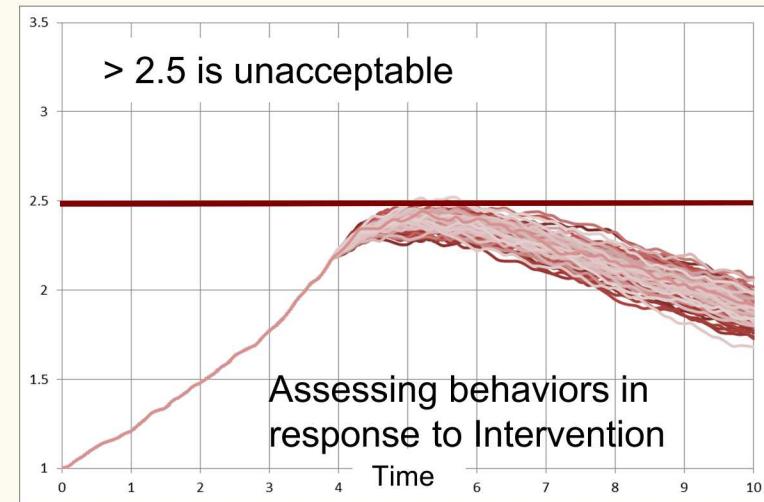
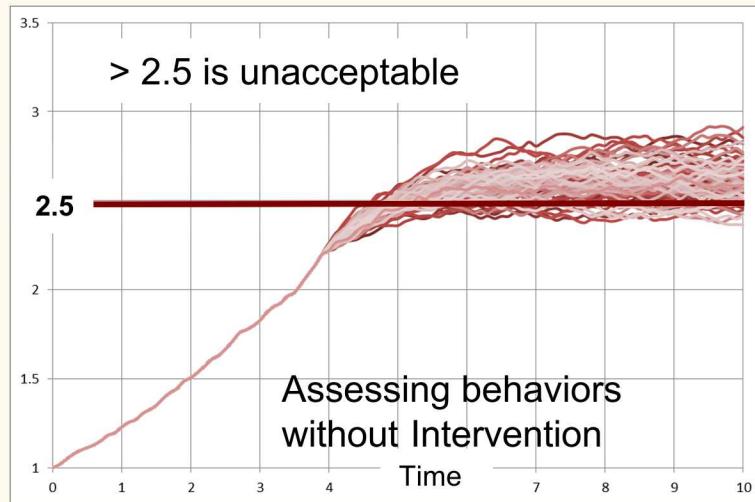
Impacts

- Enables 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



Emphasizing Uncertainty

- Given uncertainty, what interventions will most likely avoid unacceptable outcomes (including unintended consequences)?
- Start with maximum uncertainty. Any irremovable uncertainty is part of risk calculus and risk mitigation.



“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, DYNAMICA extends the logic beyond the simplistic use of “variance” confidence intervals

Modeling Focus on Broad-level Behavior and More Culturally-Specific Decisions

Behavioral Tendencies

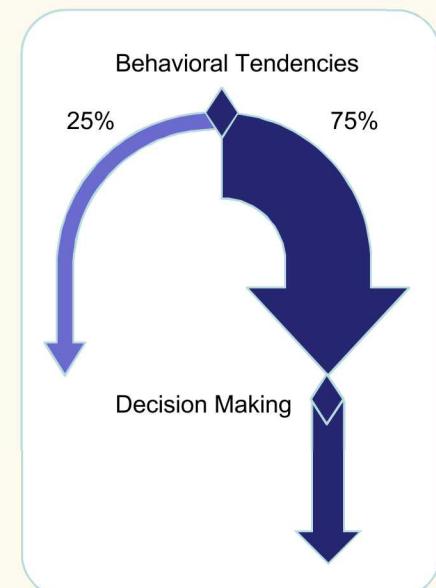
Humans unwittingly tend to fall prey to predictable forms of logic.

- *Ex., People who fear loosing something valuable are ready to take greater risks than those who hope to make a gain* (e.g., Vietcong versus U.S during the Vietnam War)

Decision Making

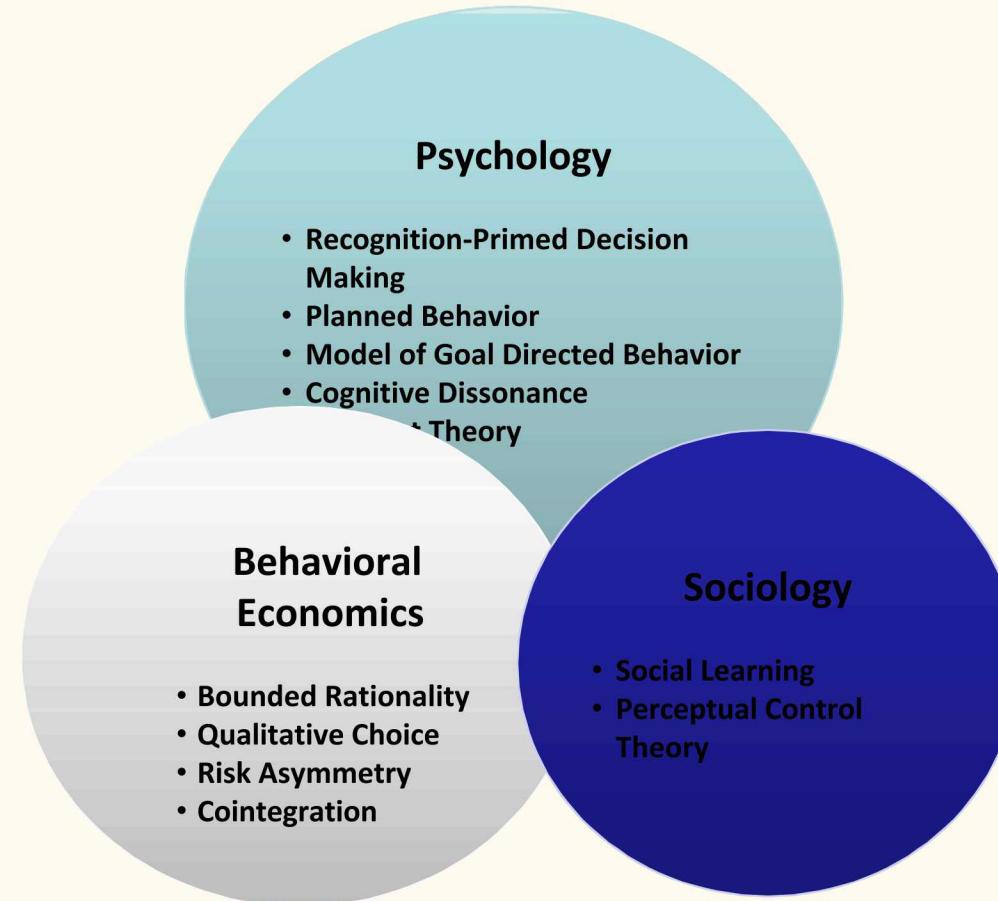
The cognitive mechanisms underlying the decision-making processes to enact intentional behaviors tend to be consistent across cultures.

- *Ex., Meta-analysis demonstrate that a large variety of social behaviors can be anticipated by sociocultural models*
(e.g., theory of planned behavior, etc.)



Based on Theories of Human Decision Making and Behaviors

Incorporated 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

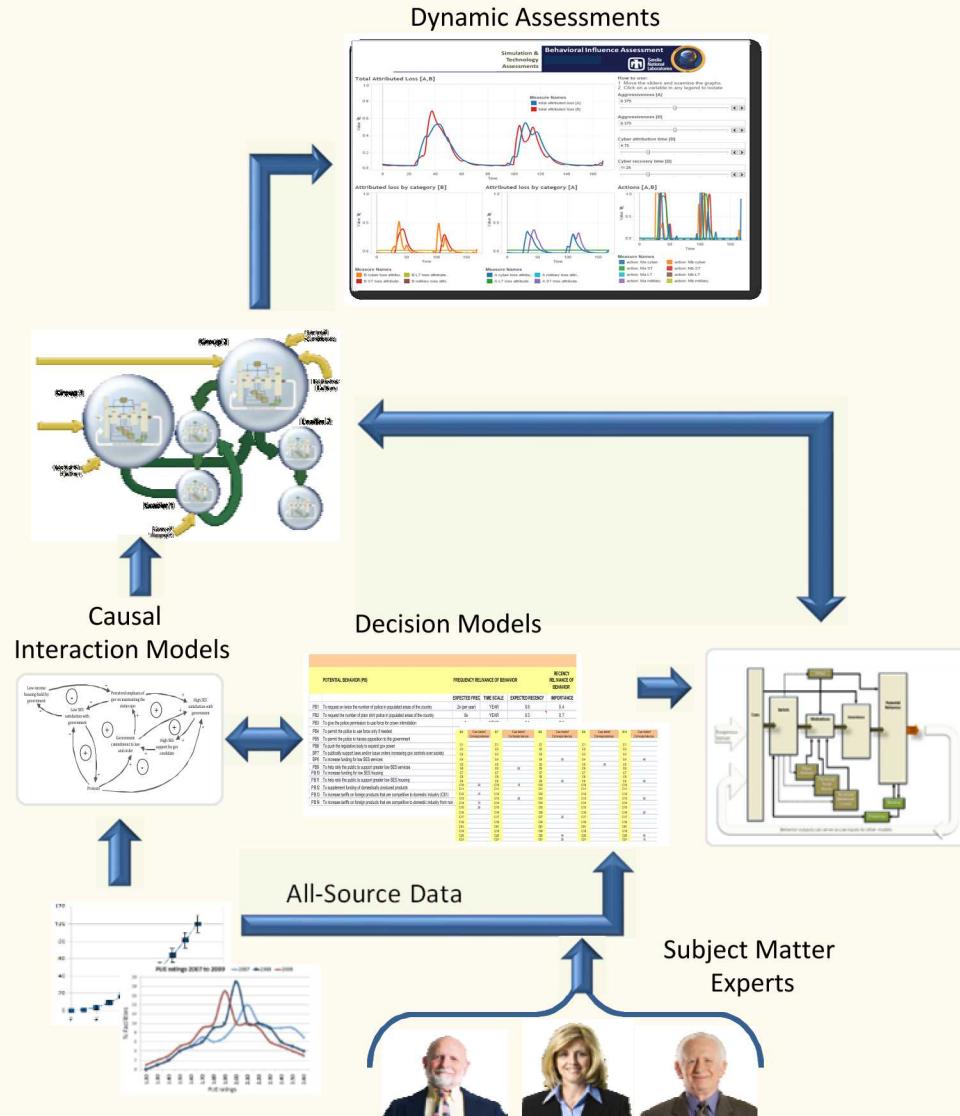
Social learning theory

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

General Process to Create DYNAMICA Models

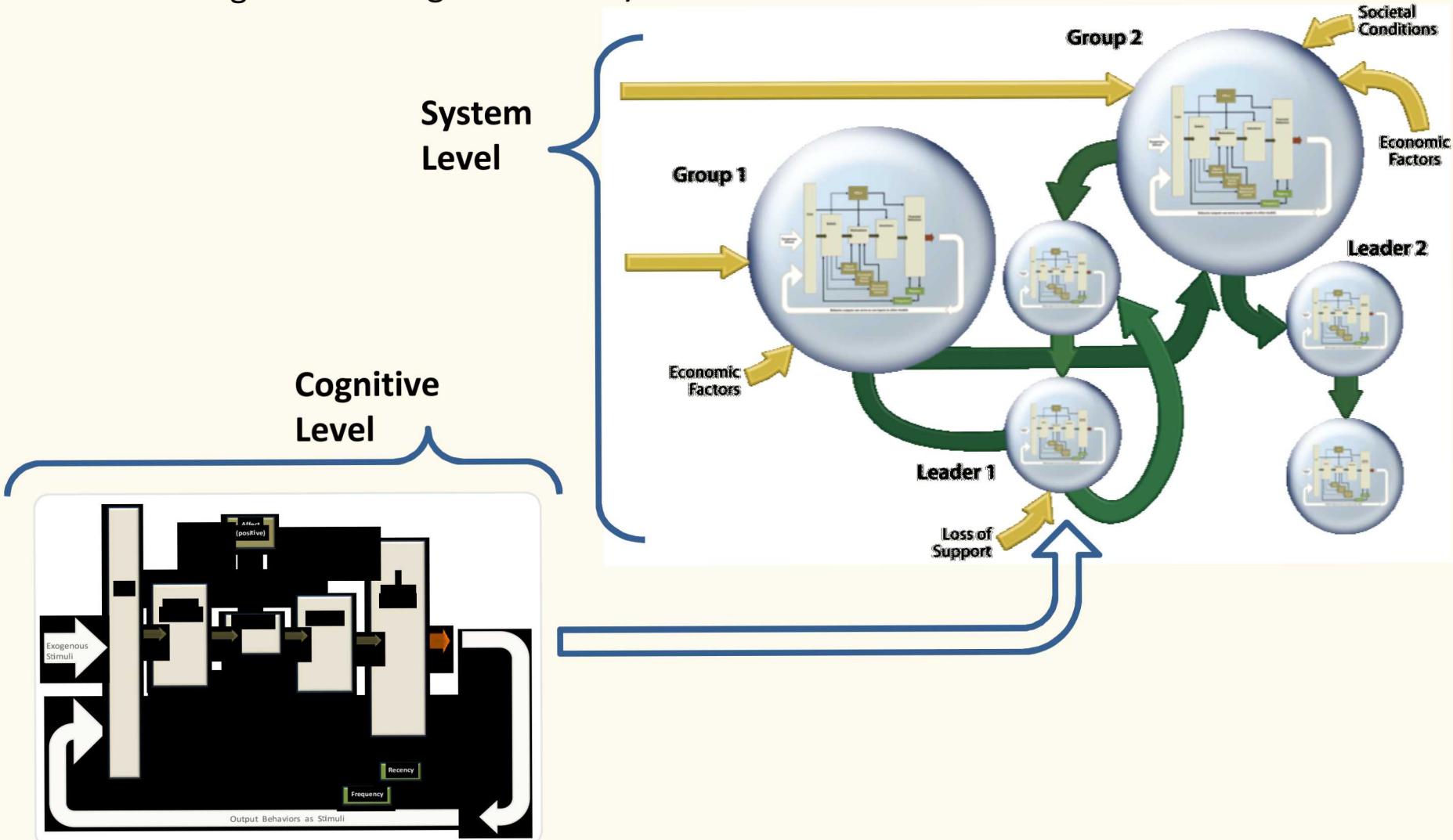
Involves 10 main steps:

1. Develop key intelligence question with customer
2. Select scope and granularity of assessment with customer
3. Perform literature review
4. Perform systems-level and decision-level elicitation from experts
5. Develop systems-level model of interactions/influences
6. Develop decision-level model of interactions/influences
7. Integrate dynamic, multi-scale computational model
8. Falsify or retain, improve, move on
9. Analysis: scenarios, interventions, sensitivity, and uncertainty, validation assessments
10. Dynamic visualization and delivery

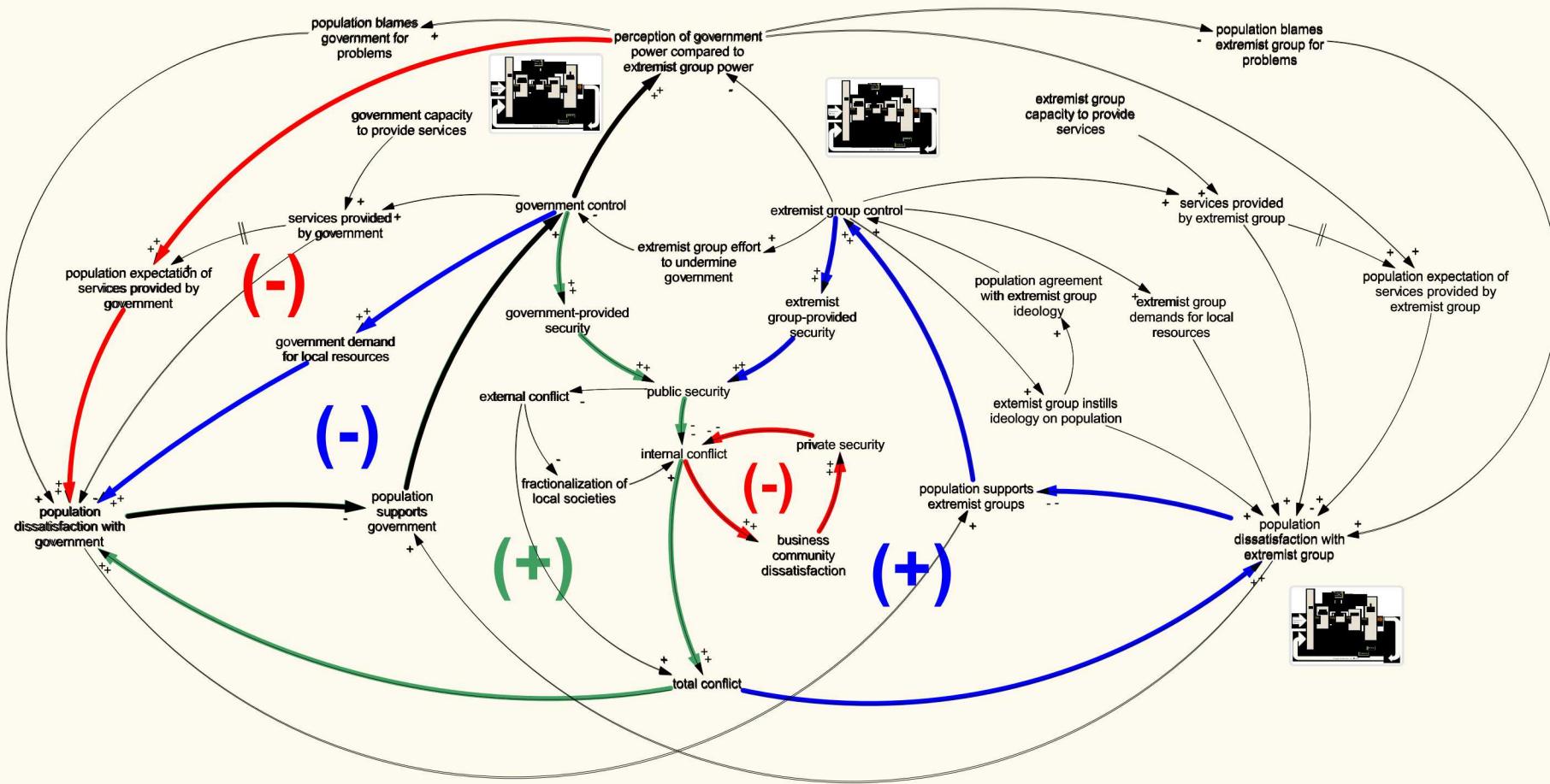
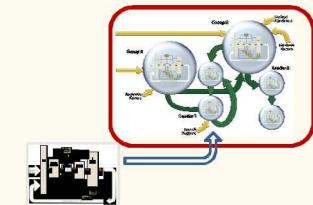


Cognitive-System Dynamic Approach

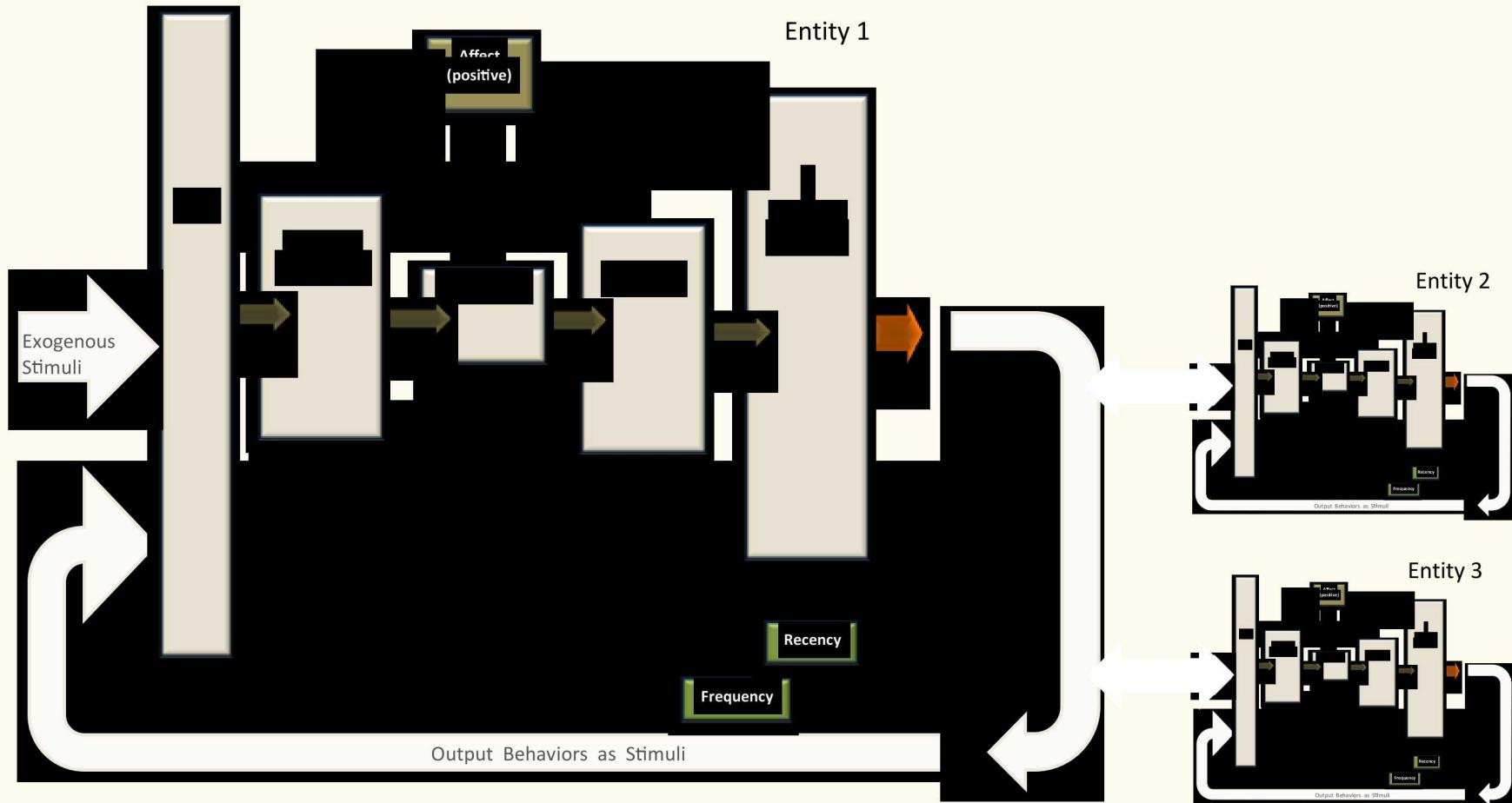
Integration of Cognitive and System Models



System-Level Model of Influences



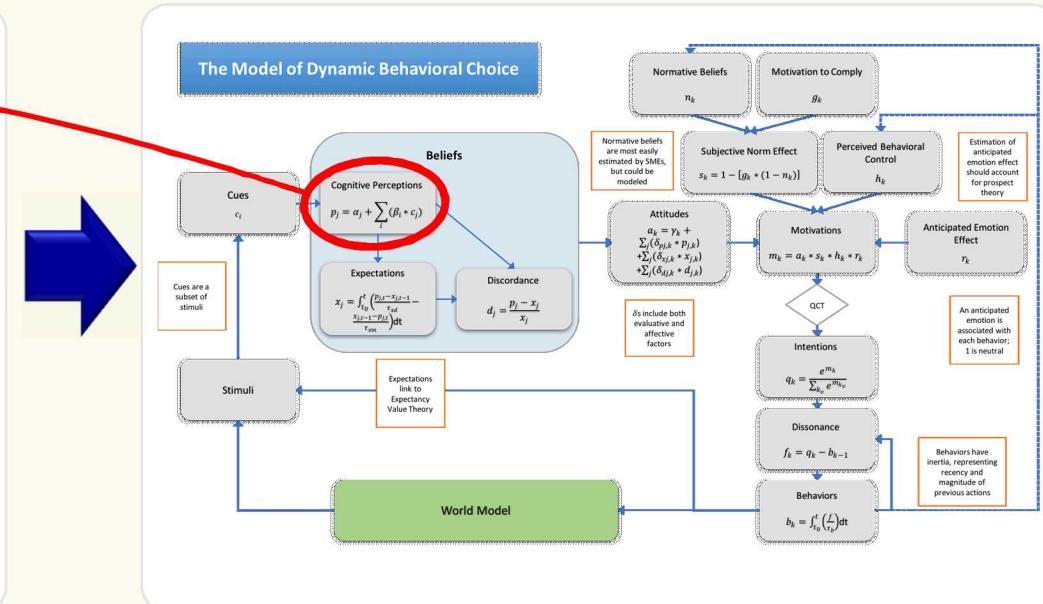
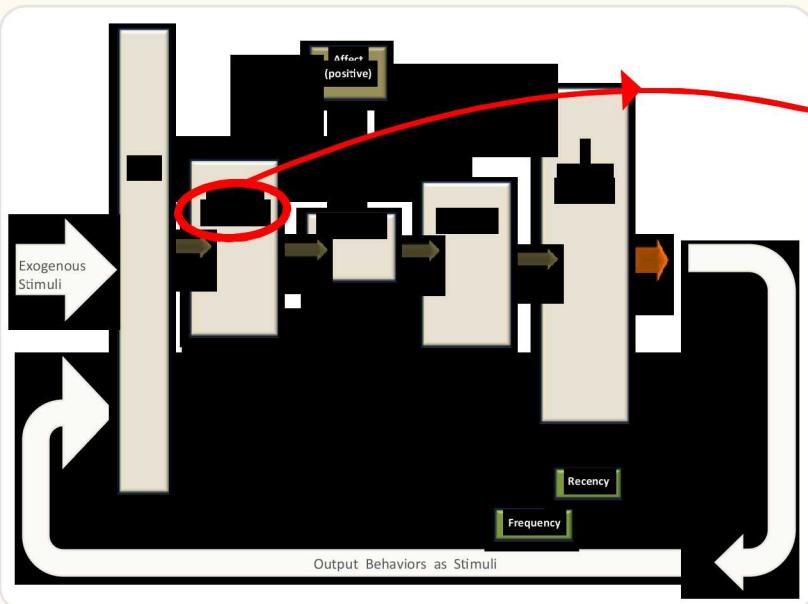
Core Psychosocial Architecture



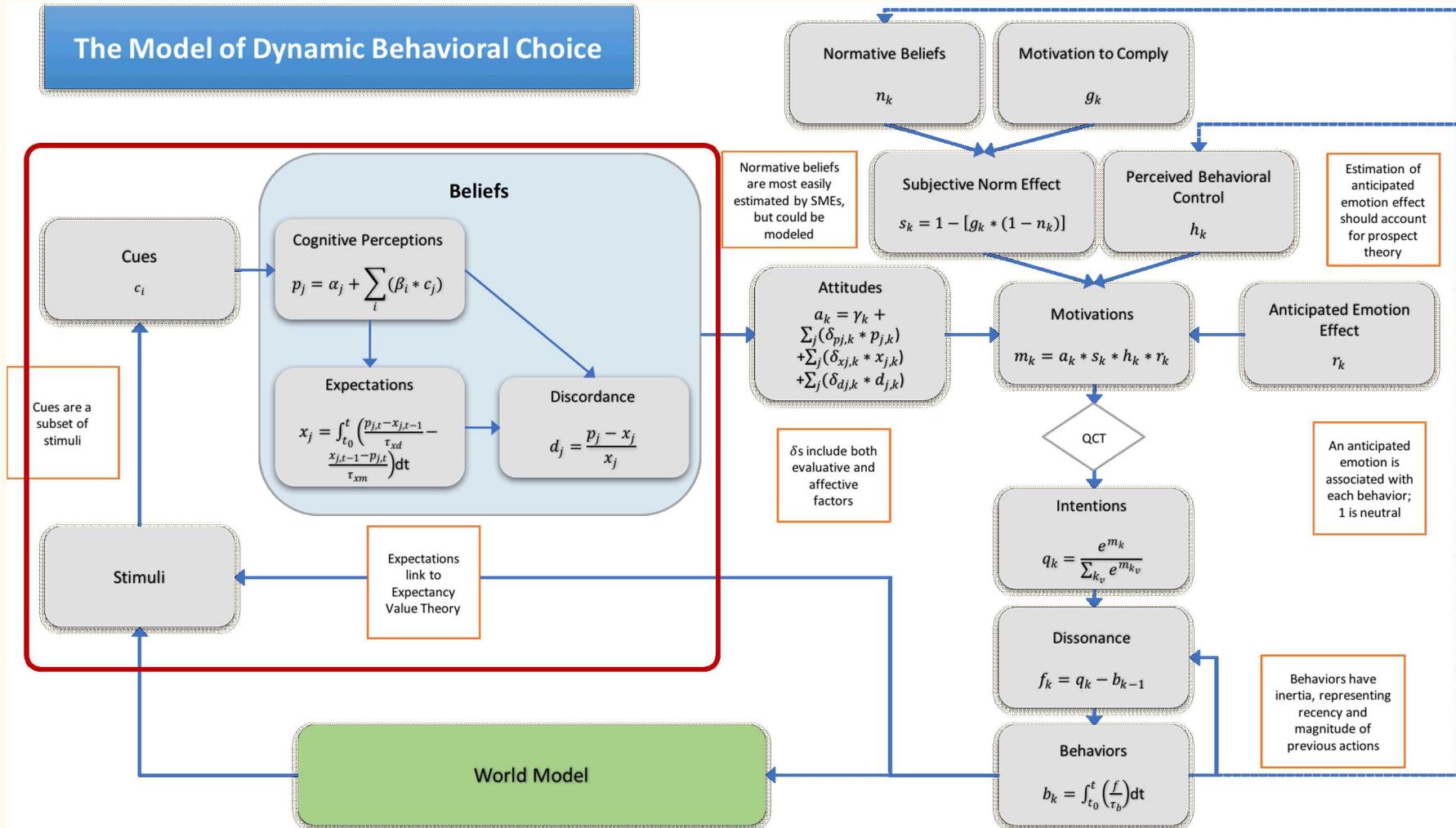
Conceptual Model to Math Implementation

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

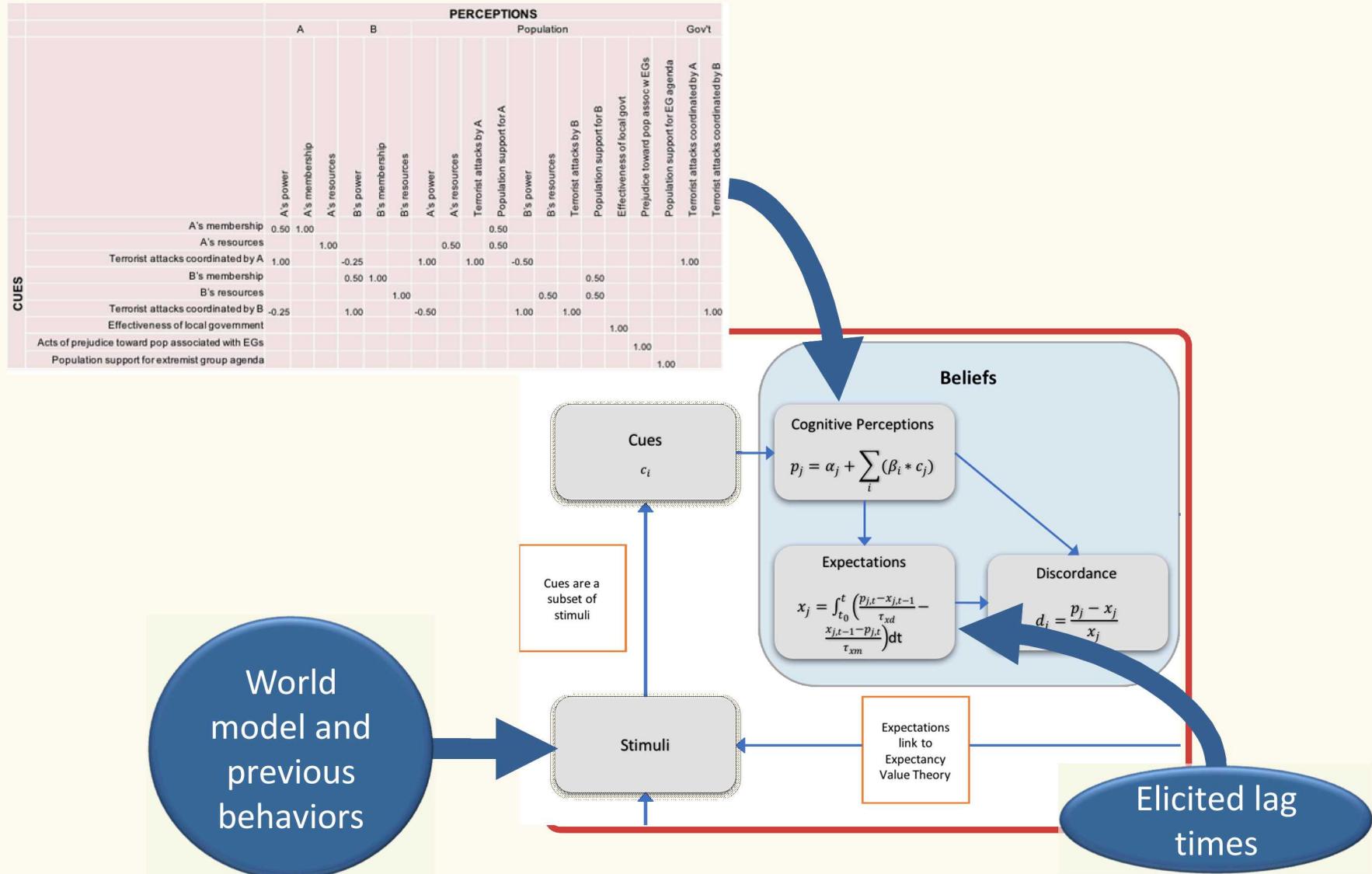
One-to-one mapping of conceptual model to mathematical implementation



Mathematical Implementation



Mathematical Implementation

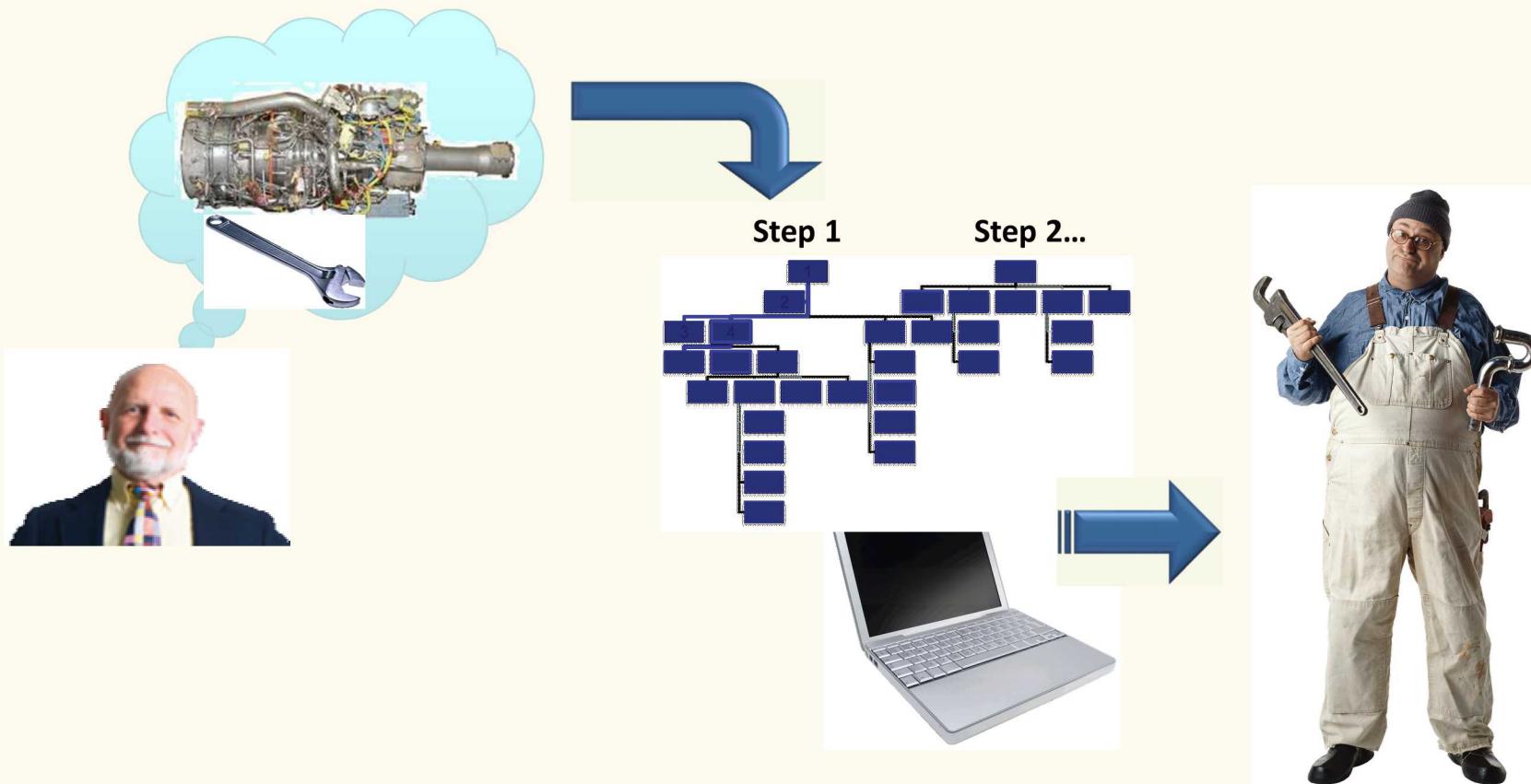


R&D Challenge 2:

Extraction of sociocultural, decision-related information to populate a computational model

Knowledge Capture and Instantiation

Typical method



Knowledge Capture and Instantiation

How to capture knowledge regarding societal decision making?

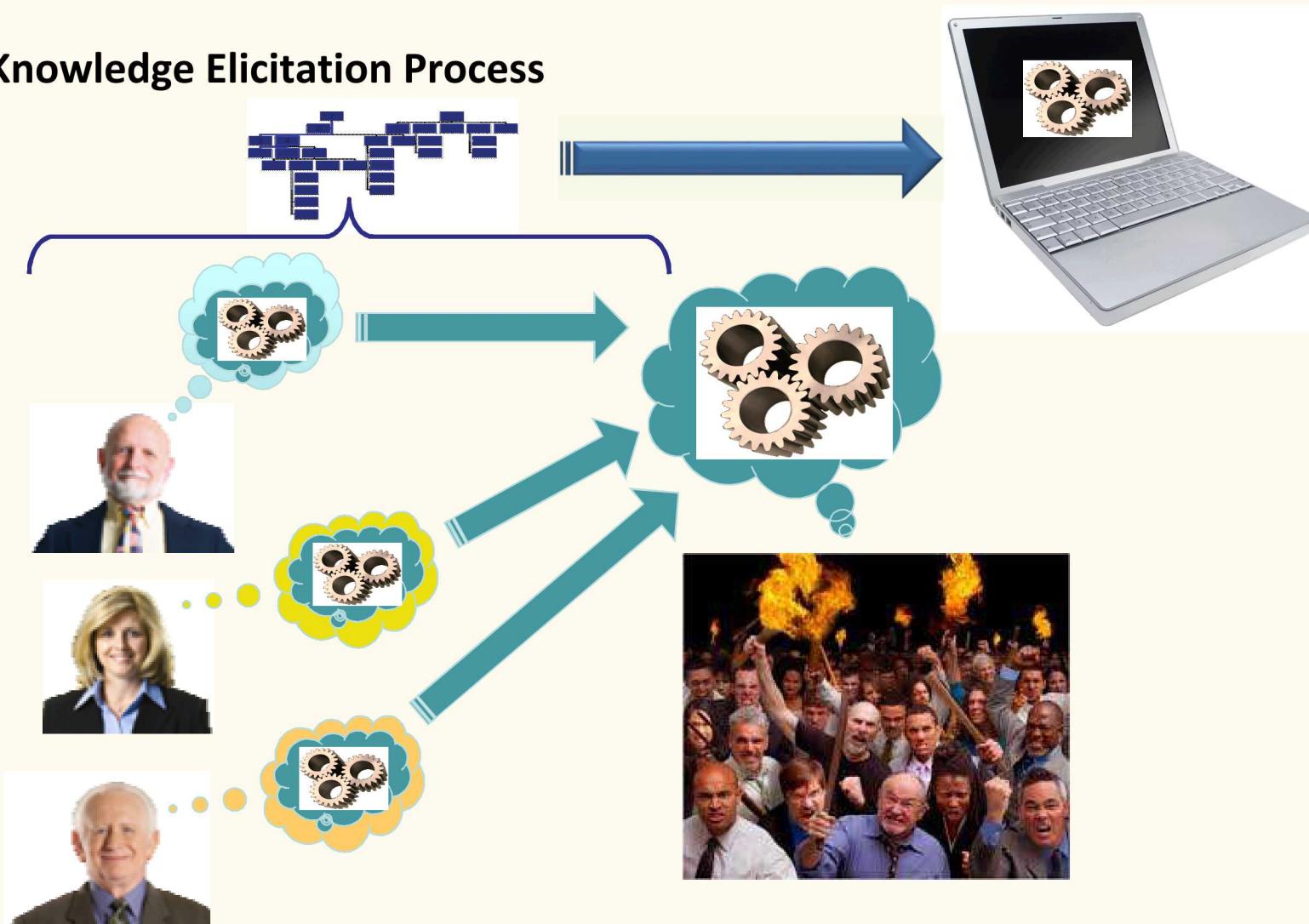


“An inherent challenge in understanding behavior in other cultures rests in gathering, analyzing, and representing the relevant cultural concepts, beliefs, and values that drive decisions in those populations”

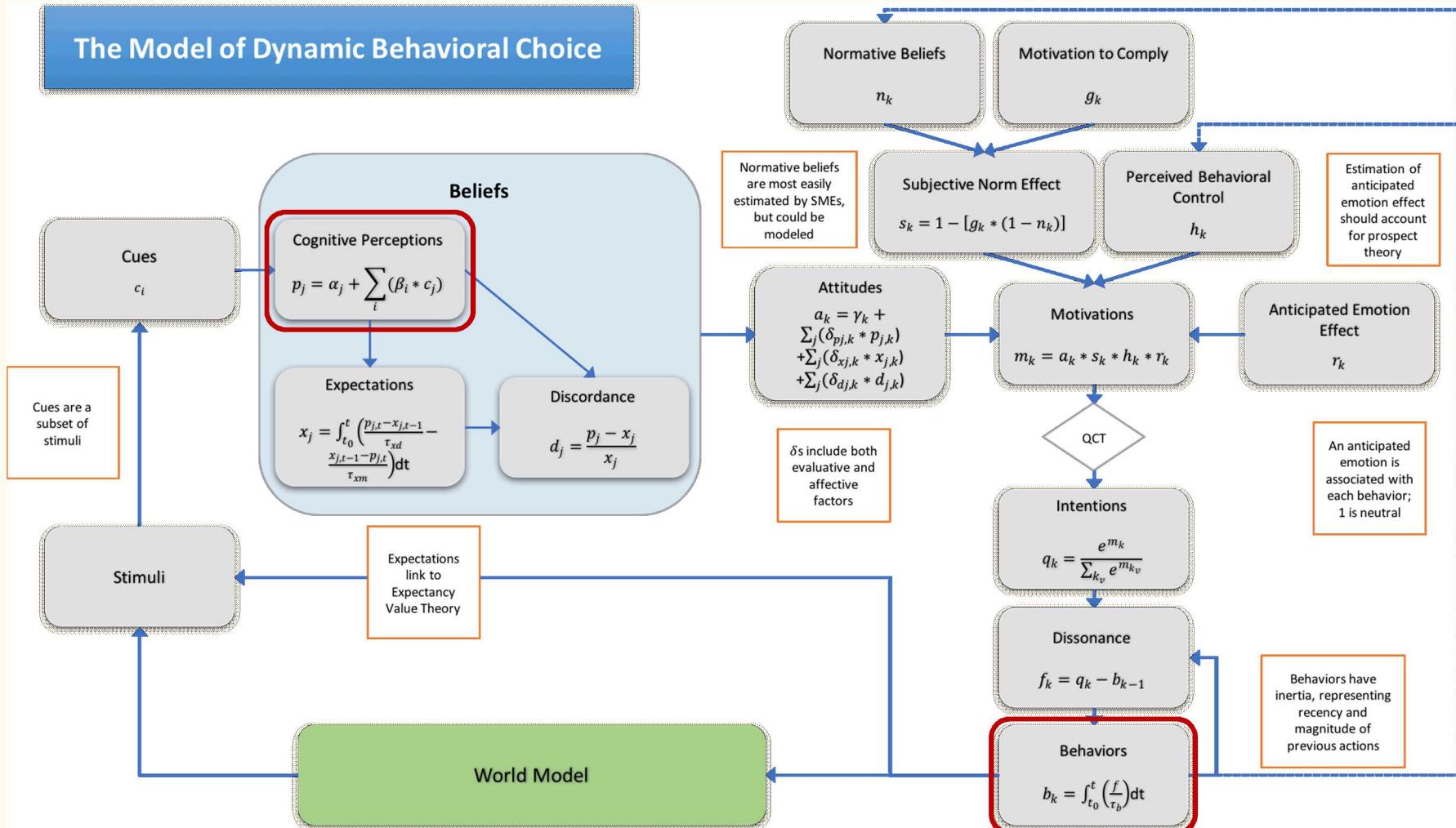
Sieck et al., 6, p. 237.

Capturing Sociocultural Information

Knowledge Elicitation Process

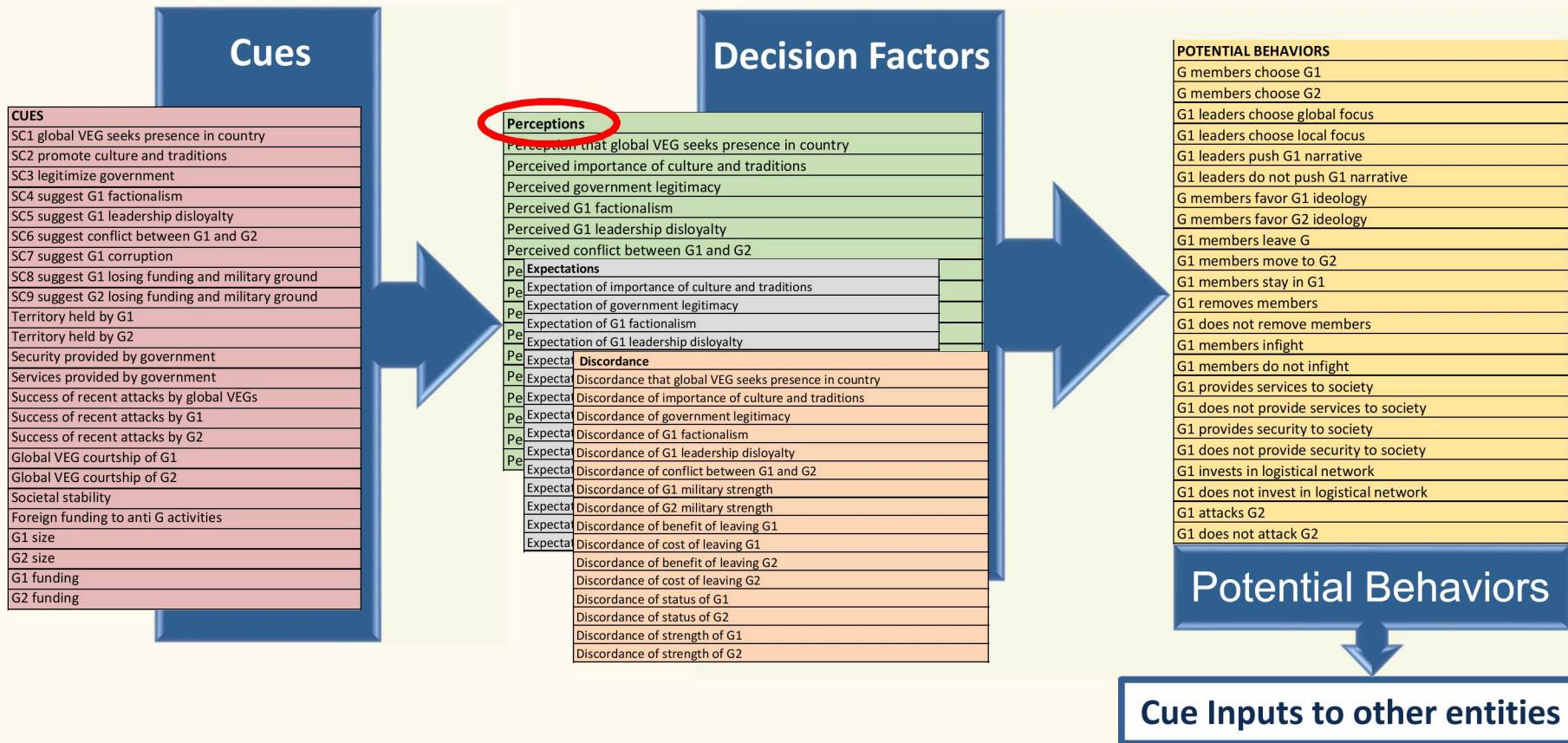


Mathematical Implementation



Information Underlying Cognitive Models

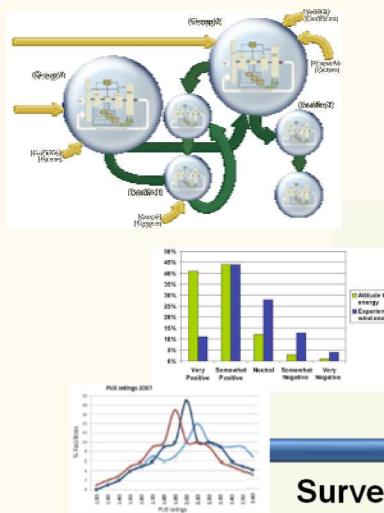
Examples of SME information, data, and report information that populate DYMATICA models



Populating DYNAMICA Models

Relies on Current Data, SME Guidance, and Models of Human Decision Making

Subject Matter
Expert Inputs



Surveys,
etc Data

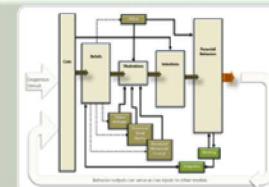
A Country's
Customs and
Practices



Geographical Region's
Customs and Practices

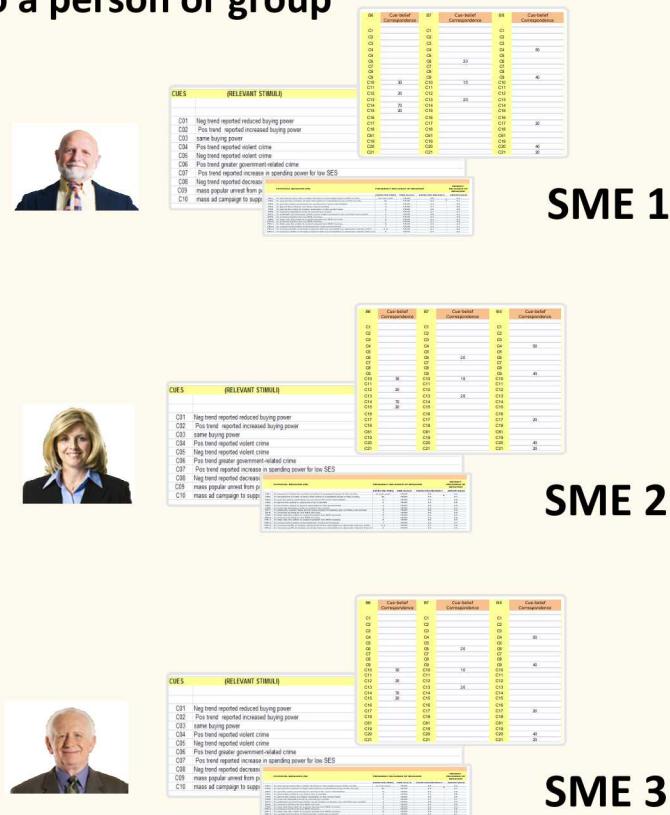


General Human Behaviors
Invariant of specific culture/behavior



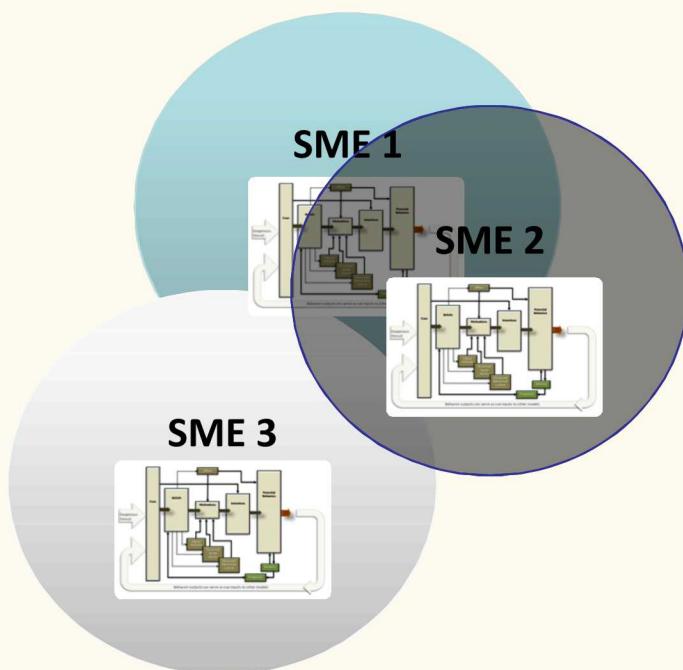
Information Underlying Cognitive Models

Knowledge structure pertaining to a person or group

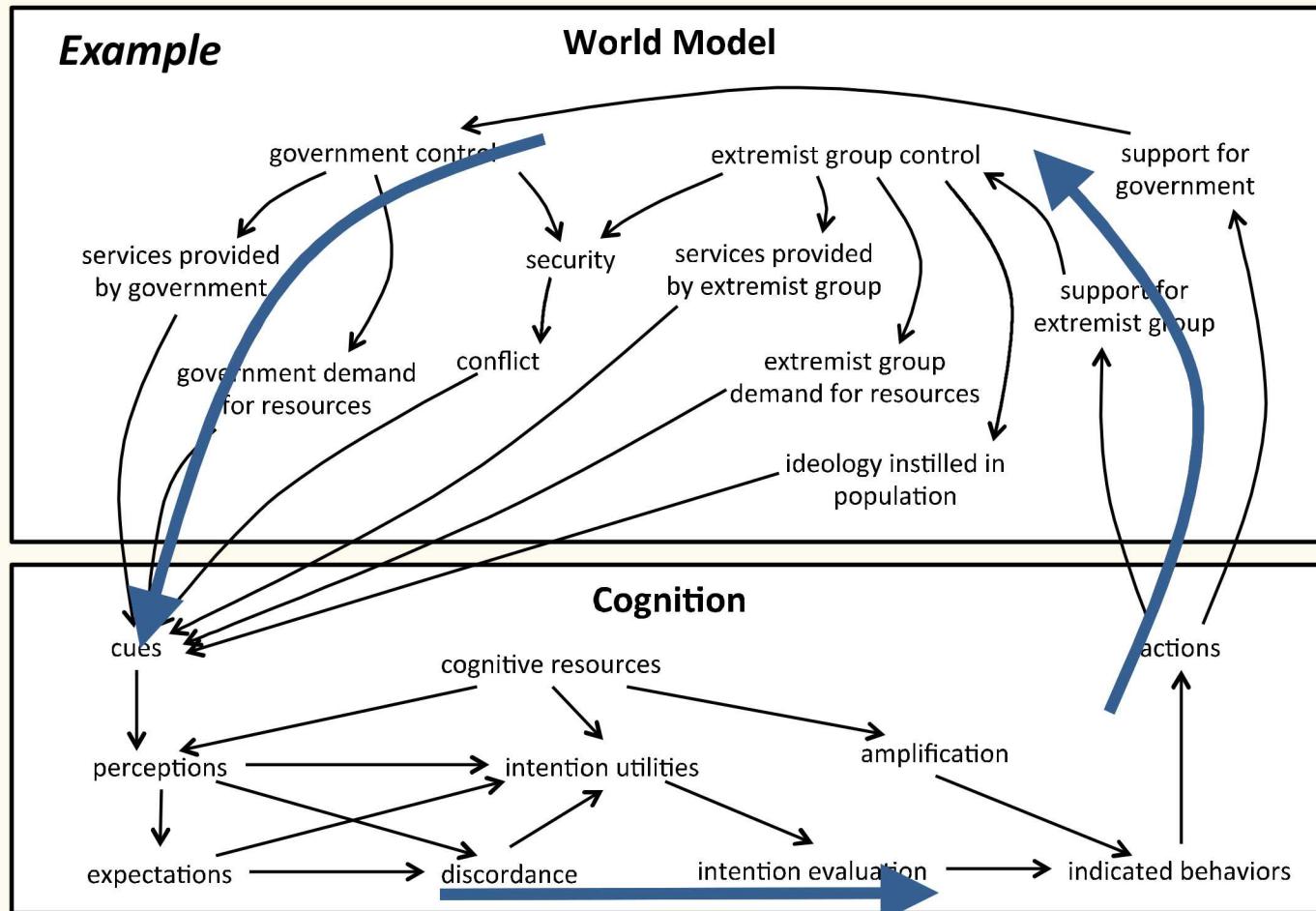


Example convergence/divergence in knowledge structures

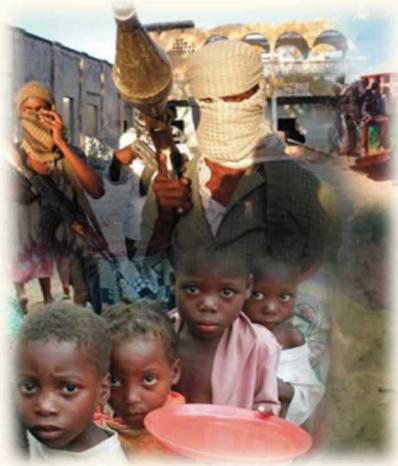
DYMATICA assesses both the convergence & divergence within these structures



Integration of Knowledge Structure



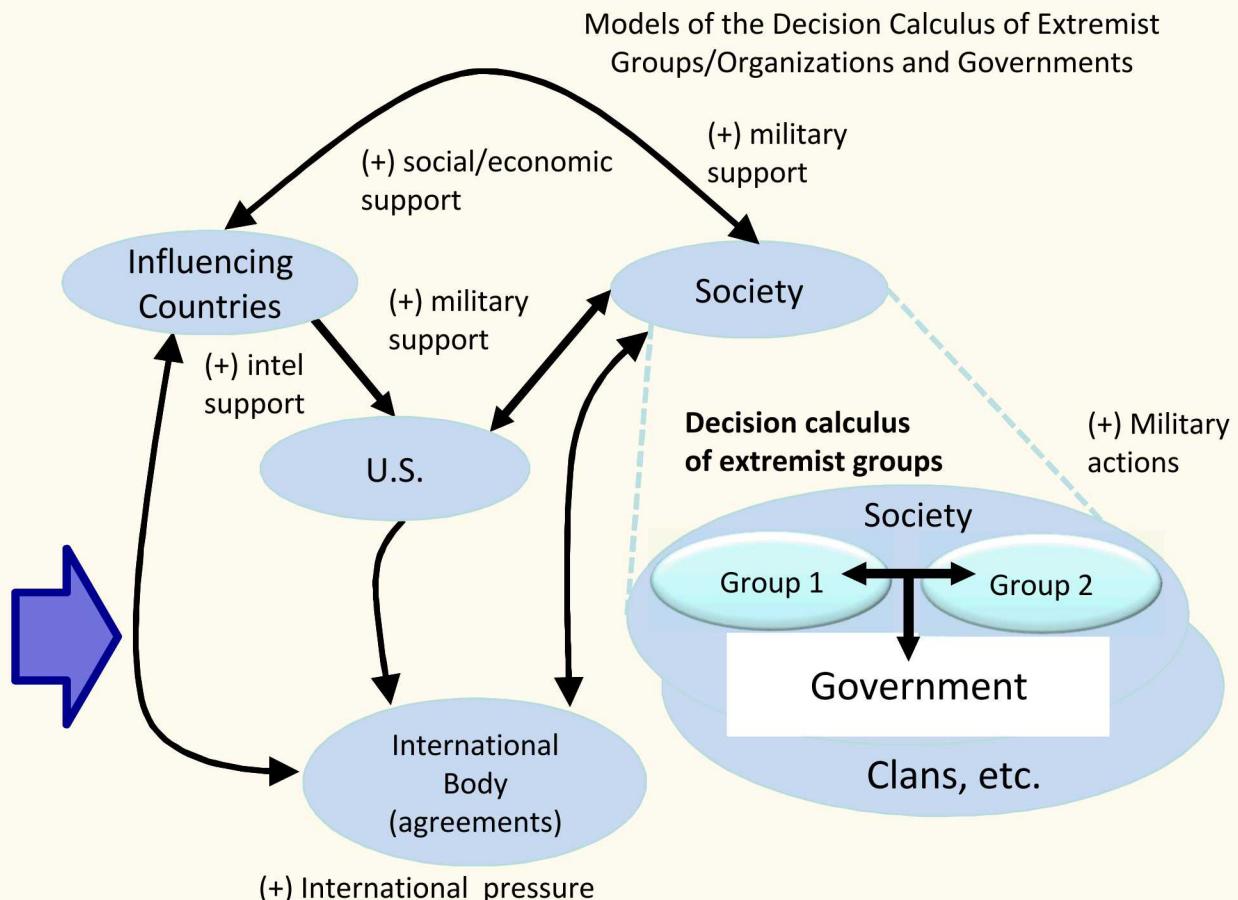
Extremist Group Assessment Example



Exogenous, rest of the world variables

- Economic Circumstances
- Social/political Circumstances
- Military Capabilities
- Ecological Resource Loss/Gain
- Resiliency
- Communication Flow (e.g., contagion)

How can we better understand and anticipate the behaviors of violent extremist groups ?



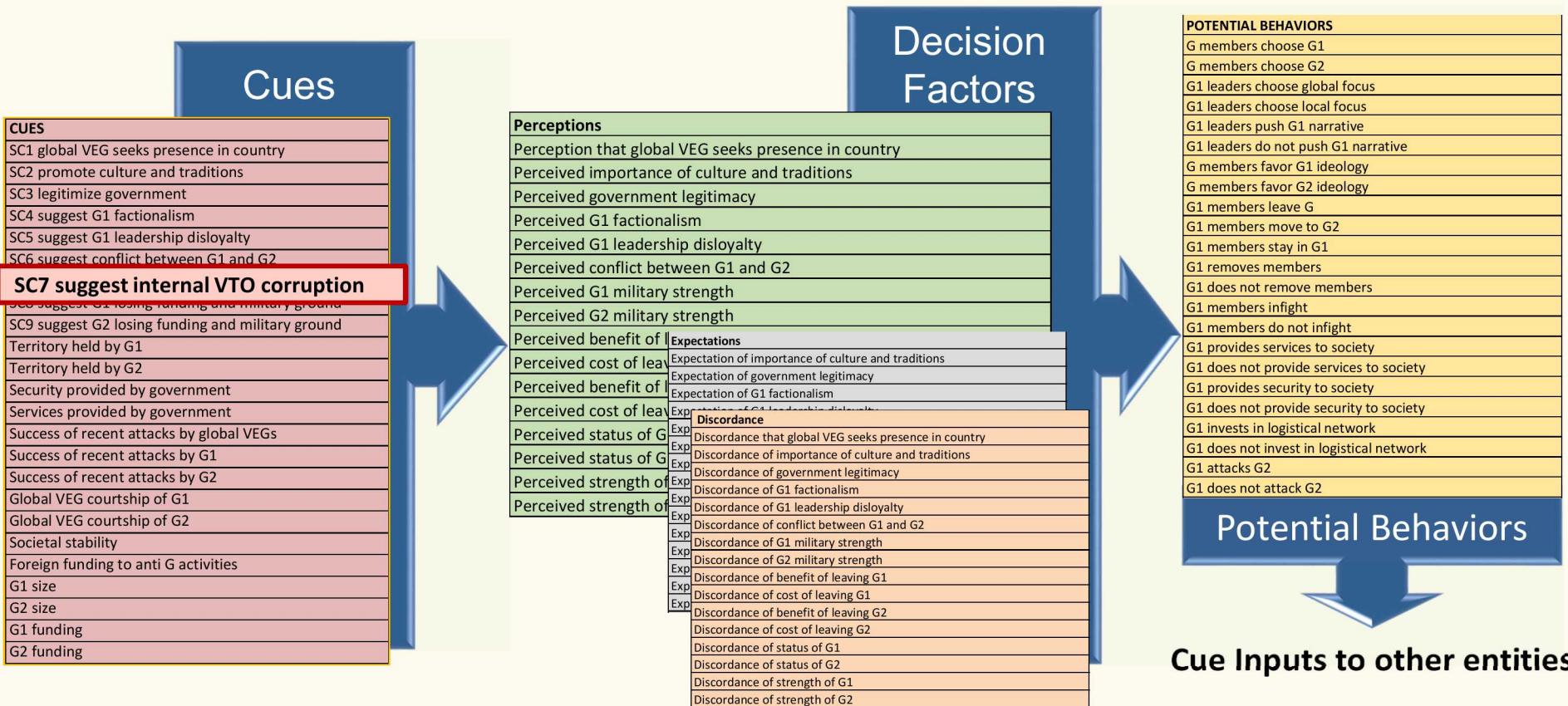
Overarching Question Example

How might the use of specific strategic communications options (defined by the content of the message, the method of sending the message, and the target of the communication) affect a violent extremist org's (VEO) behavior?

1. How resilient are the VEO to these strategic communications? Are effects of strategic communications lasting or does the VEO return to previous behaviors after some time?
2. Are there combinations of strategic communications options that would most likely provoke an identified disruption in the VEO's behavior?
3. How might strategic communications change other dimensions of the VEO's strategy, including:
 - a. Recruiting globally vs. recruiting locally
 - b. Focusing on insurgency vs. working within government channels
 - c. Aligning more closely with a transnational VEO
 - d. Following a strategy closer to specific transnational VEO

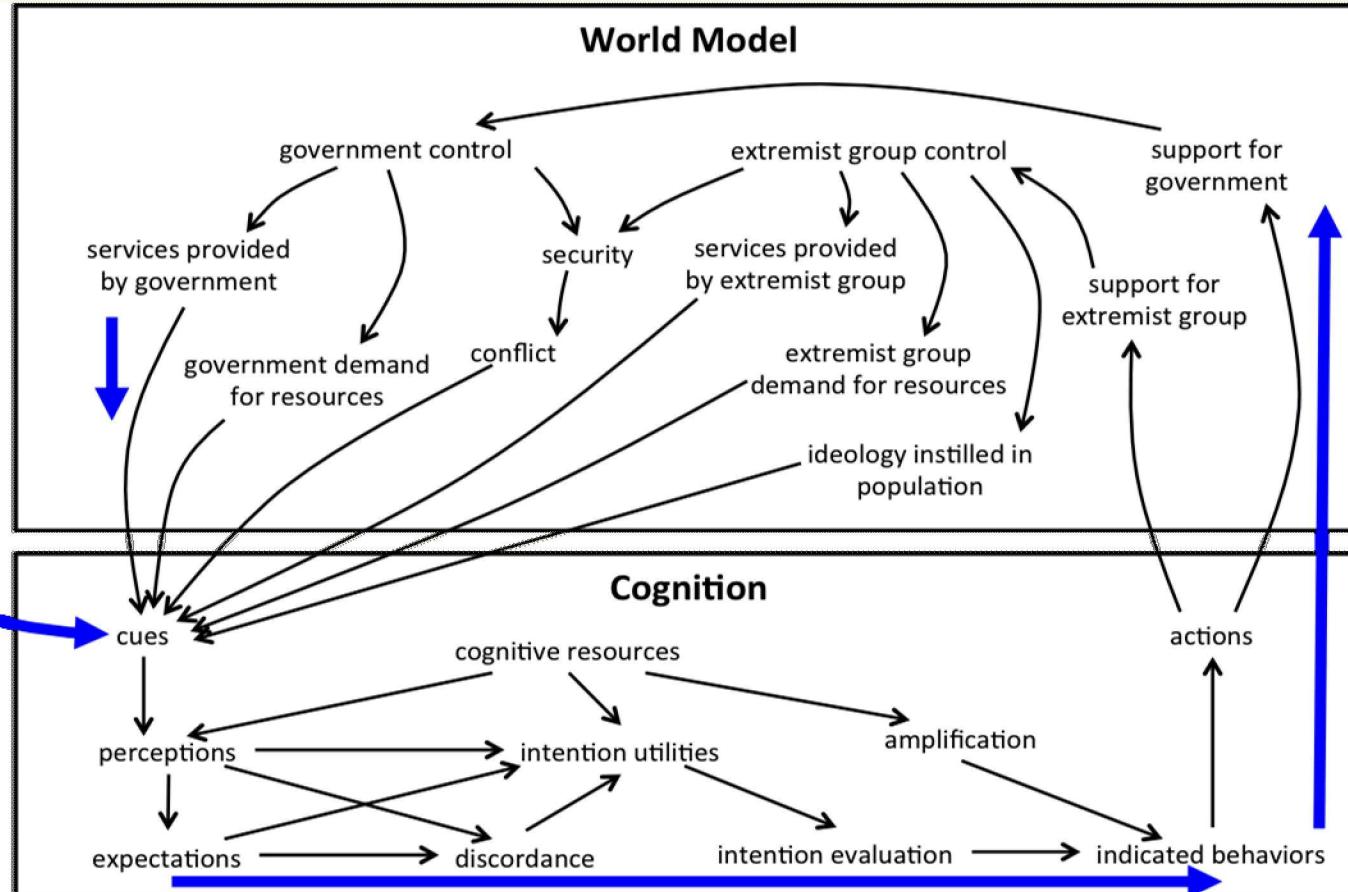
Information Underlying Decision Models

Information Underlying DYNAMICA-Mustang Models

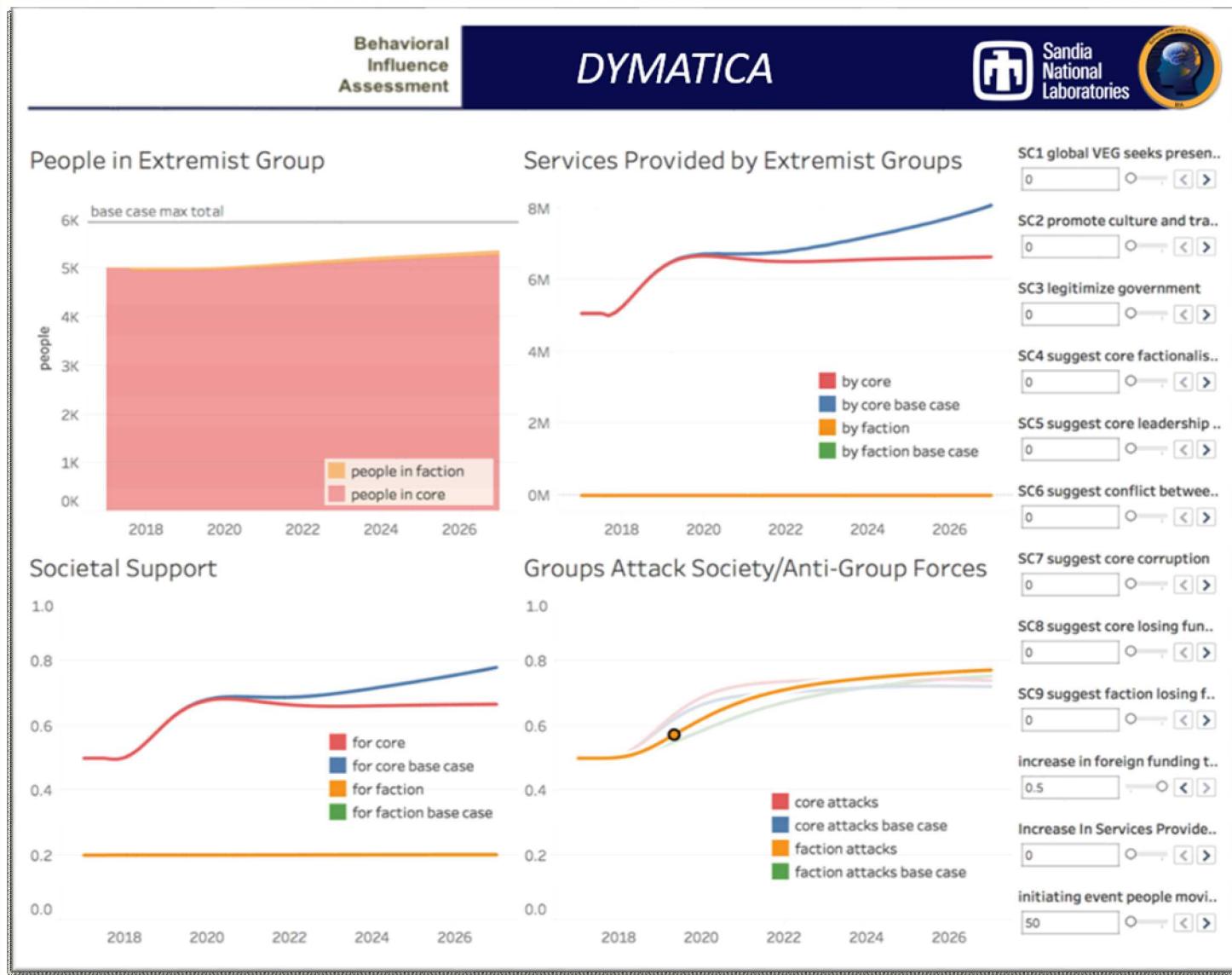


Societal Behavior and Decision Integration

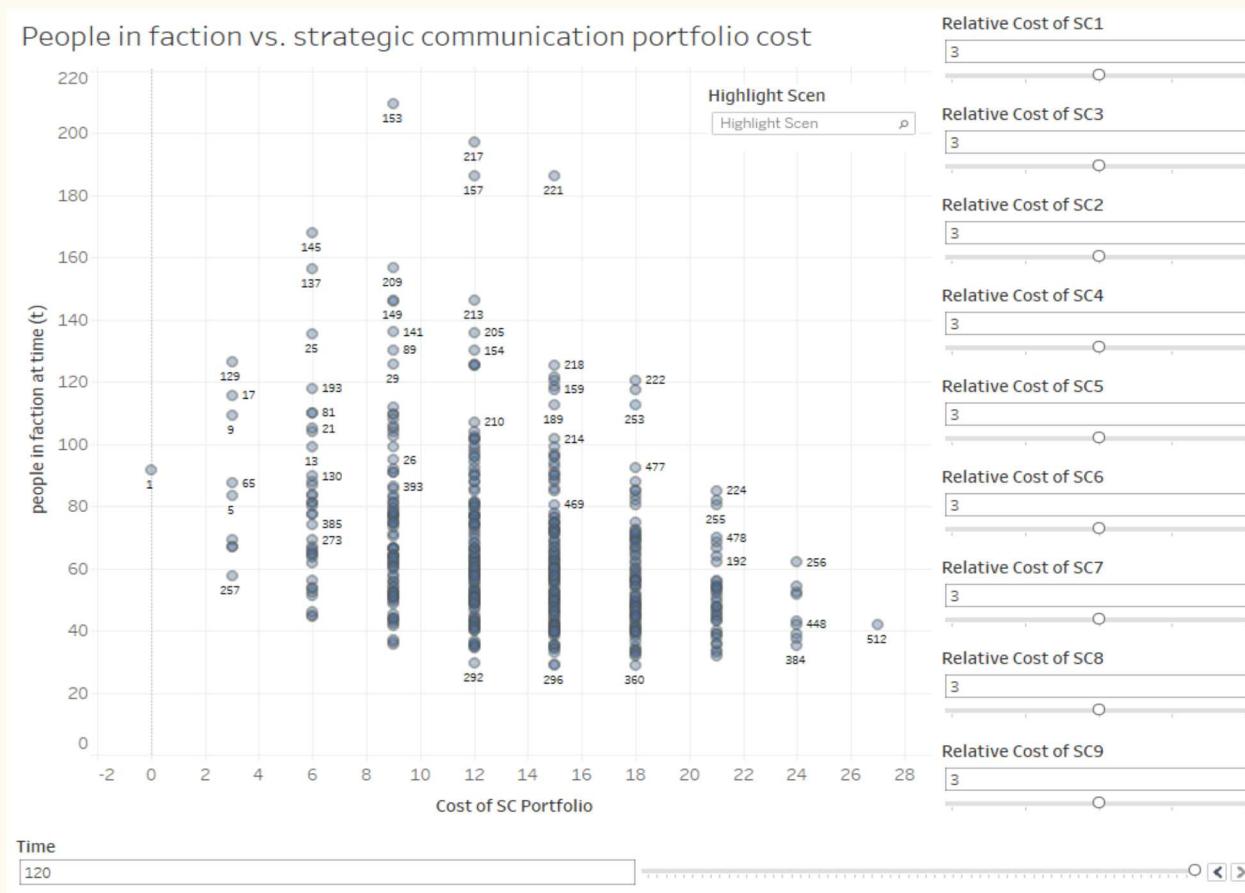
(Interactions between government, society, diaspora, and terrorist org.)



Main Dashboard Assessment



Assessing The Utility of Assessments



Research Challenge 3:

How can we have confidence in the model results?

Developing Confidence Management Methods

**Develop Theory,
Methods, and Tools to
Increase and Manage
Model Confidence**

Step	Considerations	Task detail	Products	
1. Plan project	<ul style="list-style-type: none"> Organize team and tasks 	<ul style="list-style-type: none"> Determine team, tasking, and schedule Begin organizing project tasks Clarify and document classification issues, and share with team and customers 	<ul style="list-style-type: none"> WORK PRODUCT: Process checklist WORK PRODUCT: Project schedule WORK PRODUCT: Documented classification issues 	<input type="checkbox"/>
2. Develop question	<ul style="list-style-type: none"> Begin to develop common vocabulary Defines scope/boundary of analysis 	<ul style="list-style-type: none"> Iterate with customer to clarify and refine question Create documentation document 	<ul style="list-style-type: none"> RESULT: Refined question (potentially with sub-questions) WORK PRODUCT: Create and update documentation document with question 	<input type="checkbox"/>
3. Begin general literature review	<ul style="list-style-type: none"> Gets more detailed as process progresses 	<ul style="list-style-type: none"> Team begins (ongoing) literature review Update annotated bibliography/common repository/documentation with each applicable source 	<ul style="list-style-type: none"> WORK PRODUCT: Annotated bibliography initiated WORK PRODUCT: Common repository initiated WORK PRODUCT: Update documentation with key findings 	<input type="checkbox"/>
4. Define confidence management plan	<ul style="list-style-type: none"> Based on template 	<ul style="list-style-type: none"> Create and update confidence management plan for entire project 	<ul style="list-style-type: none"> WORK PRODUCT: Update documentation with confidence management plan 	<input type="checkbox"/>
5. Begin confidence management	<ul style="list-style-type: none"> Based on confidence management plan 	<ul style="list-style-type: none"> Document model and project requirements 	<ul style="list-style-type: none"> WORK PRODUCT: Update documentation with capability requirements 	<input type="checkbox"/>
6. Select SMEs	<ul style="list-style-type: none"> Consider using different SMEs for different portions of the project (for example, Causal Loop Diagram versus Knowledge Structure) Account for both domain-specific and technical talents of potential SMEs 	<ul style="list-style-type: none"> Work with customers, internal experts, etc. to select SMEs 	<ul style="list-style-type: none"> WORK PRODUCT: Update documentation with list and relevant background of selected SMEs WORK PRODUCT: Complete expert criteria worksheet for each SME 	<input type="checkbox"/>
7. Select granularity of project/model	<ul style="list-style-type: none"> Time frame, cognitive entities, geographic region 	<ul style="list-style-type: none"> Iterate with customers and SMEs 	<ul style="list-style-type: none"> WORK PRODUCT: Update documentation with selected granularity 	<input type="checkbox"/>
8. Compile dynamic hypotheses	<ul style="list-style-type: none"> Broad-scale hypothesis of dynamic behavior of key variables over the selected time horizon given selected scenarios Helps to frame the process for SMEs, frames the problem for the entire team and SMEs 	<ul style="list-style-type: none"> Use SMEs, literature survey, historical data, current data, etc. Discuss and iterate with SMEs 	<ul style="list-style-type: none"> RESULT: Working Hypothesis RESULT: Definition of input and output variables of most interest WORK PRODUCT: Update documentation with dynamic hypothesis 	<input type="checkbox"/>
9. Develop Causal Loop Diagram	<ul style="list-style-type: none"> Defines broad, overarching model structure 	<ul style="list-style-type: none"> Discuss and brainstorm system structure with SMEs Team creates draft diagram Vet and iterate with SMEs 	<ul style="list-style-type: none"> RESULT: Causal Loop Diagram WORK PRODUCT: Update documentation with Causal Loop Diagram DELIVERABLE: Present diagram and other initial documentation to customer 	<input type="checkbox"/>
10. Define elicitation strategy	<ul style="list-style-type: none"> Use template Includes SME questions, process, etc. 	<ul style="list-style-type: none"> Define elicitation strategy for specific project Provide SME(s) with information on the elicitation process 	<ul style="list-style-type: none"> WORK PRODUCT: Update documentation with elicitation strategy 	<input type="checkbox"/>

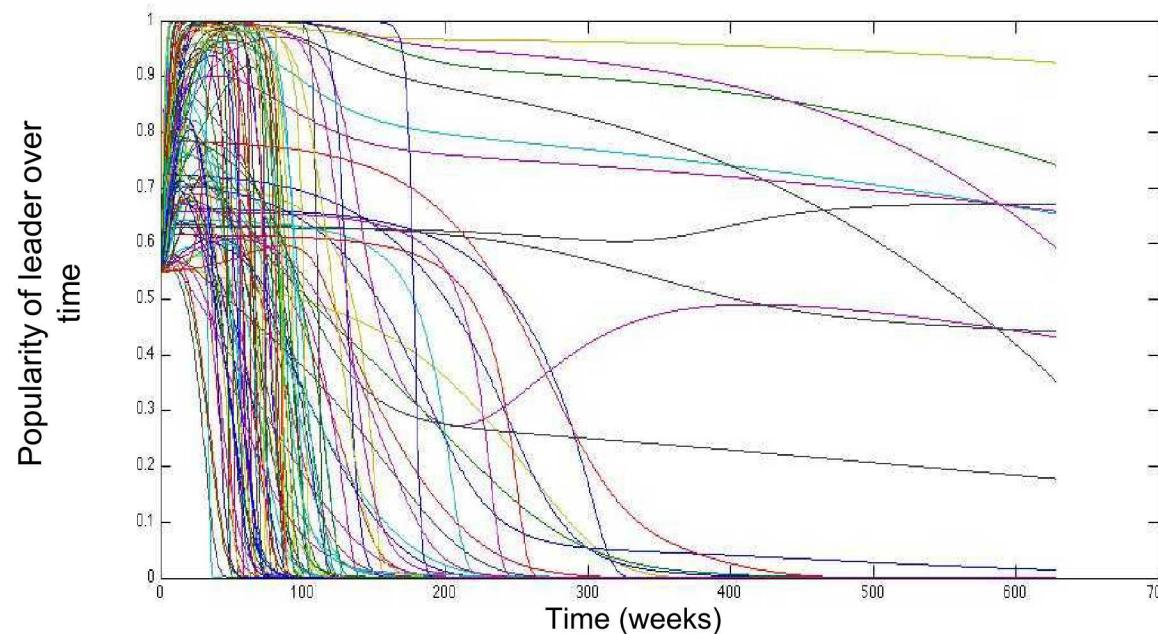
Assessing Data within Models

Summary of Methods

- **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

Example: Sensitivity Assessment of Behaviors

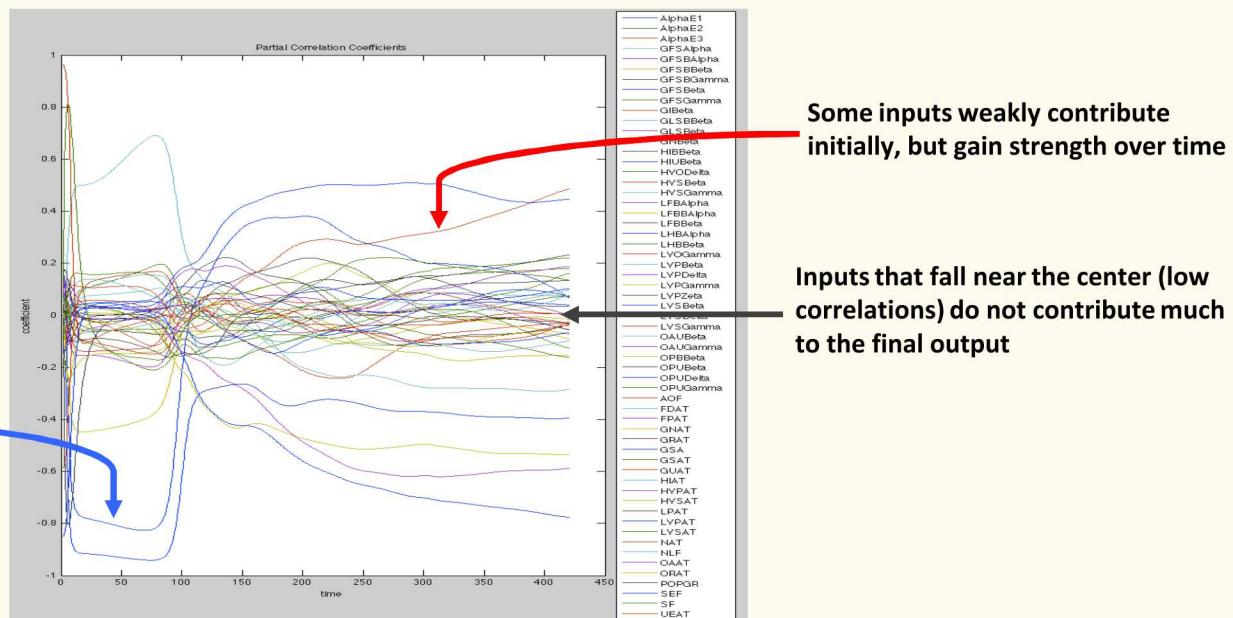
- Developing capability to assess what conditions will increase the likelihood of an event or popularity of an organization or leader.



Sensitivity Assessment of Behaviors

Sensitivity analysis of COAs to behaviors

- Can show the relative strengths of correlations for different inputs as they change over time to produce certain outputs (e.g., behaviors)



Thank You
Questions?