EMA: A Computational Model of Emotion

Stacy Marsella
Jonathan Gratch

USC Computational Emotion Group
University of Southern California

Emotion

Cognitive

Emotion is a mental phenomena

- Arises from physiological & cognitive processes
- Associated with key cognitive functions
  - Focusing mental, sensory resources
  - Influencing beliefs
  - Informing decision-making
  - Preparing action and reaction
  - Learning and long-term adaptation

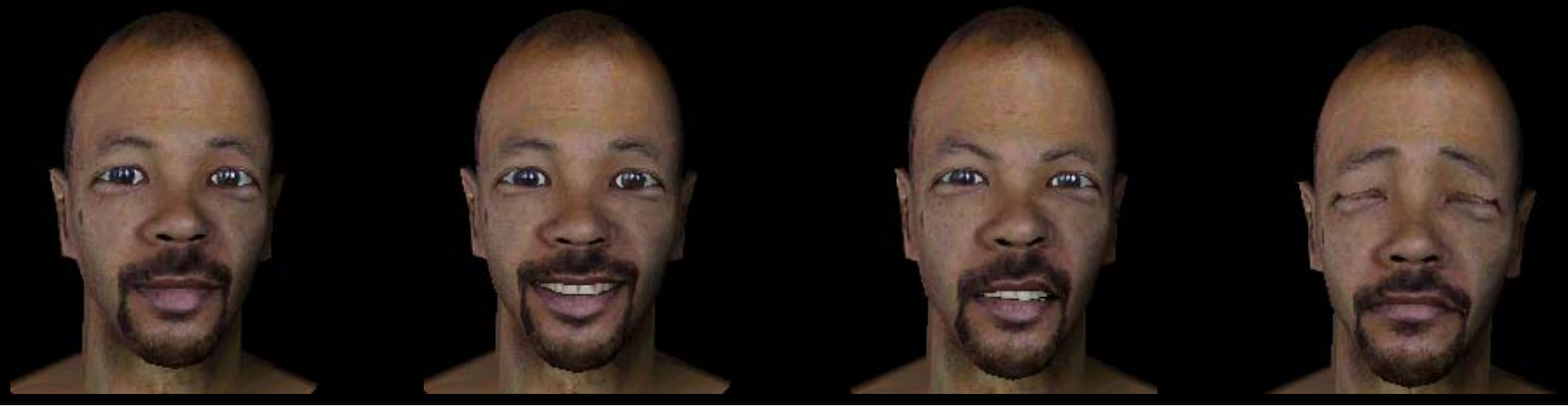
Emotion

Cognitive

Physical

Emotion is a physical phenomenon

- Emotion processes associated with specific physical behaviors
  - Facial expression
  - Body language and posture
  - Voice
  - Behavioral dynamics



Emotion

Cognitive

Physical

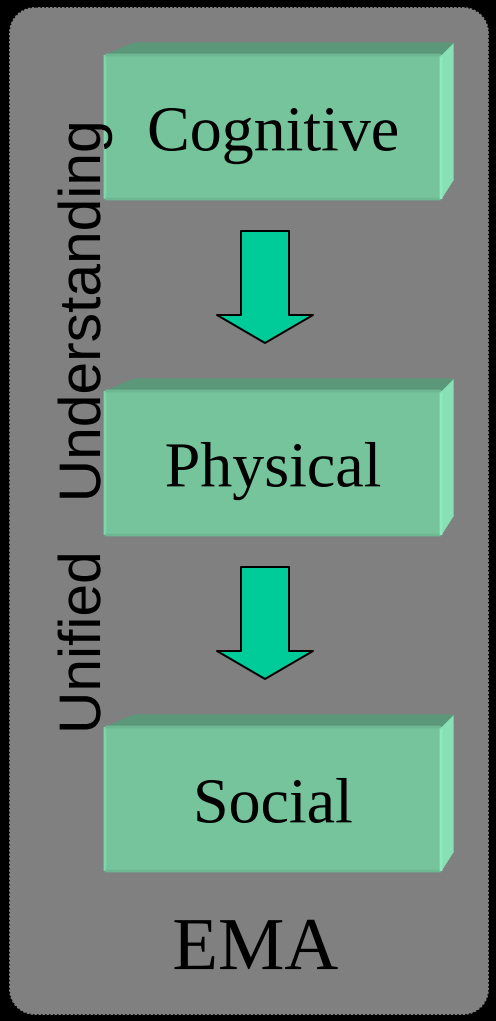
Social

Emotion is a social phenomenon

Emotion is a signal that influences the behavior of others

- Emotional contagion
- Social referencing

Why our we interested?

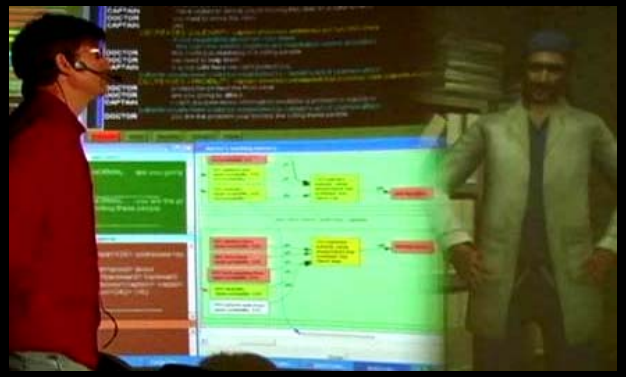


Goal is to develop unified computational framework for modeling, simulating, explaining and exploiting these phenomena

- To inform intelligent system design
  - By drawing on insights from emotion's cognitive/social function
  - Not a new idea in (Simon/Minsky)
- To inform emotion theory
  - By concretizing theory and developing methodological tools
- To drive applications
  - Education, Training and Health Interventions

Social Learning Environments

- Explore emotionally charged social interactions in safety of VR
- Virtual Role Play
- Learner interacts with Virtual Humans



Virtual Humans

- Users interact with virtual humans
  - Computer-generated simulations of humans
  - Playing mentors, teammates, adversaries, etc.
- Communicate in natural language
  - Coordinated gestures and non-verbal communication
- Behaviors not pre-scripted
  - Behave by understanding social situation
  - Reason about possible responses to events
- Respond emotionally to situation
  - Affects the way they perform tasks & interact socially
  - Affects gaze, face, gestures, posture

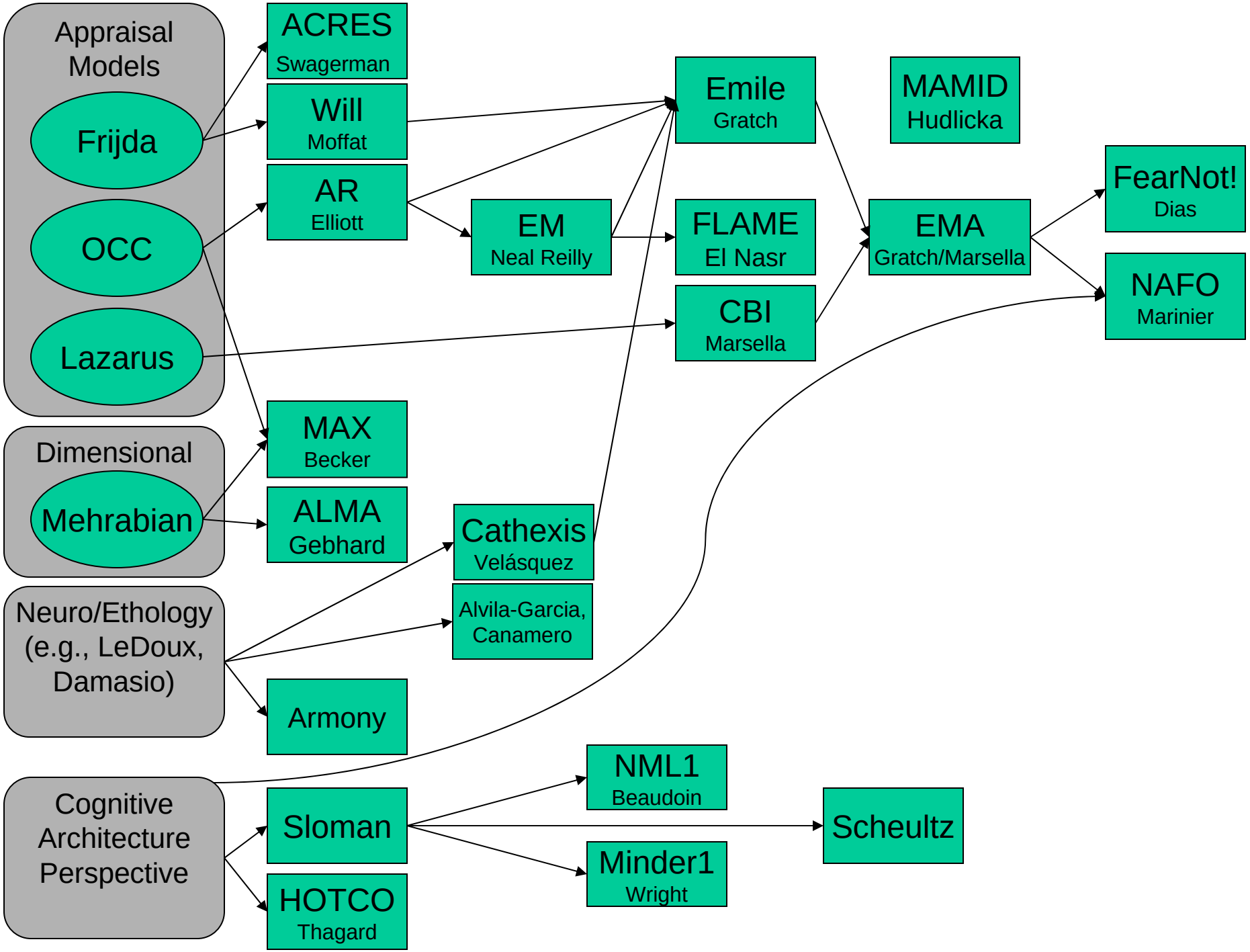

Appraisal Models
Frijda
OCC
Lazarus
Dimensional
Mehrabian
Neuro/Ethology (e.g., LeDoux, Damasio)
Cognitive Architecture Perspective
ACRES
Swagerman
Will
Moffat
AR
Elliott
MAX
Becker
ALMA
Gebhard
Cathexis
Velásquez
Alvila-Garcia, Canamero
Armony
Sloman
HOTCO
Thagard
Emile
Gratch
EM
Neal Reilly
FLAME
El Nasr
CBI
Marsella
MAMID
Hudlicka
EMA
Gratch/Marsella
FearNot!
Dias
NAFO
Marinier
NML1
Beaudoin
Minder1
Wright
Scheultz

Diagram comments

- Draw on Different Theories
  - Grounded in different experimental techniques
  - Appraisal Theories dominant
- Creating models from particular theories versus pulling from different theories
- Models of specific affective phenomena versus more general models
- Built for different Applications
- Different computational techniques
- Lineage

Modeling Appraisal Theory

Theoretical perspective

Magda Arnold

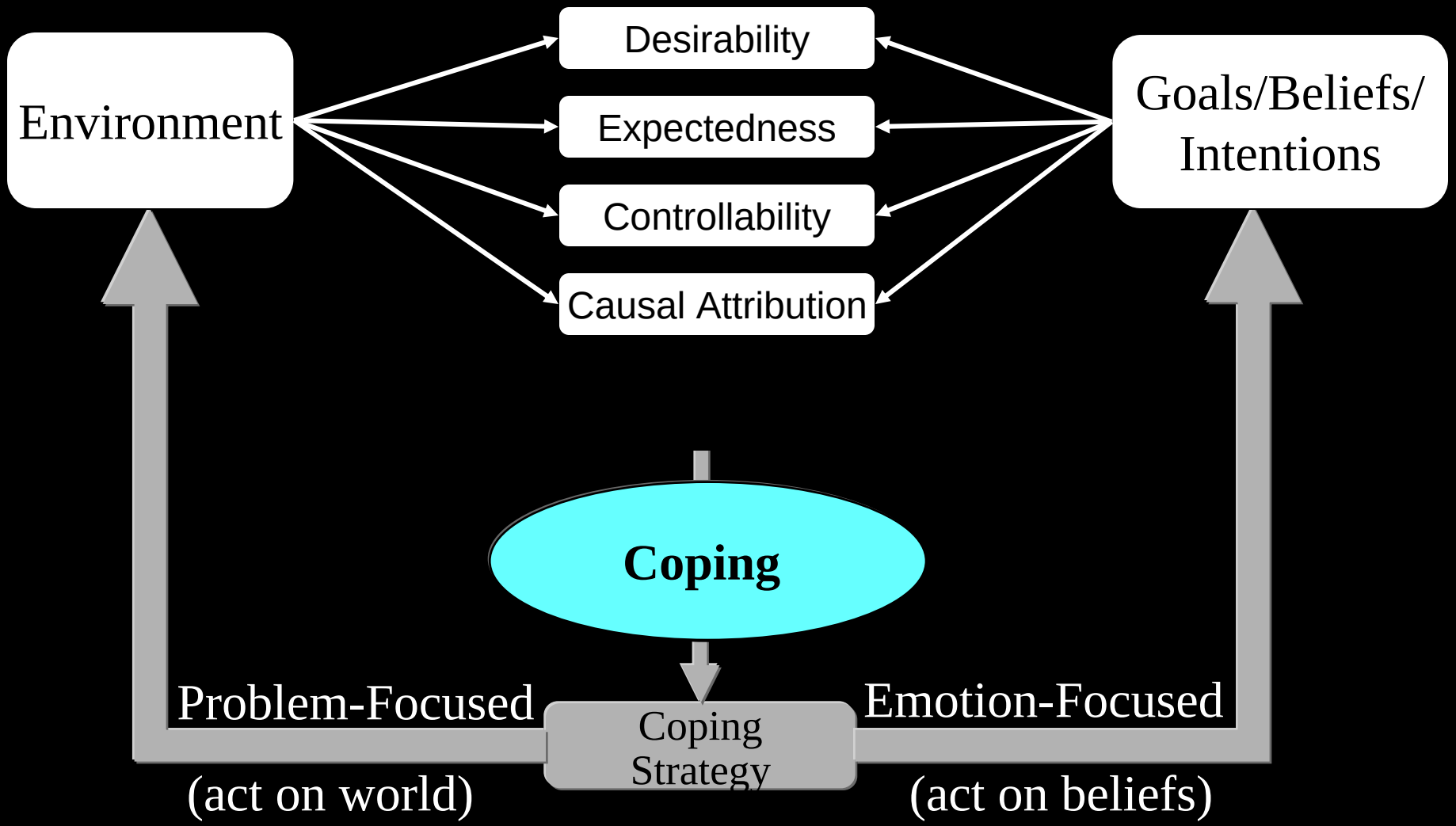
- Top down theories
  - Cognition influences emotion
  - Appraisal Theory (Arnold, Lazarus, Frijda, Scherer)

    Emotion arises from an *evolving subjective interpretation* of person's relation to their environment and informs cognitive and physical acts
  - Constructive theory

    Model the cognitive processes that inform / are informed by emotion

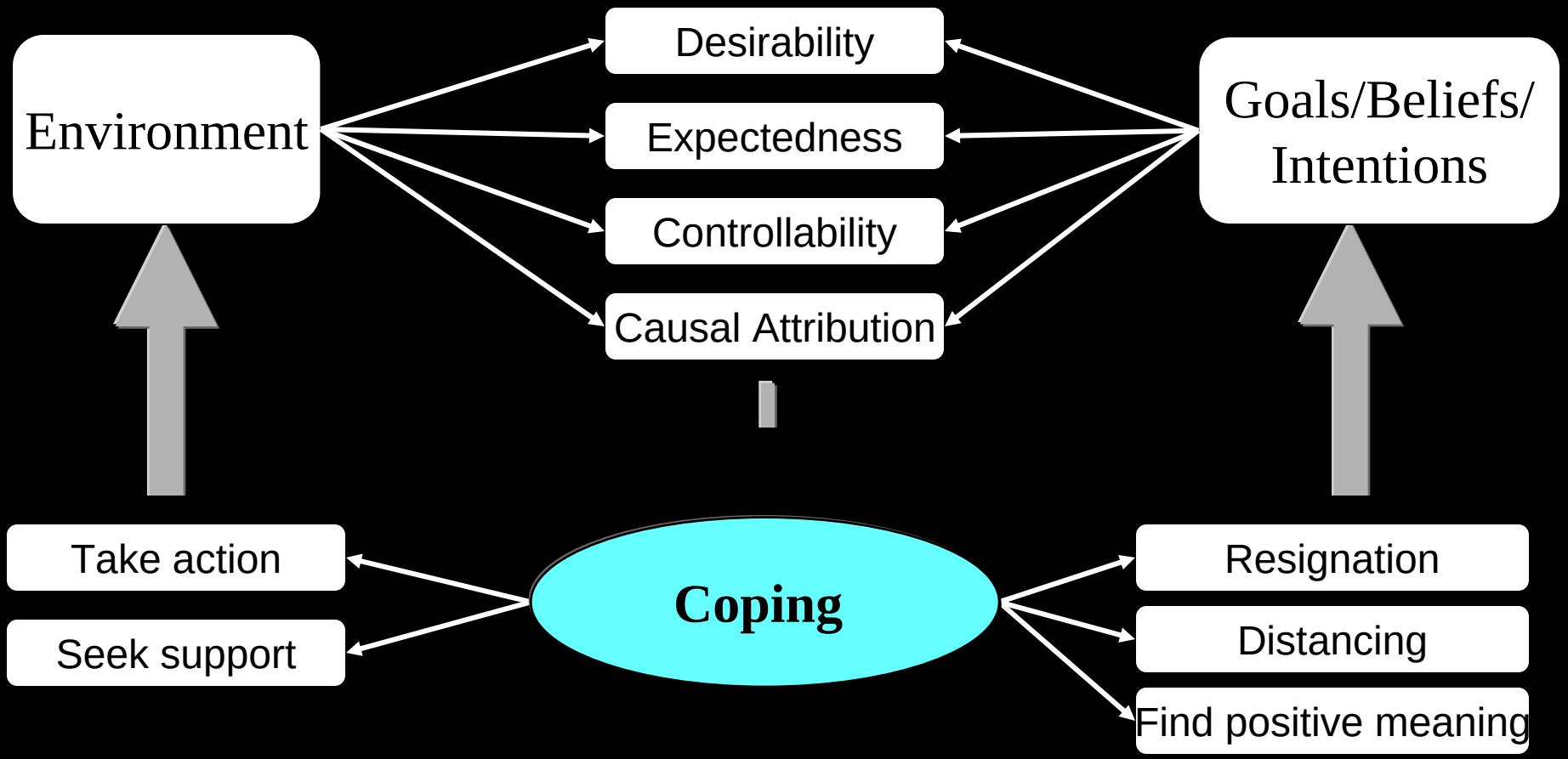
Appraisal Theory

Smith and Lazarus91 cognitive-motivational-emotive system



Appraisal Theory

Smith and Lazarus91 cognitive-motivational-emotive system



Appraisal

- Characterize via *appraisal variables*
  - Desirability
    - Does this event help/hurt my goals
  - Likelihood
    - How likely is it that this event will occur
  - Unexpectedness
    - Was this event expected
  - Causal attribution (causality, agency, blame/credit)
    - Who deserves blame for causing the event
  - Coping potential (controllability, adaptability)
    - What chance do I have for dealing with this event
- Superset of criteria considered by intelligent systems
  - Decision theory: desirability, likelihood
  - Scheduling: desirability, urgency

Coping Strategies

- Problem-focused (act on the world)
  - Action execution
  - Planning
  - Seek instrumental social support

- Analogous to:
  - Deliberative or reactive problem solving
  - Team negotiation

Coping Strategies

- Emotion-focused (act on belief)
  - Denial/Wishful Thinking
  - Find positive meaning
  - Resignation
  - Shift blame
  - Distancing
- Not typically considered by intelligent systems
  - More than a decision (e.g. abandon current plan)
    - Provides self-justification for why
    - Related to motivational / explanatory coherence
    - Leads to persistent change in behavior
  - Self-deception can be beneficial
    - But need to determine when a belief should change
      - Can't simply wish away the world

Appraisal Theory as architectural specification

- Provides high-level requirements
- How do we map this into an architecture
  - How do we represent the person-environment relation?
  - How do appraisal processes operate over this representation?
  - How do coping processes impact beliefs, behavior
  - What is the relation between the processes of
    - Appraisal
    - Cognition
    - Coping
  - How do these interact/unfold over time?

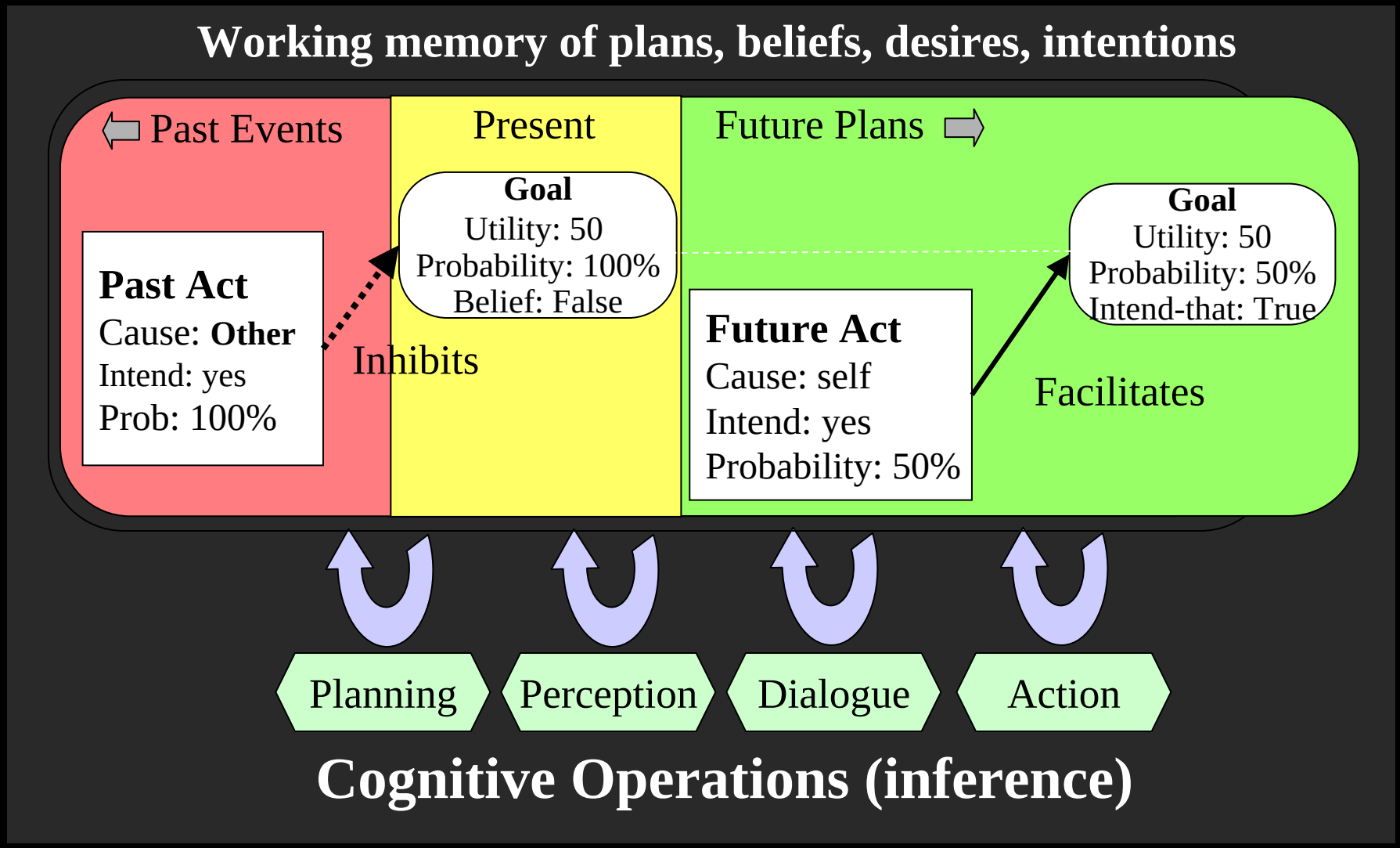

EMA
Gratch & Marsella

Design Principles

- Appraisals
  - Key: attention regulation, interrupt and timely response
  - Operate in parallel
  - Fast (pattern based)
  - Leverage cognitive processes
- Coping
  - Sequential
- Appraisals central

EMA

Causal Interpretation



Modeling Appraisal & Coping

- Appraisal as evaluation of the causal interpretation
  - Define appraisal variables in terms of features of interpretation
  - Fast, automatic

- Coping: Operators that suggest ways to change interpretation
  - Sequential, deliberate, mediated by focus of attention
  - Problem-focused → Take Action, Make Plans
  - Emotion-focused
    - **Denial/Wishful Thinking → Change belief / likelihood**
    - **Find silver lining → Change utilities**
    - **Shift blame → Change causal attribution**
      → Dialogue moves
    - **Distancing/acceptance → Drop goal / intention**
    - **Avoidance → Change topic**
      → Add goal (e.g., go to party)

Key: A "Content" & "Process" Model

Emotion Dynamics

Emotional Dynamics

Surprise

Fear

Anger
(Aggressive)

Empathy

Humor/Relief

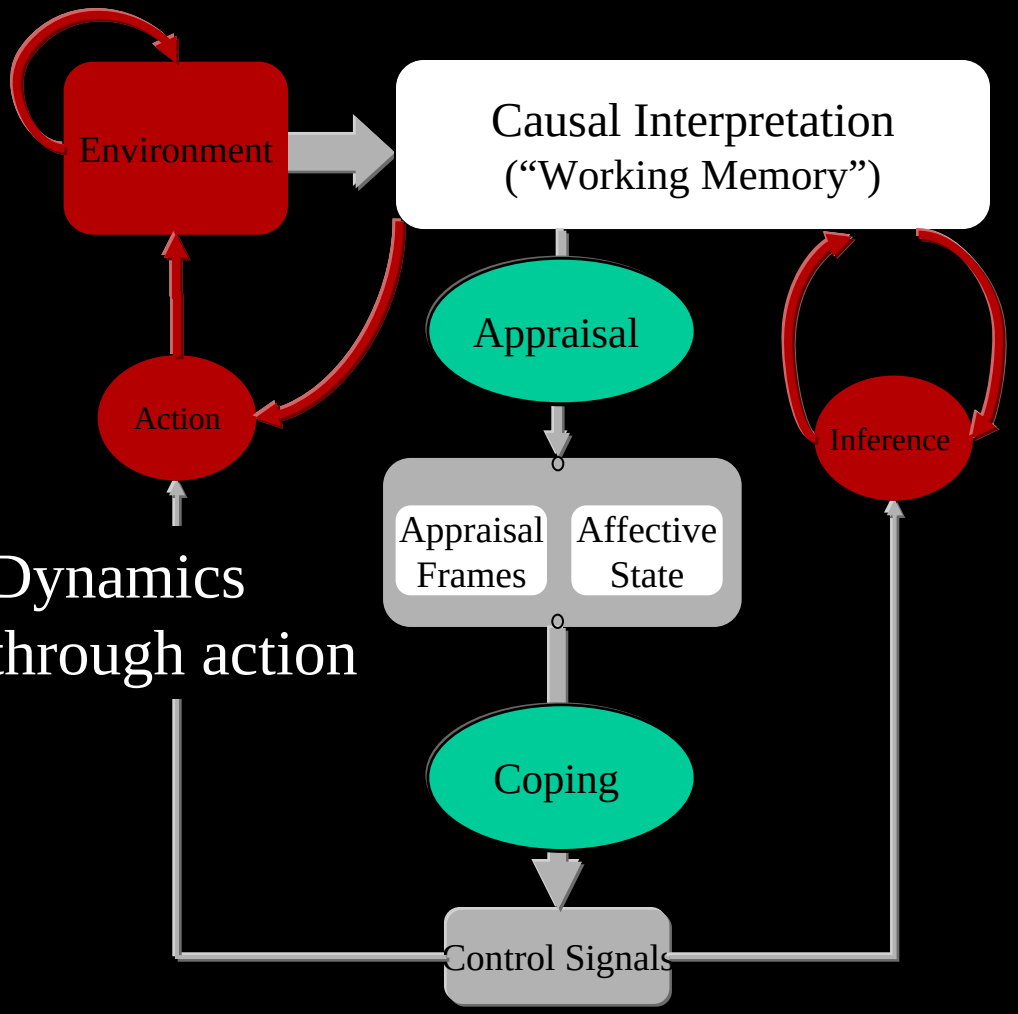
Scherer's Sequential Checking Model

Appraisal

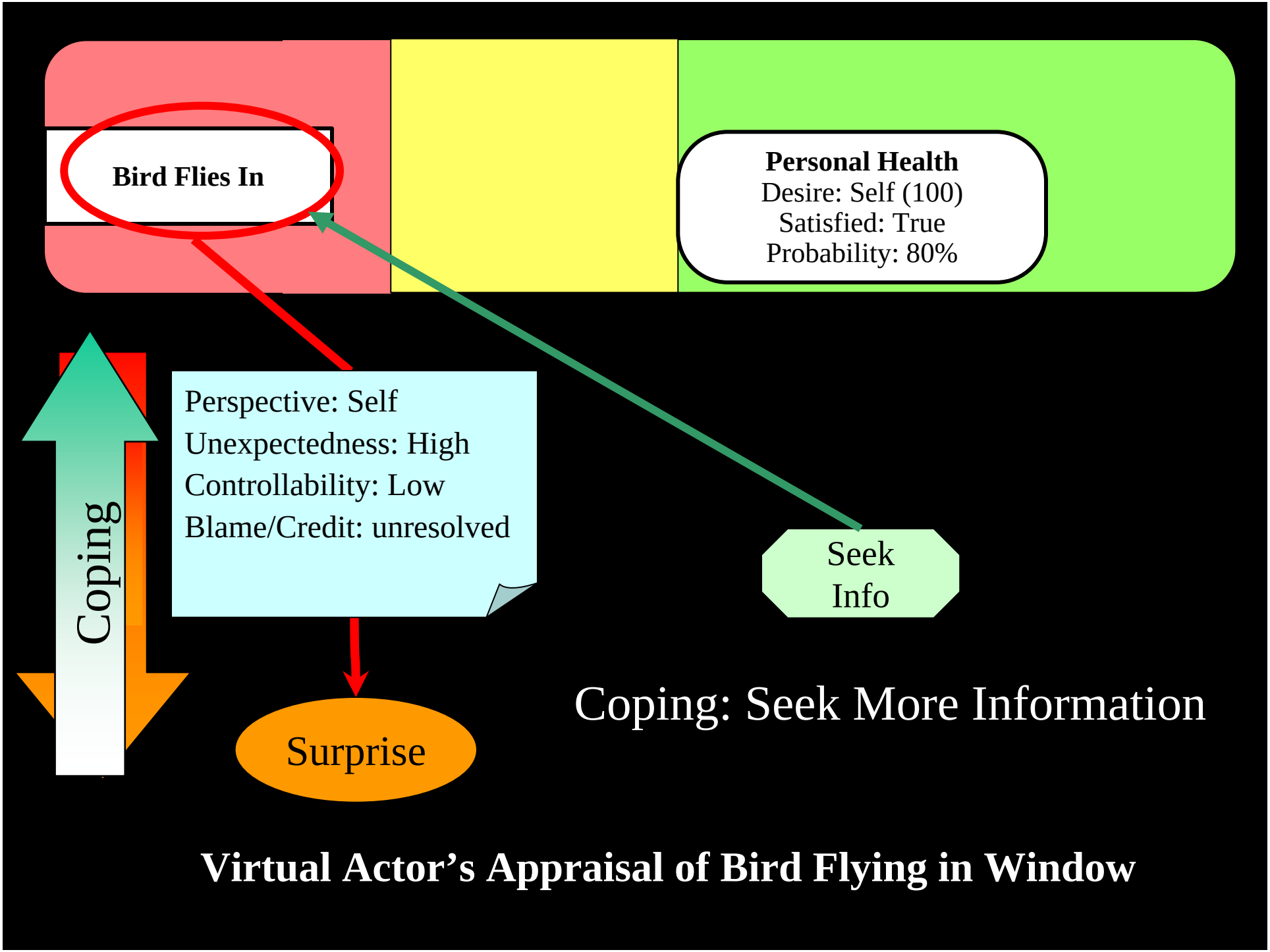
- Relevance
- Implication
- Coping Potential
- Normative Significance

Dynamics in the world

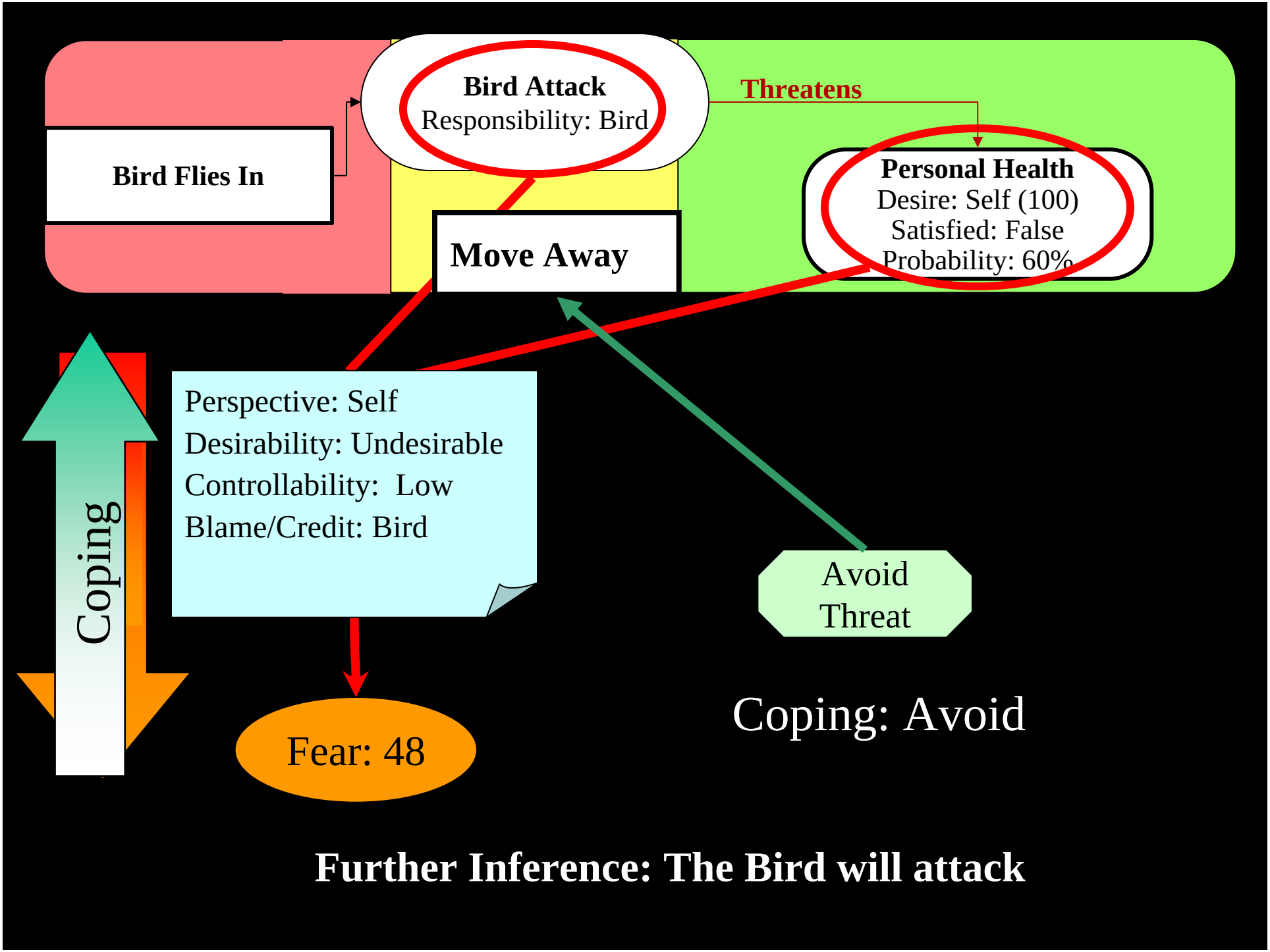
Dynamics in perceived world relationship

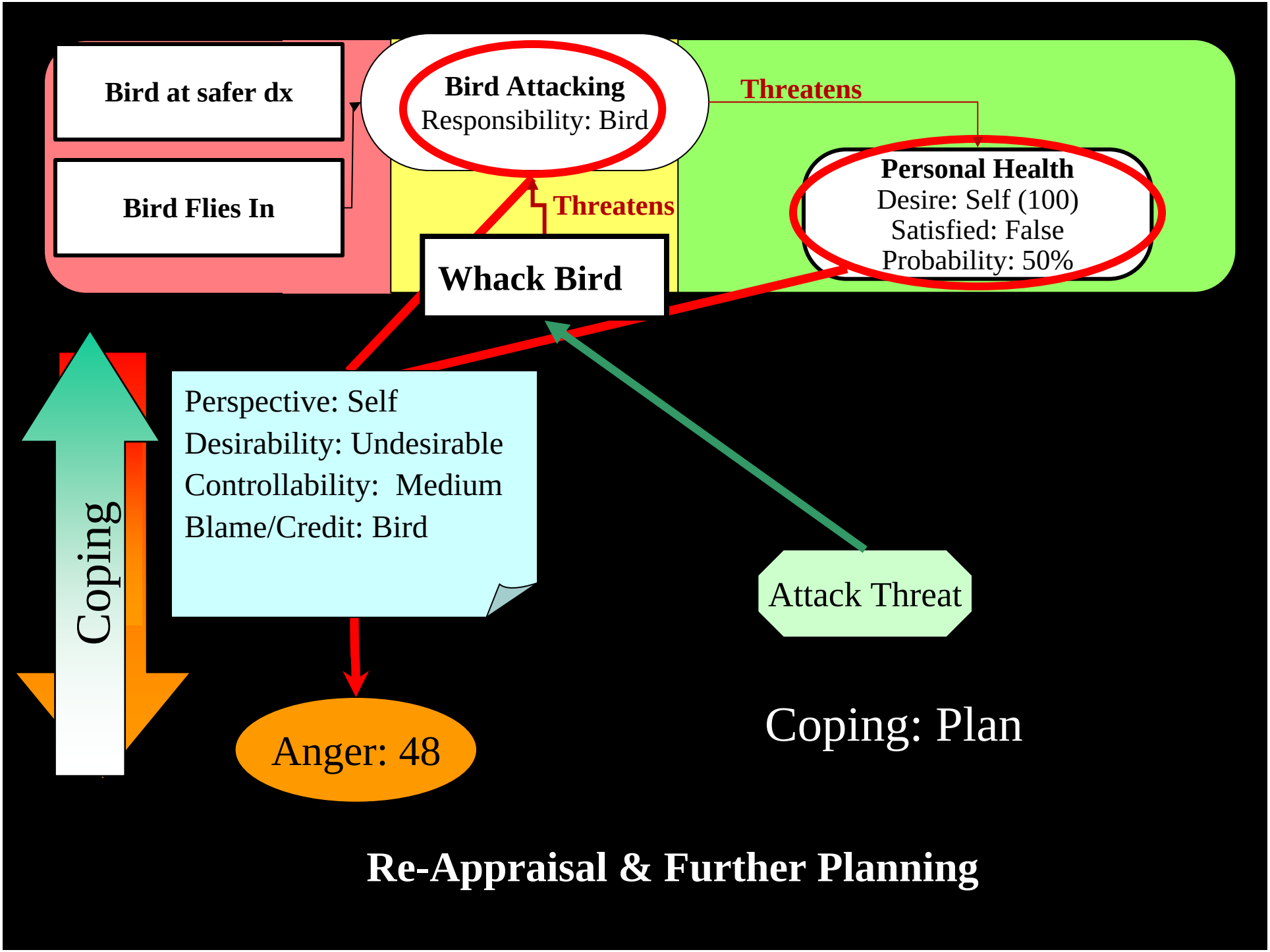


Dynamics through action

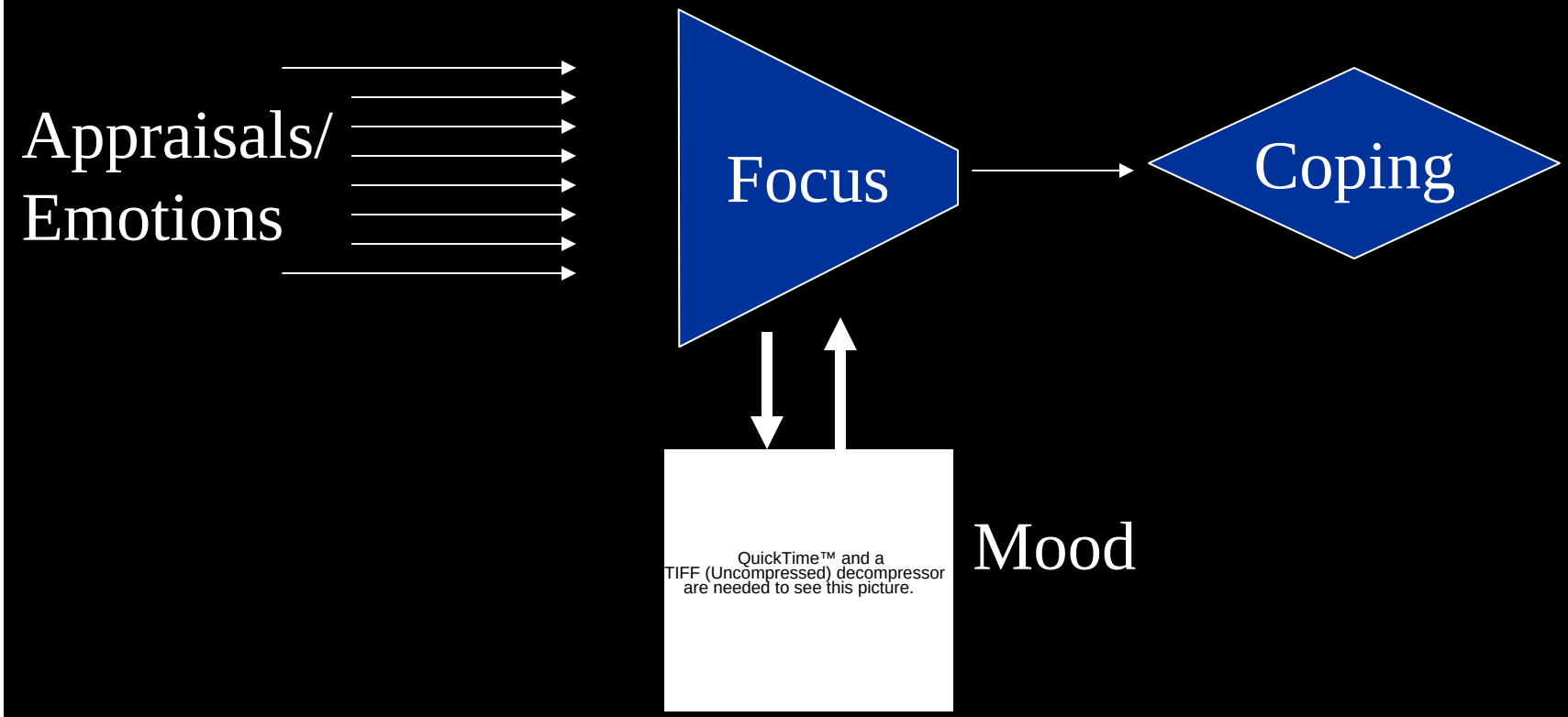


Virtual Actor's Appraisal of Bird Flying in Window


Bird Attack
Responsibility: Bird
Threatens
Bird Flies In
Personal Health
Desire: Self (100)
Satisfied: False
Probability: 60%
Move Away
Coping
Perspective: Self
Desirability: Undesirable
Controllability: Low
Blame/Credit: Bird
Avoid
Threat
Fear: 48
Coping: Avoid
Further Inference: The Bird will attack

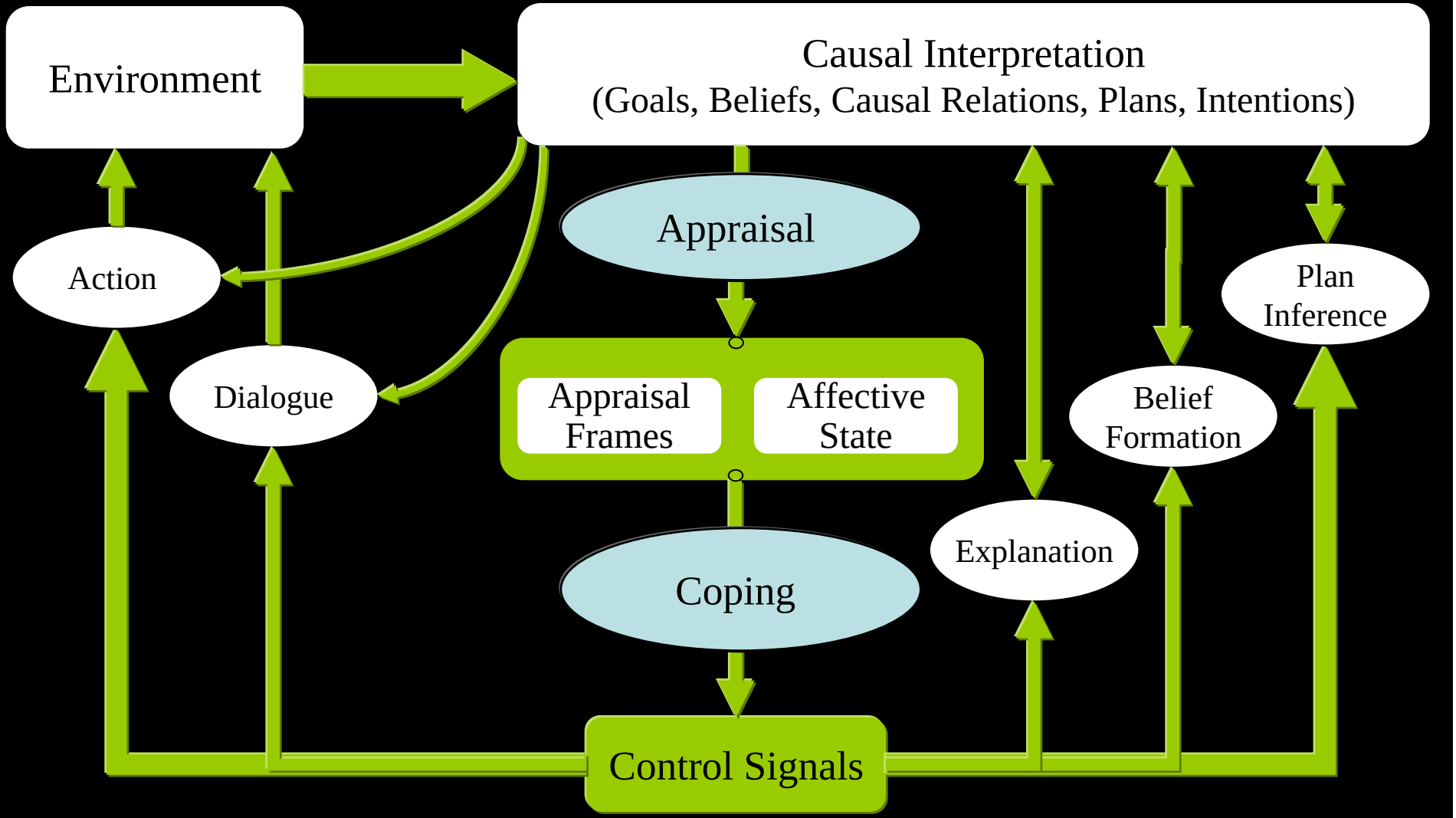

Bird at safer dx
Bird Flies In
Bird Attacking
Responsibility: Bird
Threatens
Personal Health
Desire: Self (100)
Satisfied: False
Probability: 50%
Threatens
Whack Bird
Perspective: Self
Desirability: Undesirable
Controllability: Medium
Blame/Credit: Bird
Coping
Attack Threat
Anger: 48
Coping: Plan
Re-Appraisal & Further Planning

Focus



Focus selects based on intensity, influenced by “Mood”

Emotion as Meta-control system



Dynamics a function of coping/cognitive processes and evolving situation


EVG
Louise
$ 0
Alexis
$ 0

Evaluation of EMA

(Gratch&Marsella, JAAMAS2005)

Does the model derive appropriate

- Appraisals?
- Emotional State?
- Coping Strategies?
- Dynamics (appraisal → coping → re-appraisal)

Assessed model using standard clinical instrument

Stress and **C**oping **P**rocess **Q**uestionnaire (Perrez&Reicherts92)

- Presents evolving situations
- Elicits self-reports of emotional state, Appraisals, Coping tendencies
- Identifies “normal” emotional trajectories

Model consistent with “healthy” emotional trends

Ongoing Work

- Give EMA a Theory of Mind / Perception of others
  - A body?
- Continue emphasis on evaluations
  - SCPQ immersed
  - Games & behavioral measures
  - Individual differences
- Expressive Behavior
- Mental health applications
  - Clinician training
  - Post-traumatic stress disorder
  - Adolescent violence

http://www.isi.edu/~marsella

http://www.ict.usc.edu/~gratch

Conclusion

- EMA is computational model of appraisal
  - Emphasize role of coping in guiding inference
- Effective in deriving virtual characters
- May have value in concretizing theory
- An approach to studying dynamics

Thank You