Unifying Cognitive Functions and Emotional Appraisal

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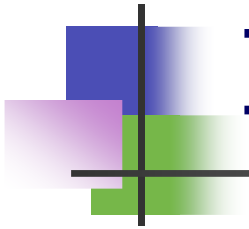
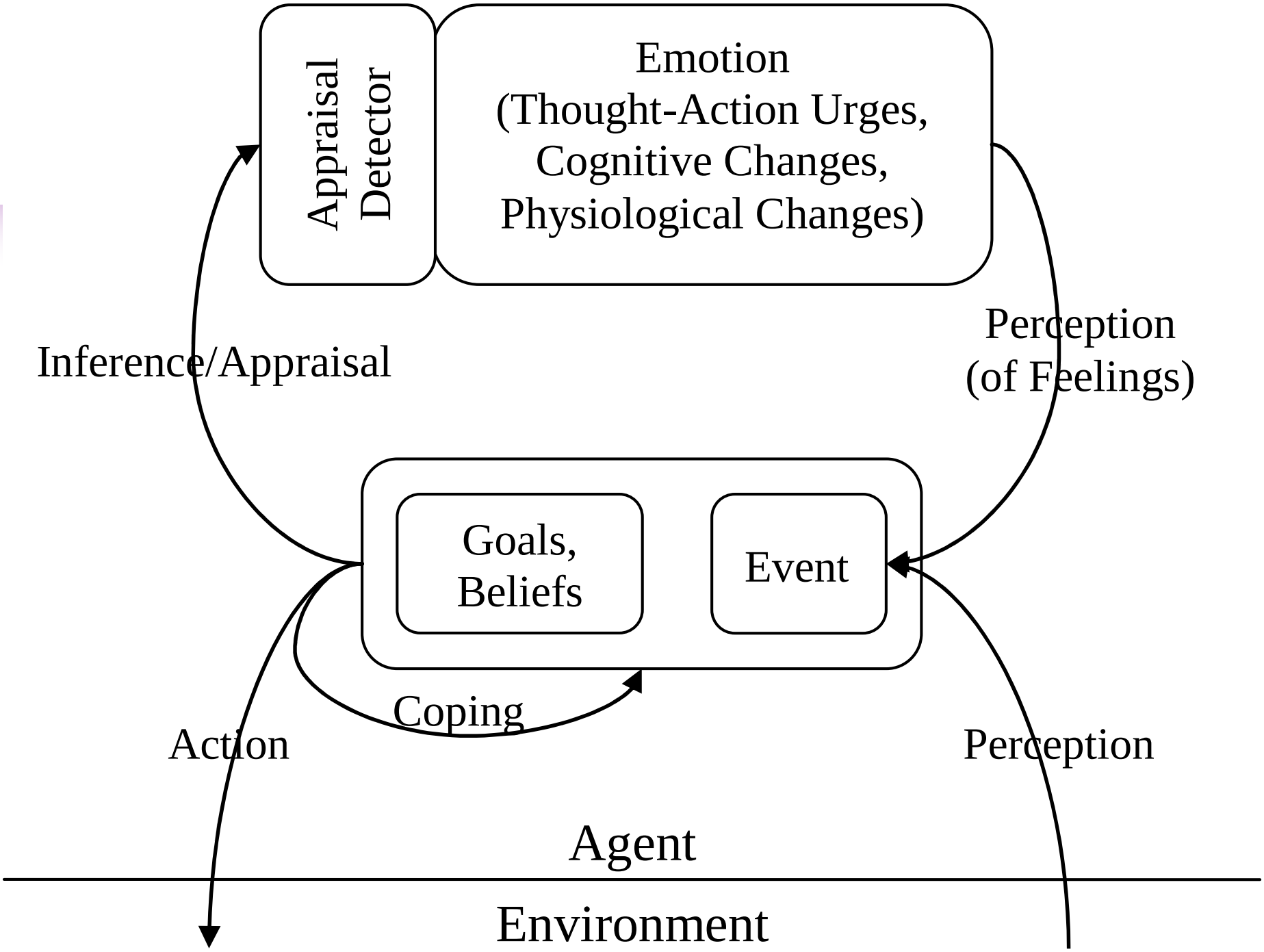


Introduction

- Have independent theories of emotion and cognitive functions
  - Emotion: Appraisal Theory
    - Data without process
  - Cognitive Functions: Allen Newell's PEACTIDM
    - Process without data
- Each of these is incomplete
- Emotion and cognition are tightly integrated in humans
- How can we unify cognitive functions with appraisal?
  - Claim: Both are concerned with *event processing*


Appraisal Detector
Emotion
(Thought-Action Urges,
Cognitive Changes,
Physiological Changes)
Inference/Appraisal
Perception
(of Feelings)
Goals,
Beliefs
Event
Coping
Action
Perception
Agent
Environment

Appraisal Theory of Emotion

- Suppose a person has some goals, beliefs, etc. (knowledge)
- An event occurs (internal or external)
- The person *appraises* the *relationship* between his goals and the event along a number of dimensions (e.g. unexpectedness, conduciveness, agency, etc).
- The appraisal automatically leads to *emotion* (e.g. physiological/cognitive changes, thought-action urges, etc)
- The person perceives emotion as *feelings* (internal event)
- The person *copes* with feelings by taking internal or external actions to improve/maintain the relationship between his goals and the environment

Proposed Appraisals Dimensions

Scherer 2001	Roseman 2001	Smith & Lazarus 1990; Smith & Kirby 2001	Lazarus 1991/2001	Gratch & Marsella (2004)
Novelty: Suddenness				
Novelty: Familiarity				
Novelty: Predictability				
Intrinsic pleasantness				
Goal/need relevance		Motivational relevance	Goal relevance	Relevance
Cause: agent	Agency	Self/Other accountability	Blame and credit	Causal attribution
Cause: motive				
Outcome probability	Probability	Future expectancy	Future expectations	Likelihood
Urgency				
Discrepancy from expectation	Unexpectedness			
Conduciveness	Situational state	Motivational congruence	Goal congruence	Desirability
Control	Control potential	Problem-focused coping potential	Coping potential	Changeability
Power				Controllability
Adjustment		Emotion-focused coping potential		
Internal standards compatibility			Type of ego involvement	Perspective
External standards compatibility				
	Motivational state			
	Problem type			

Appraisals to Emotions

	Scherer 2001	Elation/Joy	Fear	Rage/Hot Anger
Relevance	Suddenness	High/medium	High	High
	Familiarity		Low	Low
	Predictability	Low	Low	Low
	Intrinsic pleasantness		Low	
	Goal/need Relevance	High	High	High
Implication	Cause: agent		Other/nature	Other
	Cause: motive	Chance/intentional		Intentional
	Outcome probability	Very high	High	Very high
	Discrepancy from Expectation		Dissonant	Dissonant
	Conduciveness	Very high	Obstruct	Obstruct
	Urgency	Low	Very high	High
Coping potential	Control			High
	Power		Very low	High
	Adjustment	Medium	Low	High
Normative Significance	Internal standards compatibility			
	External standards compatibility			Low

What's Missing?

- When are appraisals generated?
- Why are the appraisals generated then?
- How are appraisals generated?
- How do appraisal and emotion impact behavior?

Cognitive Functions: Allen Newell's PEACTIDM

An agent must be able to perform the following functions

Event Processing	Perceive	Raw perception
	Encode	Create domain-independent representation
	Attend	Chose stimulus to process
	Comprehend	Generate structures that relate stimulus to goals and can be used to inform behavior
Response Processing	Tasking	Perform goal maintenance
	Intend	Chose an action
	Decode	Decompose action into motor commands
	Motor	Execute motor commands

What's Missing?

Example: Bob steps down from the curb.

Perceive	What information is generated?
Encode	What information is generated?
Attend	What information is required?
Comprehend	What information is generated?
Tasking	What information is required?
Intend	What information is required?

Unifying Cognitive Functions and Appraisal

Appraisal Generators

Appraisal Consumers

Event Processing

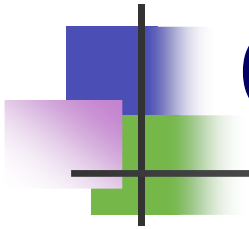
Perceive	Raw perception
Encode	Domain-independent representation
Attend	Chose stimulus to process
Comprehend	Generate structures that relate stimulus to goals and can be used to inform behavior
Tasking	Perform goal maintenance
Intend	Chose an action

Encode and Event Structure

- Encode generates domain-independent *event* structures from the raw Perceptual information
  - *Events are the foundational data structure that unify appraisal and PEACTIDM*
- Simplification of Talmy (1975)
  - Actor Bob
  - Action Walking across street
- Also includes metadata about the event

Attend

- Most events are probably not worth paying attention to
- Attend uses metadata from Encoded structure determine if an event should be processed further
- What metadata?
  - Suddenness
  - Familiarity
  - Predictability



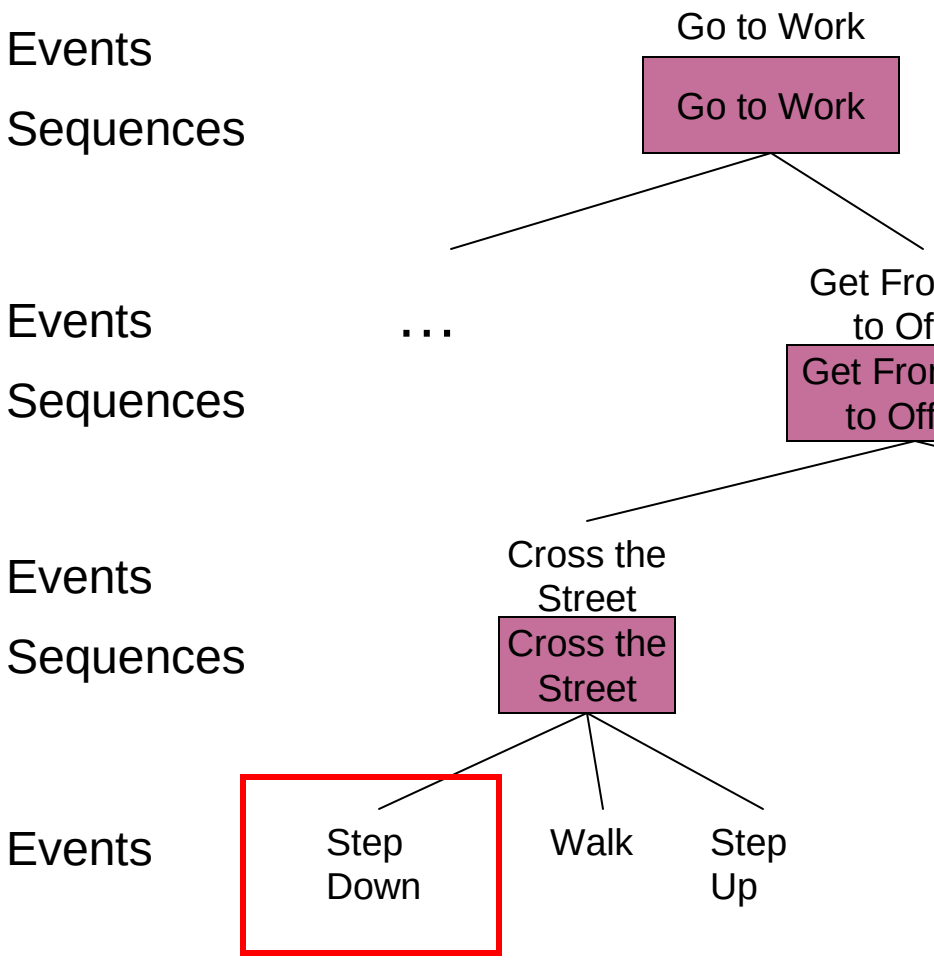
Comprehension Process

- Goal: To create data structures that inform behavior
- Key: Process *sequences* of events
- Process
  - Observe partial sequence of events
  - Match partial sequence to known complete sequence
  - Use complete sequence to predict next event
- Only work on one event or sequence at a time (i.e. processing is local)
- Since the event structures are domain independent, this process is also domain independent

Abstract Events, Sequences and Subgoals

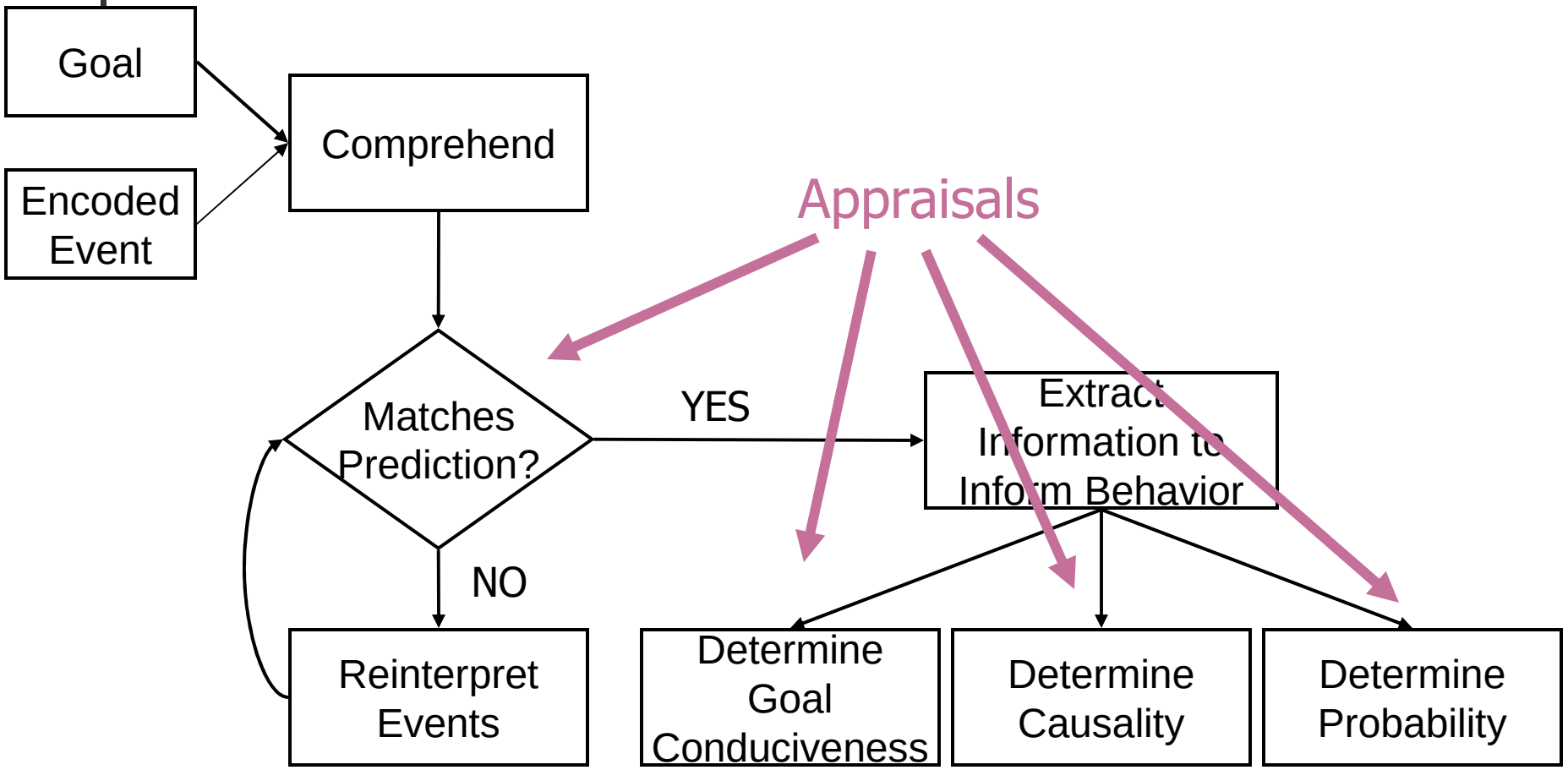
- An event sequence can be abstracted to represent a single event in a more abstract sequence
- Example:
  - Step down from curb
  - Take a few steps
  - Step up onto curb
  - …this is just the "Cross the Street" event, which may be just one event in the "Get from Car to Office" sequence, which may be one event in the "Go to Work" sequence…which may be just one event in the "Living My Life" sequence.
- Abstract events can be thought of as subgoals

Event Knowledge Hierarchy



- Domain Independent
- Limited Working Memory
- Immediate Comprehension
- Hierarchical Comprehension
- Incremental Processing
- Supports Prediction

Comprehension Process Details



Unifying Cognitive Functions and Appraisal Revisited

Perceive	Raw perception
Encode	Domain-independent representation
Attend	Chose stimulus to process
Comprehend	Generate structures that relate stimulus to goals and can be used to inform behavior
Tasking	Perform goal maintenance
Intend	Chose an action

Response Processing

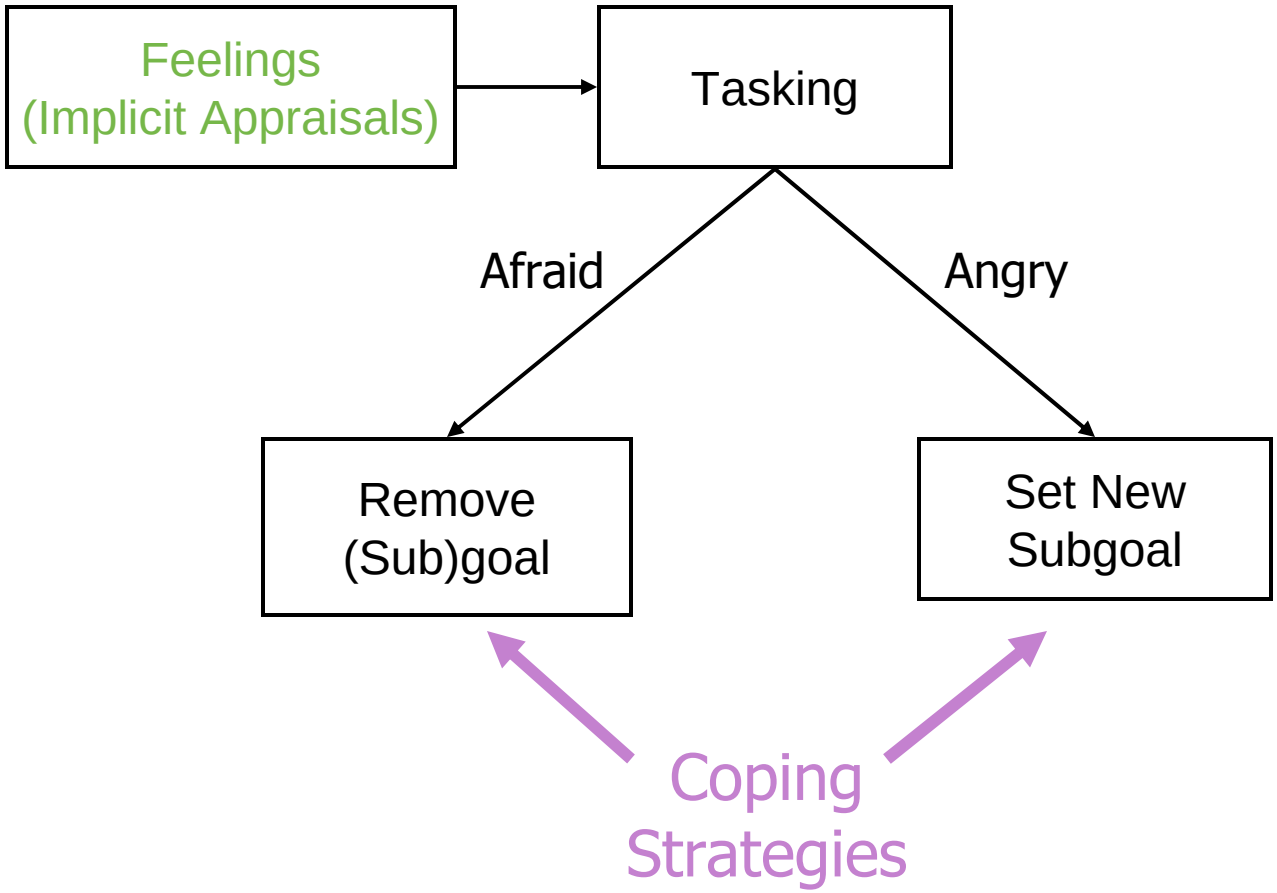
Appraisal Generators

Appraisal Consumers

Tasking Process

- Goal: Update current (sub)goals as necessary
- Key: Emotion automatically signals with status (goal threatened, situation alterable) and how to fix it (e.g. whose fault is it, etc)
- Process:
  - Determine how to proceed based on implications of emotion

Tasking Process Details



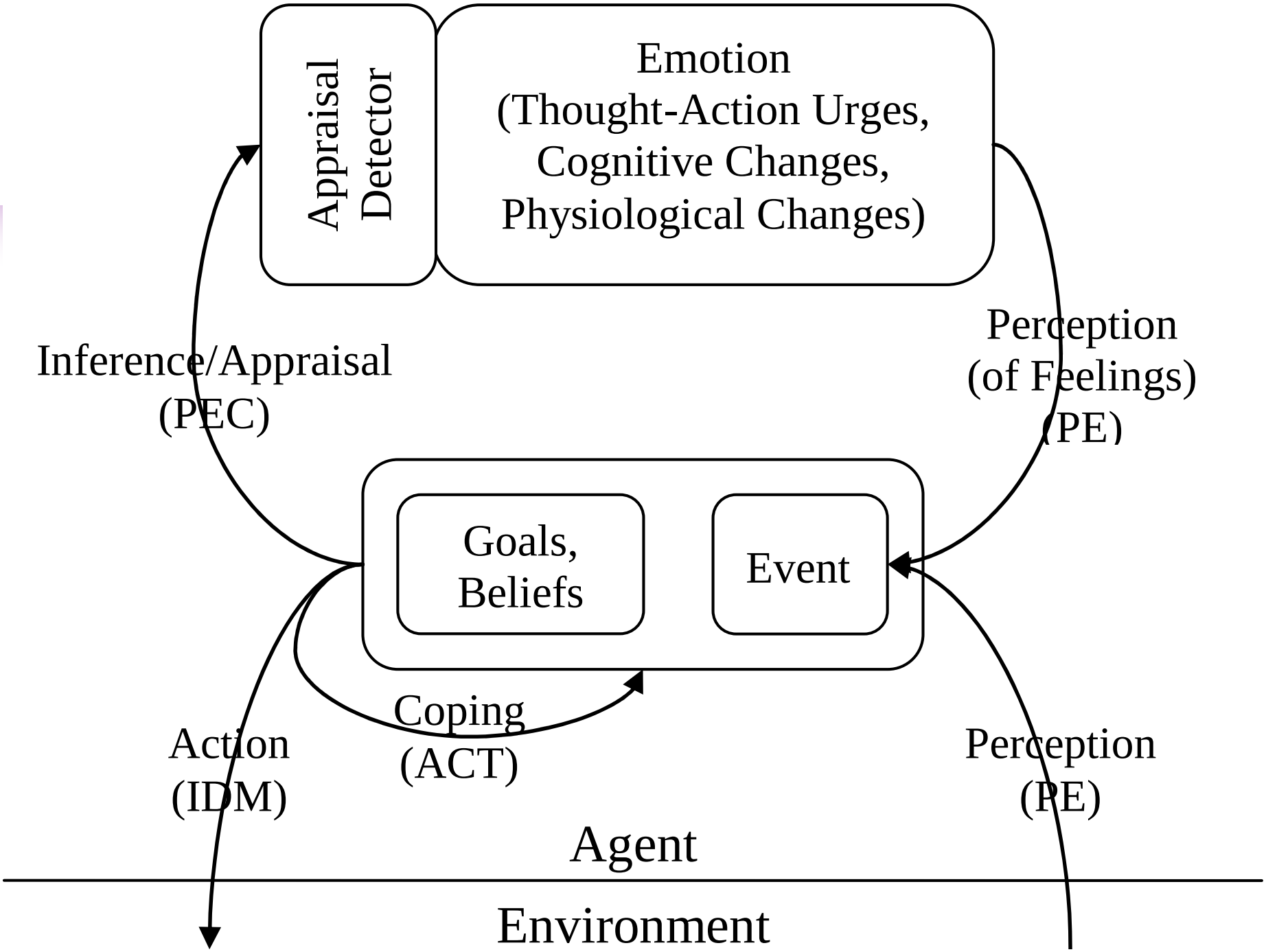
Intend Process

- Goal: Determine next action to execute
- Key: In general, there may be many paths from the current situation to the goal, so Intend must pick one
  - Also has to compete with action tendencies (e.g. automatic responses)
- Process:
  - If urgency is high, "automatic" responses win
  - Otherwise, walk event hierarchy to find path to goal

Appraisal

Unification

Scherer 2001	Generated By	Required By
Novelty: Suddenness	Perception	Attend
Novelty: Familiarity	Encoding	
Novelty: Predictability		
Intrinsic pleasantness		Tasking (via Feelings)
Goal/need relevance	Comprehension	
Cause: agent		
Cause: motive		
Outcome probability		
Urgency		Intend (via Feelings)
Discrepancy from expectation		Comprehension
Conduciveness		Tasking (via Feelings)
Control		
Power		
Adjustment		
Internal standards compatibility		
External standards compatibility		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Action
(IDM)
Perception
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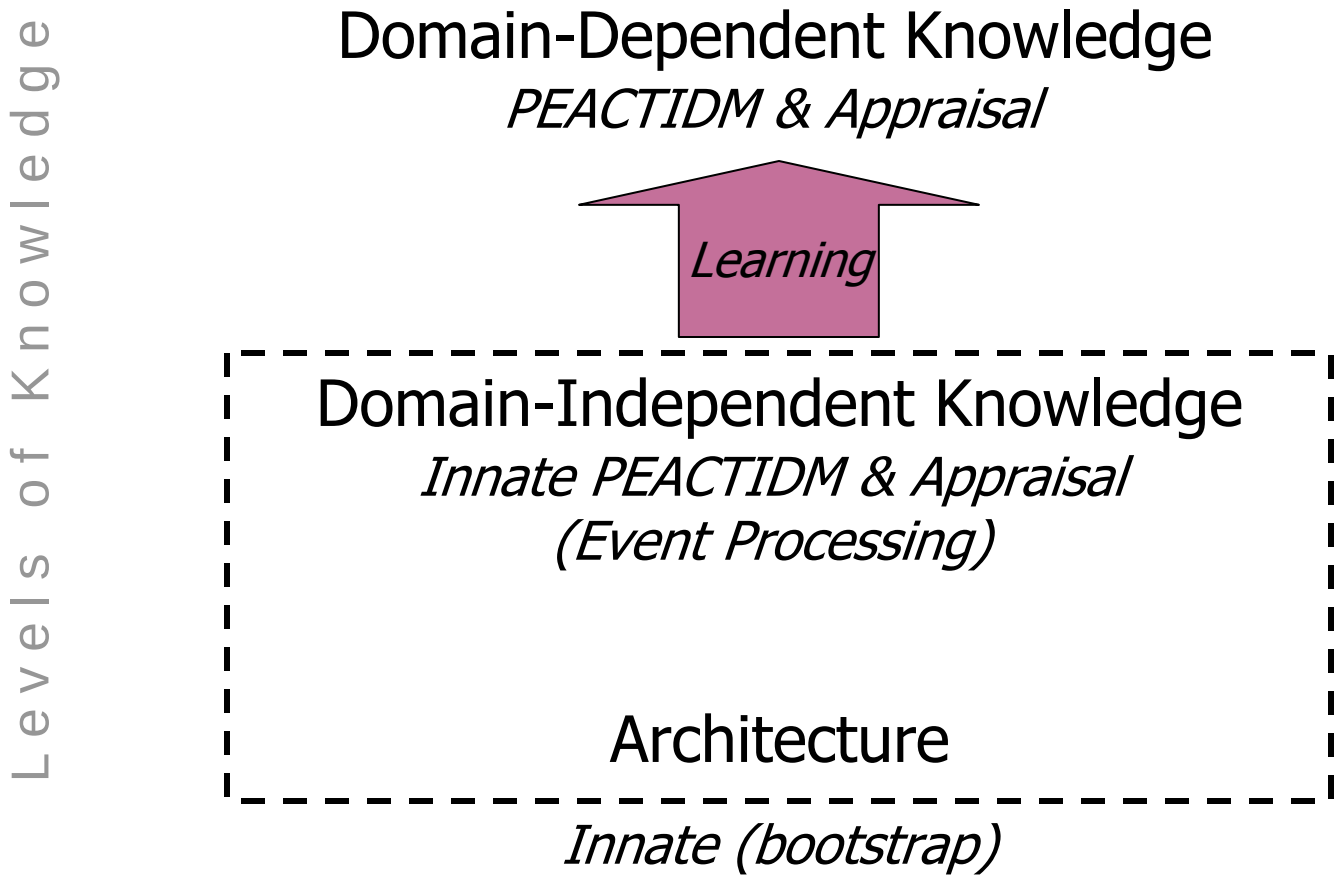
Predictions

- Agent will be interruptible
- Partial ordering constraint on appraisal generation
- Different emotions may require different amounts of processing
- Time constraints may lead to errors in Comprehension (and thus emotion)

Impact on Soar: Innate Knowledge



Summary

- Nuggets
  - Appraisal processing and PEACTIDM both fill in missing pieces of each other
  - The story satisfies multiple psychological constraints
  - May give some insight into innate knowledge
  - **Appraisal generation isn't special – it results from normal processing**
- Coal
  - Unifying these does not solve everything: theoretically and implementationally, there are still a lot of hard, unanswered questions