MODELING WITH PERCEPTUAL, MEMORY, AND MOTOR CONSTRAINTS

An EPIC-Soar model of a simplified enroute air traffic control task

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PRESENTATION PLAN

- Introduction
- Architecture
- Model
- Brief Demo

- **We developed a low-level behavior model, at the level of eye and hand movements, eye/hand coordination, and perceptual, memory, and motor limitations.**

- **Modeling philosophy: High-level performance that is representative of human performance can emerge from good, low-level behavioral models.**

- **Why model at this level?**
  - The model evaluation focus on the model's relation to psychological theory, psychological plausibility and behavioral efficacy.
  - Our prior modeling experience and research bias.
  - Our observations and assumptions about the task and human behavior.

- **Observations and assumptions about the task and human behavior**
  - There is a strong *perceptual* component. The eyes/perception are responsible for finding features in the world that satisfy the prerequisites of task actions.
  - *Memory* plays an equally crucial roll since there is temporal spacing between when a blip is seen and when an action can be performed.
  - *Cognition* provides strategies to control perception (eye scan patterns), manage memory (creating/rehearsing memories), and perform task actions.
  - *Manual motor* behavior—mouse clicks and movements—is trivial. No reasoning is involved and the time to perform a sequence is independent of the task load.

- **Hypothesis: For this task, perception, memory, and cognition most strongly influence behavior, performance, variability, and workload effects. In contrast, manual motor behavior contribute little to these factors.**

INTRODUCTION, CONT'D

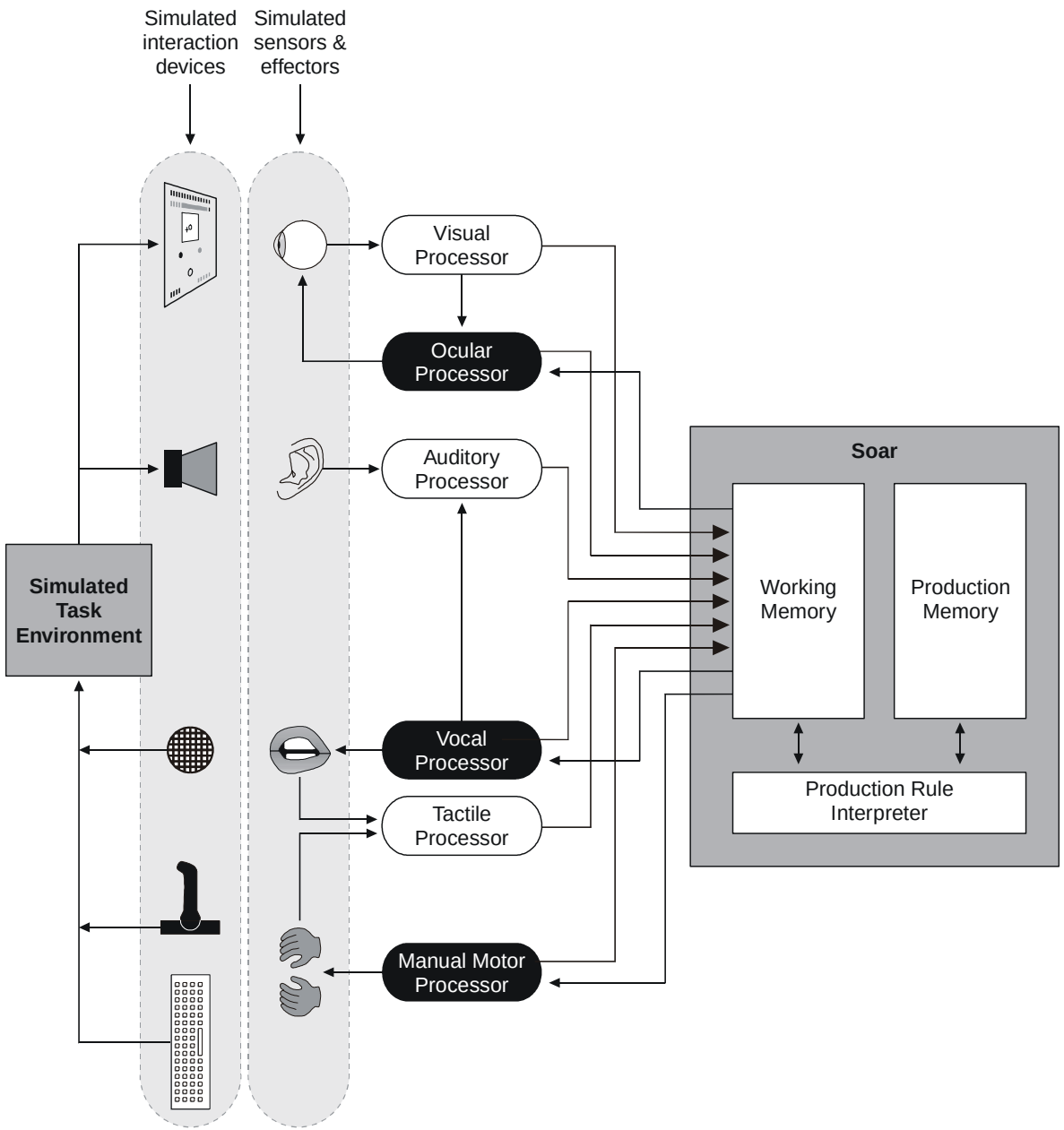
- Caveat: We had no data to direct the modeling of perceptual limits and strategies, memory effects, or cognitive strategies. We were given *task action* data—mouse click times—but as our hypothesis indicates, we expect this data can provide little guidance to these components.

- Consequence: We build the model by applying relevant psychological theory, observation, reflection and intuition about human behavior.

- Spin: We are using architectures that, by definition, provide *some* constraints. At some point, we will have to start building models without relying so heavily on specific data before a single rule is written.

ARCHITECTURE: EPIC-SOAR

- *EPIC-Soar* is an integration of the perceptual and motor processors of EPIC with Soar.
- An attempt to get both the detailed predictions and explanations provided by EPIC and the cognitive abilities of Soar.
- To model forgetting, we added working memory activation to Soar, as found in ACT-R.



MODEL: SOAR OPERATORS

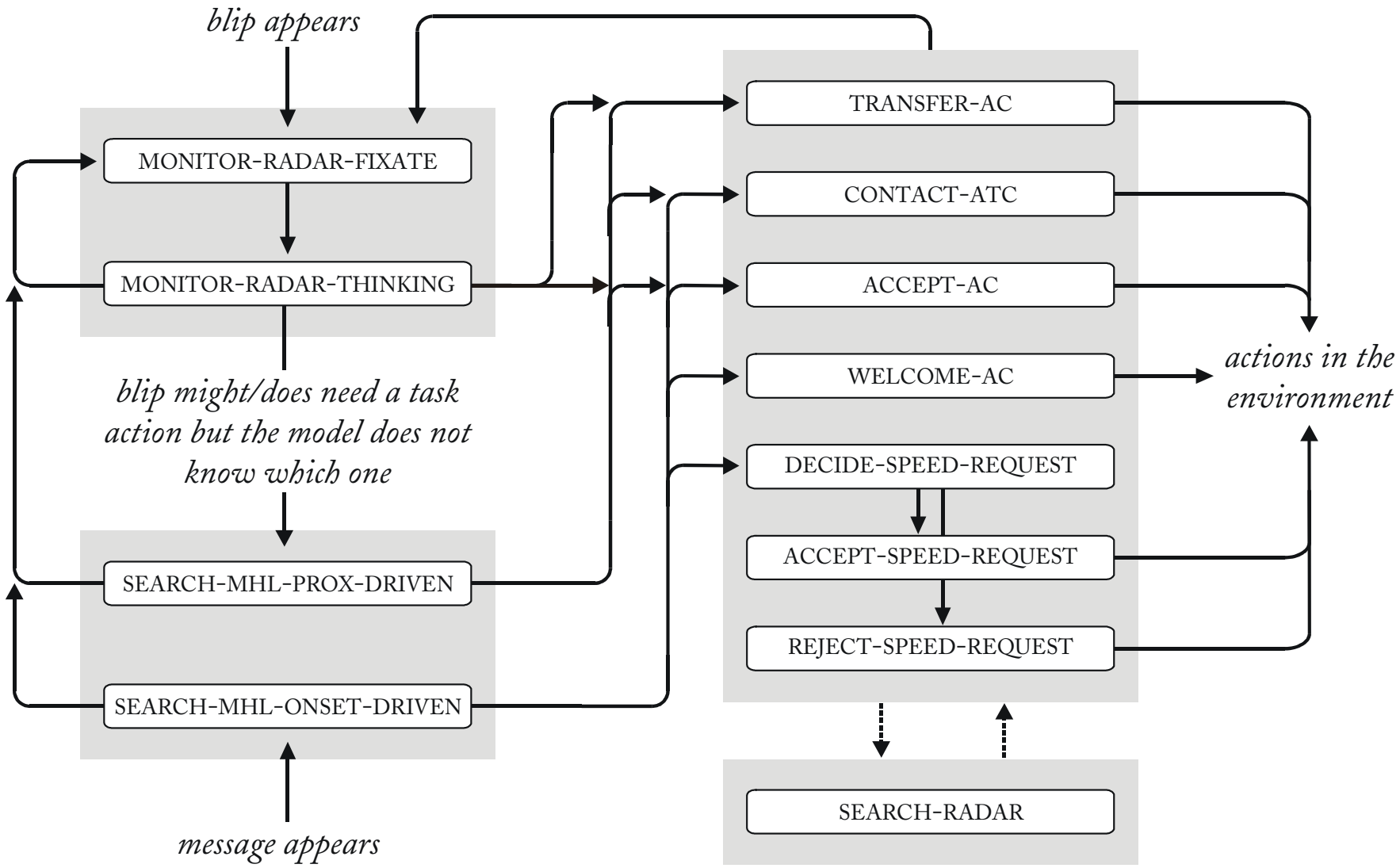
- monitor-radar: **scans the radar display; there has two sequential operators:**
  - monitor-radar-fixate: moves the eyes to blips on the radar display.
  - monitor-radar-thinking: thinks about each fixated blip.

- search-mhl: **reads message in the message history list; there are two styles:**
  - search-mhl-onset-driven: initiated when a new message has appeared.
  - search-mhl-proximity-driven: initiated when there is a blip close to a border and the model does not know if the blip has been adequately processed.

- task-actions: **six styles that execute the six task commands plus one,** decide-speed-request, **that analyzes the display to determine if a speed-request should be accepted or rejected.**

- search-radar: **when the location of a blip is unknown, this operator searches the radar display. It is only performed in service of (i.e., as a subgoal to)** task-action **operators.**

MODEL: FLOWCHART OF THE MODEL (FOR THE UNAIDED CONDITION)



MODEL: MULTIPLE TASK MANAGEMENT & WORKLOAD COMPUTATION

- **Multiple task management**
  - Implicit executive process.
  - "Implicit" means there is no operator that performs executive functions.
  - Meta-knowledge that enforces priorities stated in the task instructions.

- **Workload computation**
  - Jillions of possible features to use to compute workload
  - Based on a "realization of work to be done"
  - In the *aided* condition, this realization occurs when a blip's color changes from white.
  - In the *unaided* condition, this realization occurs whenever an anticipation and/or expectation memories are created or *recreated* (because these memories have decayed).
  - Each kind of realization is assigned a score (v) reflecting its importance in the task.
  - Workload (t) = $\alpha * \Sigma v / t$

DEMO OF THE MODEL