Toward A Symbolic Model of Attention

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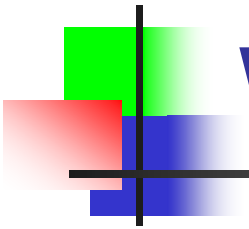


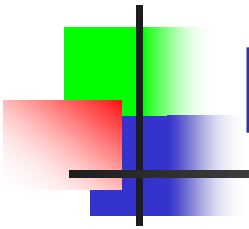
What is attention?

- "Everyone knows what attention is.".

  – William James, 1890

- "On attention itself, it is needless to discourse at length; its nature and conditions are familiar to every thoughtful student".

  – Munsell, 1873



Modeling Attention

- The dominant approach to modeling attention is connectionism (e.g., Cohen et al, 1990).
- One question is, can attention be modeled symbolically?
  - Capturing psychological meaningful processes
  - Attention shapes how the mind constructs and utilizes psychological space
- Attention in Act-R/PM
  - Mainly a function of the visual module
  - Explicitly speaking: orienting attention only
    - Bottom-up: attention capture
    - Top-down: “move-attention”, ~85ms

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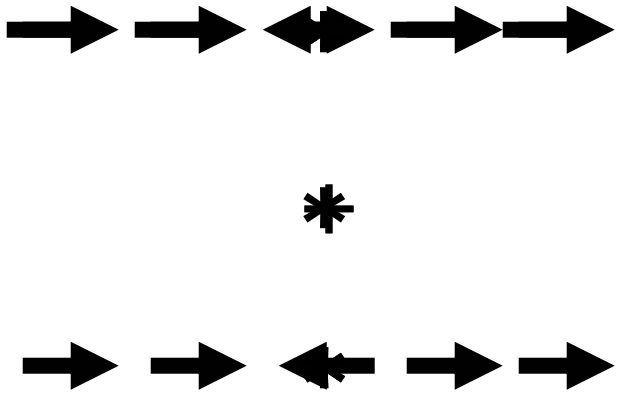
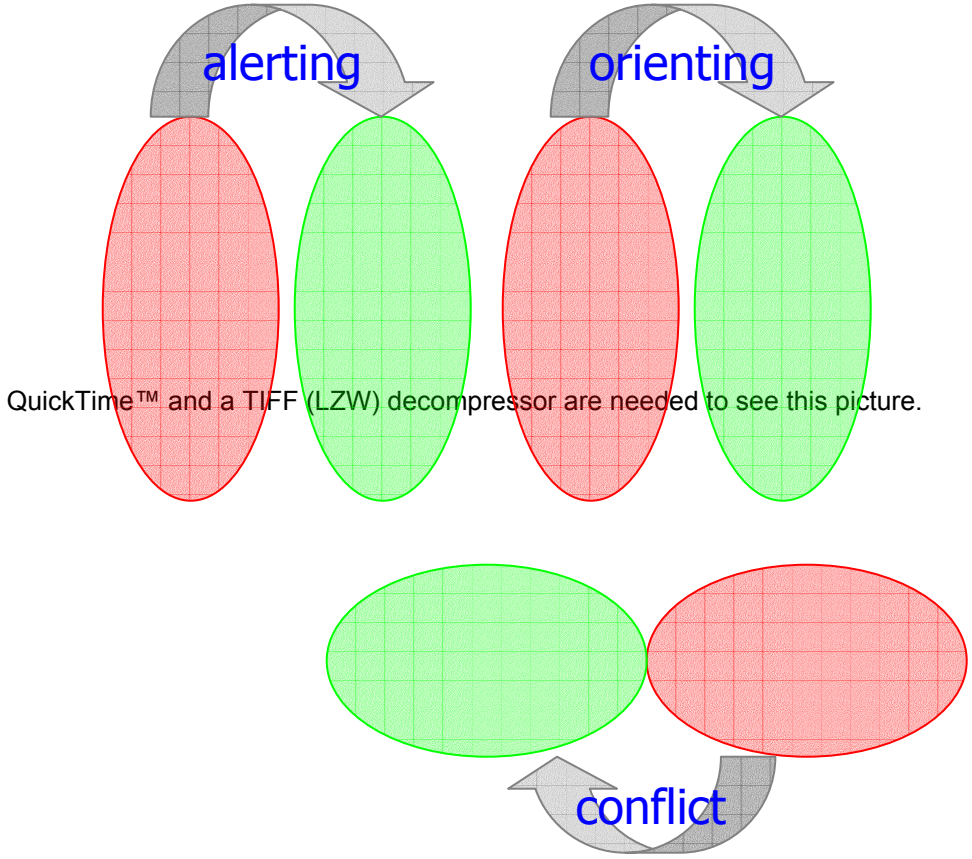
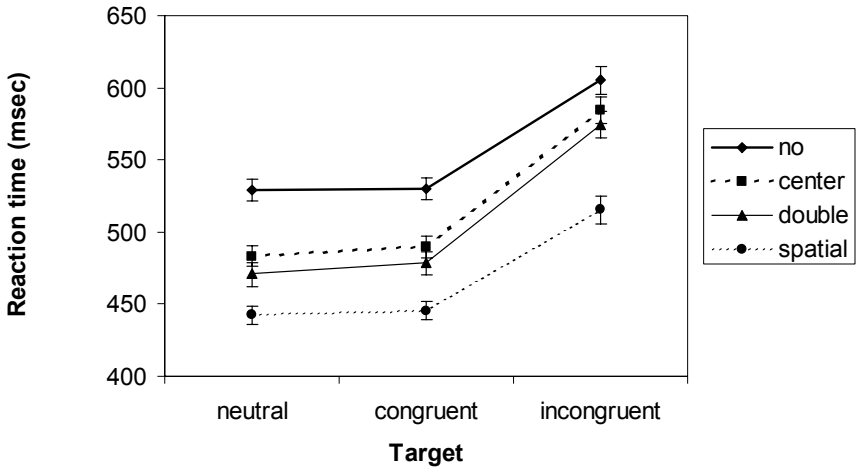


(Fan et al, 2002)

Attention is more than "just move-attention"

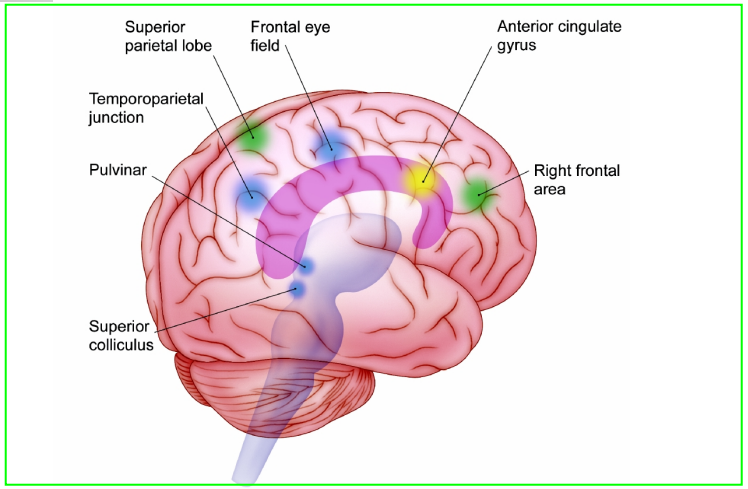


ANT Results

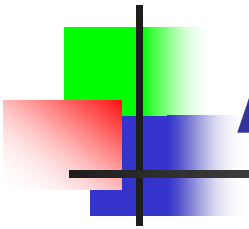


- Alerting = 47ms +- 18ms
- Orienting = 51ms +- 21ms
- Conflict = 84ms +- 25ms

(Fan et al, 2002)



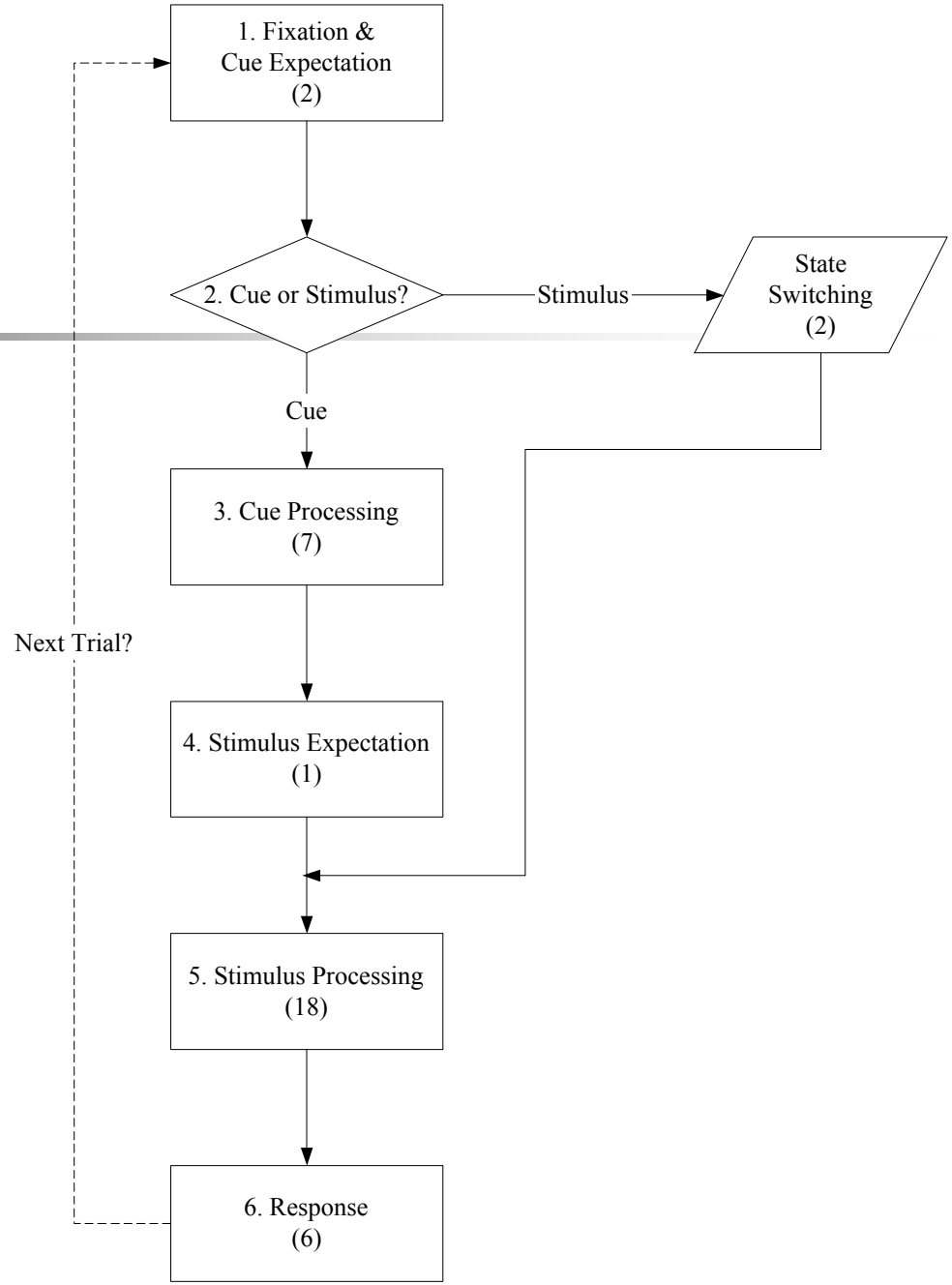
- Variables
  - Genetics
  - Early development
  - Pathology
    - ADHD
    - Schizophrenia
    - Borderline Personality



ANT on Act-R?

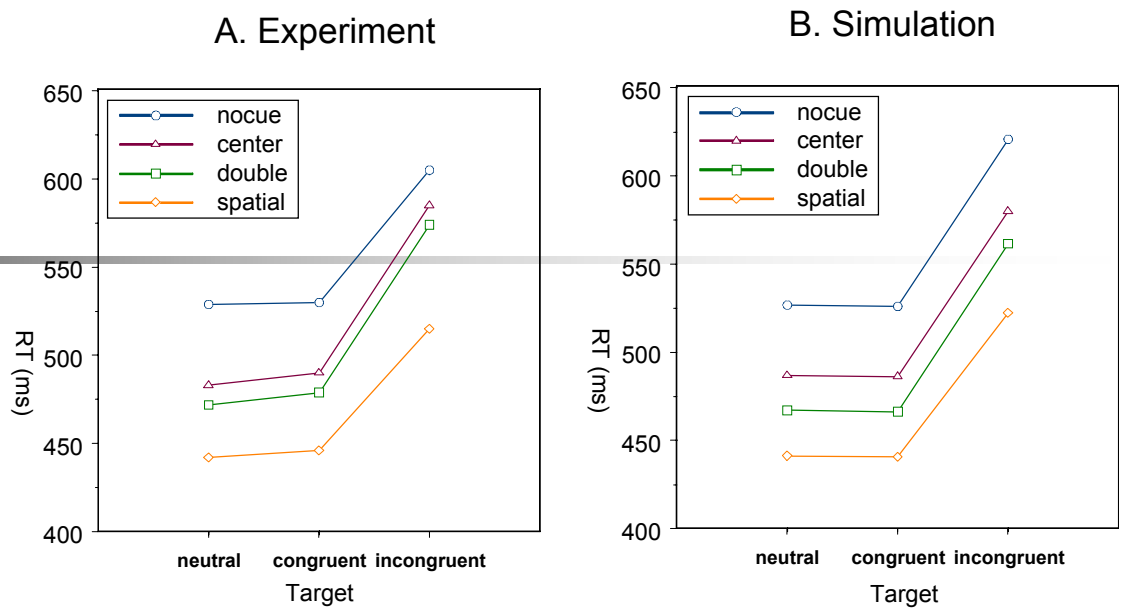
- The short answer: Yes, we can.
- The key is to represent/implement alerting, orienting, and conflict symbolically, via rules.

ANT on Act-R/PM



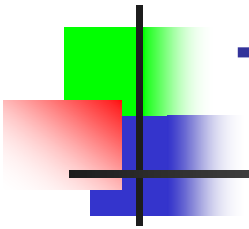
- Task analysis
- Mapping the task components to about 36 production rules
- Demo?

Model Results



- Fan et al (2002) design
- 100 simulated subjects
- r = 0.99

Effects (ms) (mean±stddev)	Attentional Networks		
	Alerting	Orienting	Executive Control
Experiment	47 ± 18	51 ± 21	84 ± 25
Simulation	55 ± 7.4	45 ± 7.0	86 ± 7.4



Three Attentional Effects

;;;Alerting:**47**+-18ms

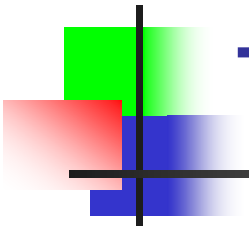
There is **one rule**, called *not-cue-so-switch-state-and-shift-attention*, that fires in the no-cue condition but not in any other cued condition. This rule summarizes the preparatory state change (from expecting either a cue or a stimulus to specifically expecting a stimulus) and is responsible for a major part of the alerting effect.

;;;orienting: **51**+-21ms

We assume that in the spatial-cue condition attention has already been allocated to the correct spatial location before the stimulus is to appear, whereas in the center-cue condition the firing of this additional production rule is necessary to bring the system to a comparable level of stimulus processing. This additional step, through **a rule** called *notice-stimulus-with-centercue-and-shift,* is the major source of the orienting effect.

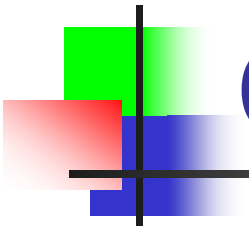
;;;conflict:**84**+-25ms

The result of *move-attention* is not perfect. When attention is directed to one location, an object nearby may be selected, especially when the scene is crowded or the objects are similar. This kind of imprecision causes **another move-attention** is one fundamental reason for the flanker effect.



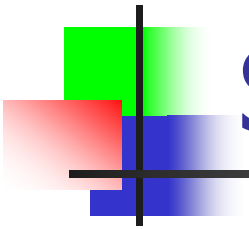
The Question

- Although the model seems capture the three attentional effects nicely, is the model interesting?



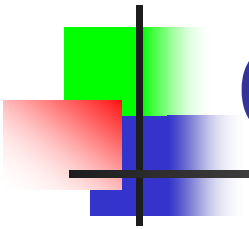
Open Issues

1. How far can we go with symbolic modeling of attention?
   - Minimum symbolic time scale?
   - 11ms issue.
2. Relations with subsymbolic modeling
   - Different mechnisms (e.g., serial & parallel)
   - Multilevel modeling and cross-validation
3. How to evaluate the model?
   - Pathology & development: rule missing & rule tuning?
   - What do they mean?
4. 40ms/rule issue?



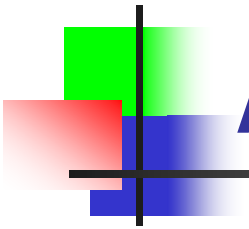
Symbolic Diffusion?

- 10ms effect: doublecue condition is 10ms less the the center cue condition.
  - the center-cue induces the participant to focus attention on the fixation location while the double-cue makes the participant diffuse attention at both the top and bottom locations so that each location receives a little priming.
  - A challenge to symbolic modeling: How can attention be diffused symbolically when we only have in hand a *move-attention* command, which presumably shifts the *focus* of attention to a pre-specified spatial location?
  - Instead of using a neurally plausible diffused attention mechanism, we assume that attention is moved twice, each time to one of the two cues. This is like a betting strategy.
  - 19 +- 8 ms.



One Key Manipulation

- 40 ms cost / rule
  - At least 1 move-attention (85ms) + 1 press-key (210ms) + 4-8 rule firings
  - Practice effect?



Acknowledgment

- Office of Naval Research grant N00014-01-1-0074 on “modeling spatial cognition”.
- Drs. Jin Fan and Michael I. Posner at Cornell.