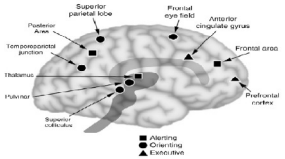


# A Cognitive Model of Modulation between Attentional Networks

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## Introduction

- Functional neuroimaging has enabled researchers to view many cognitive processes in the window of which brain areas are activated when various attention components are working[3,6,11,12]
- This has led to a different kind of theory based on separate but collaborating attentional networks in which attention can be viewed as an organ system or as a system of anatomical areas that consist of more specialized networks.
- Based on these anatomical findings, Posner proposed his three-component theory whereby attention is divided into three components: alerting, orienting and executive control[9].

## Objective

A cognitive model[7] is implemented in ACT-R 6.0 [1] to demonstrate how modeling can help us understand better not only how our attention system works but also explain how it functions in a coordinated way to produce effective behavior.

## Design

Attentional Network Test (ANT) [5] is computer based reaction time test, a combination of cueing experiments [8] and a flanker task [4]. This study is an adapted version of ANT, the experimental design, illustrated in figure 1, involves 2 auditory Signals, 3 visual cues and 2 congruency conditions[2]. The ACT-R model of Wang[13] is modified for this design.

**Figure 1: Sketch of the design of the adapted version of ANT based on Callejas study[2]**

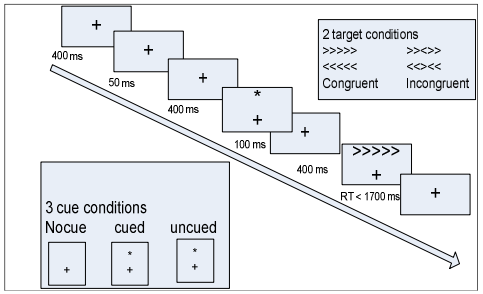
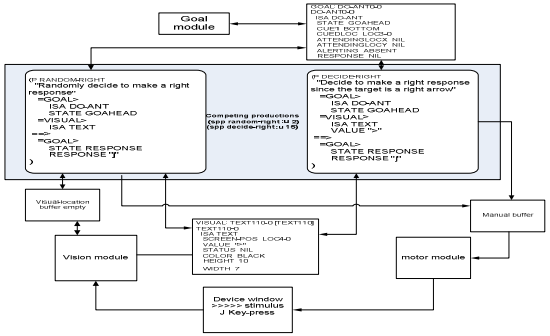



**Figure 2: Snapshot of the ACT-R model showing data and control flow**




## Results

The model demonstrates similar interactions to those seen in the original experiment:

- Alerting network has an inhibitory influence on the congruency effect (in line with Posner's [10] view of 'clearing of consciousness' phenomenon).
- When the location of the target was cued, the congruency effect was smaller compared to the condition when the location of the target was cued in the opposite location.
- Alerting system helps prepare for a task and prevents the control network from further processing the stimulus.

Model's performance and evaluation:

- Correlation of latency 0.89 and accuracy is 0.83 showing good fit to human data.

This shows that though these networks may be anatomically and functionally independent, they function under the influence of each other in order to produce effective behavior.

**Figure 3: Interactions between networks: Congruency effect as a function of alerting and orienting**

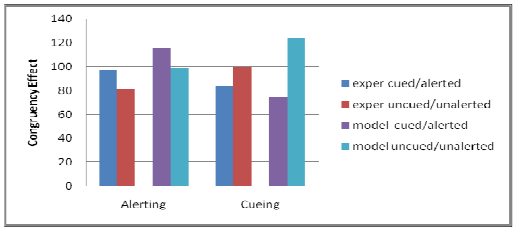



**Table 1: Comparison of the latency and accuracy results from the original experiment [2] and simulation of the ACT-R model.**

| Mean Reaction Times in ms and error percentages for experiment and (the model simulation) | | | | | | |
|---|---|---|---|---|---|---|
| | No Alerting tone | | | Alerting tone | | |
| | No cue | Cued | Uncued | No cue | Cued | Uncued |
| **Congruent** | 573 (577 ) | 533 (527) | 561( 595) | 530 (545 ) | 519 (475 ) | 547(545 ) |
| **Incongruent** | 644 (690 ) | 617(597 ) | 648 (710 ) | 625 (680 ) | 603 (543 ) | 659(680 ) |
| **Congruent** | 1.39(7.6) | 1.22(2) | 1.56(6.2) | 1.74 (4.4) | 1.04(5.7) | 1.56(5.1) |
| **Incongruent** | 2.60 (12.9) | 3.82 (8.1) | 6.08 (14.9) | 7.64 (15.1) | 3.82 (7.9) | 7.47(12.3) |

## Conclusions

This cognitive model can be used as a potentially important assessment tool for neuropsychology. Modeling the deficit/dysfunction of attention and attention related functions using behavioral data associated with neurological disorders, we can show the effect of neglect. Simulating deficits in the attentional networks may not only facilitate understanding of these functional systems but may also help to design rehabilitative procedures.

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