Getting the Selective Attention for Identification model (SAIM) in touch with the neurophysiological side

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School of Psychology

University of Birmingham

Overview

- Selective Attention for Identification model (SAIM)
- Visual search
  - Natural images
  - Asymmetry
- Spiking version

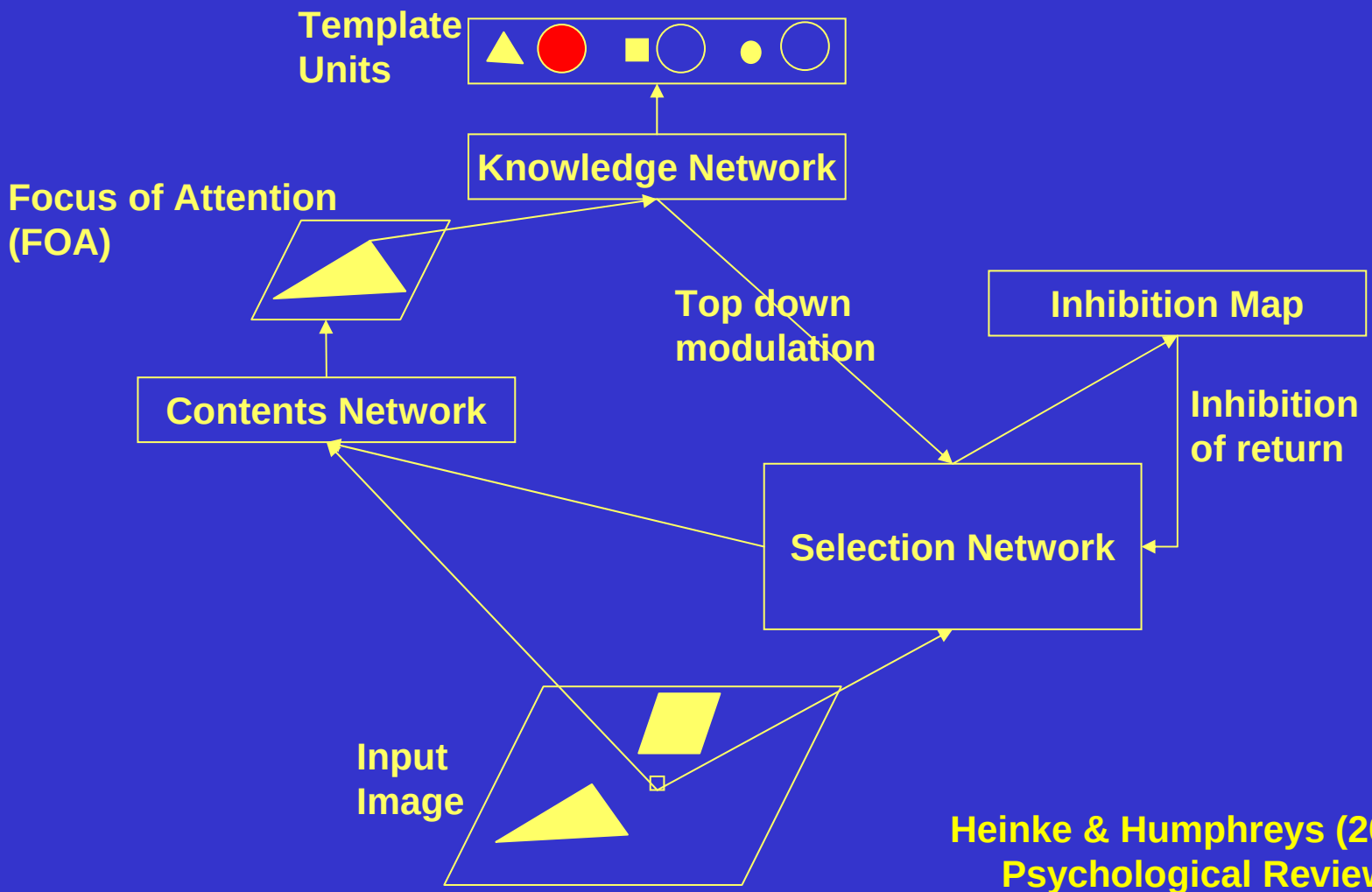
- Andreas Backhaus
- Christoph Boehme
- Yuanyuan Zhao
- Martin Kreyling
- Yarou Sun
- Eirini Mavritsaki

Selective Attention for Identification Model (SAIM)

How do humans identify objects in a scene with multiple objects?

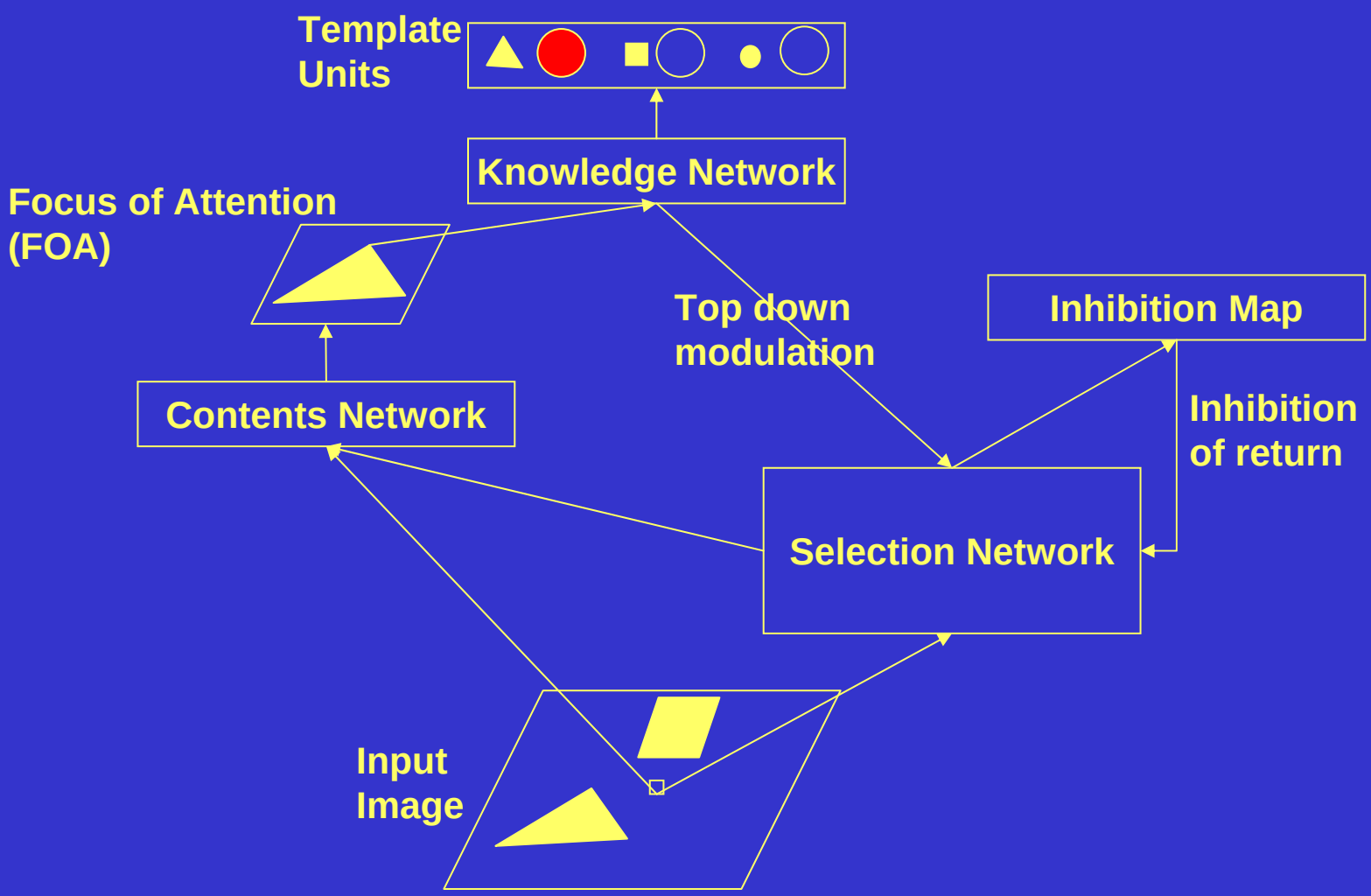
- **Translation-invariant object identification**
- **Spatial selection**
- **Serial Scan**
- **Connectionist Framework**

Architecture of SAIM



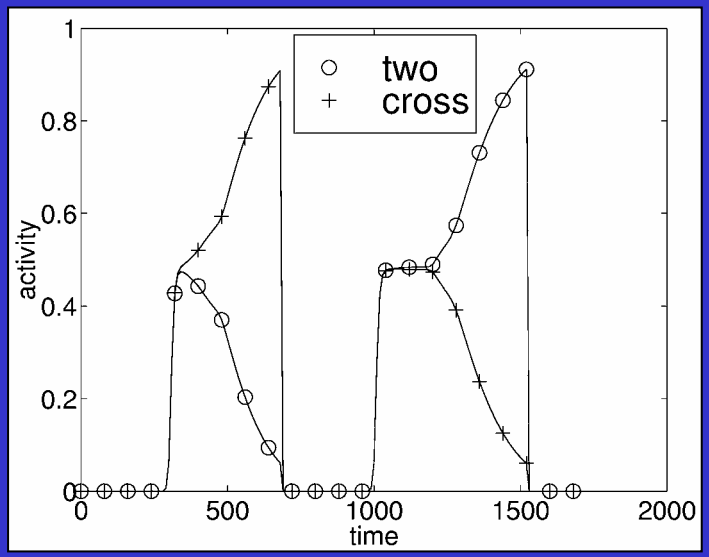
Heinke & Humphreys (2003)
Psychological Review

Architecture of SAIM

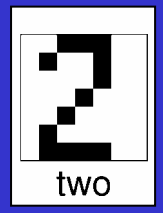


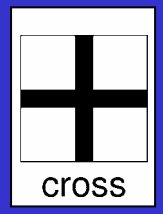
Result

Knowledge Network

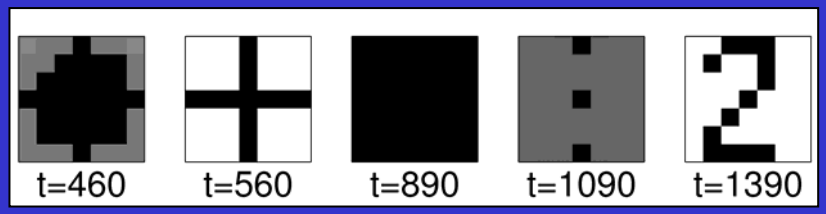


Templates

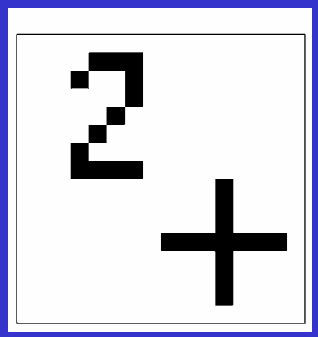




Focus of Attention

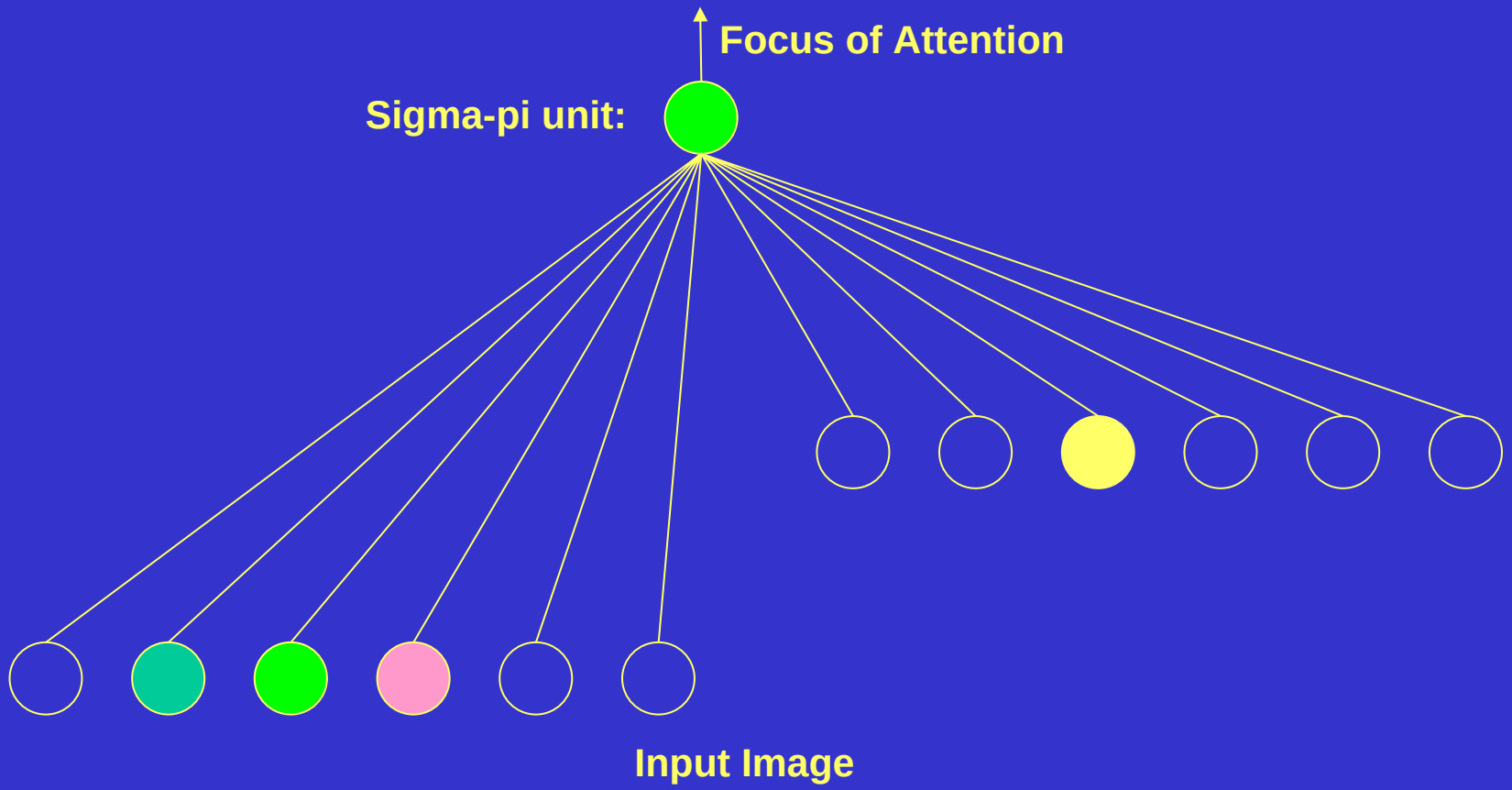


Stimulus

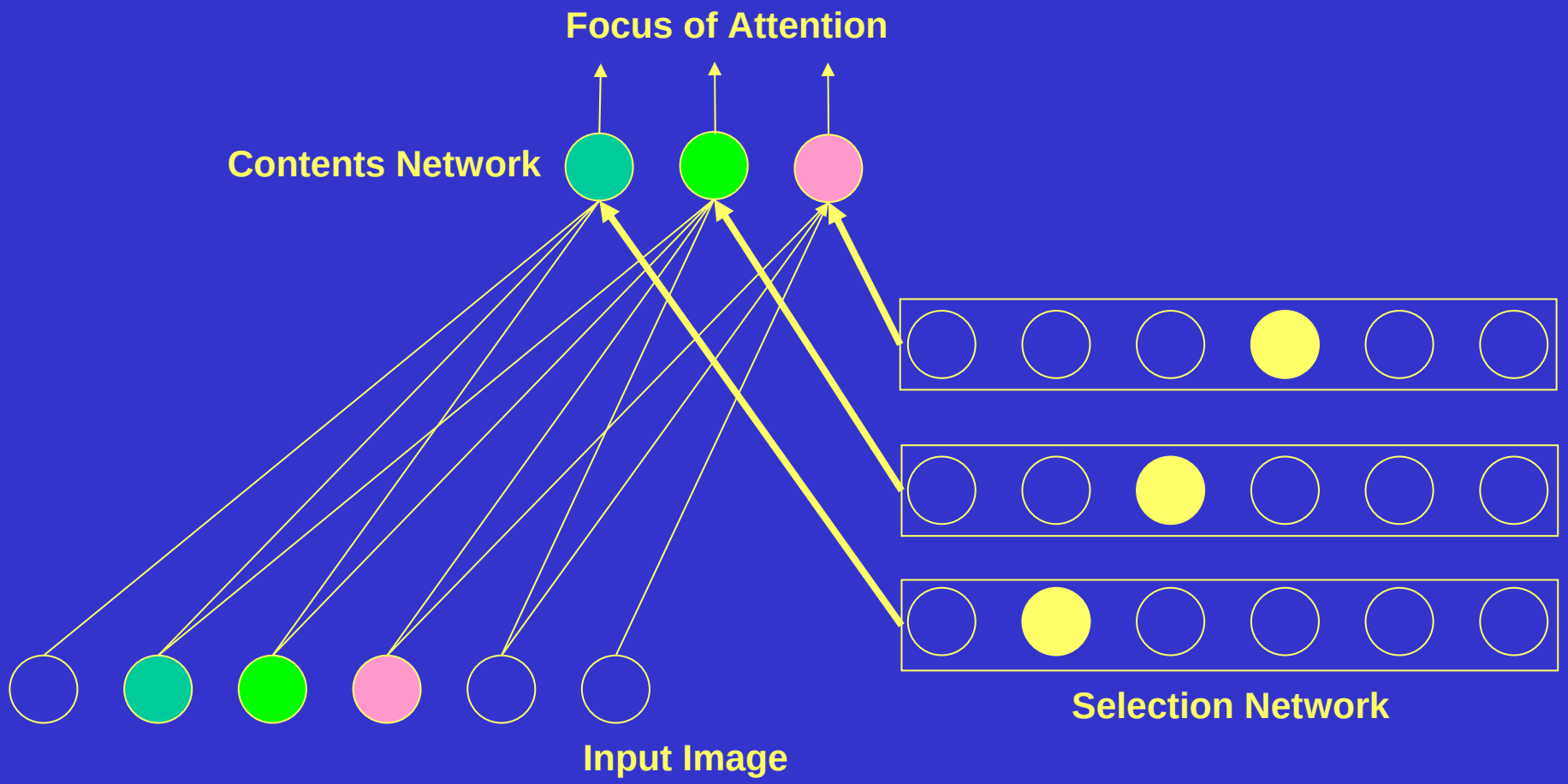


Contents Network

Goal: Enabling Translation-invariant Mapping

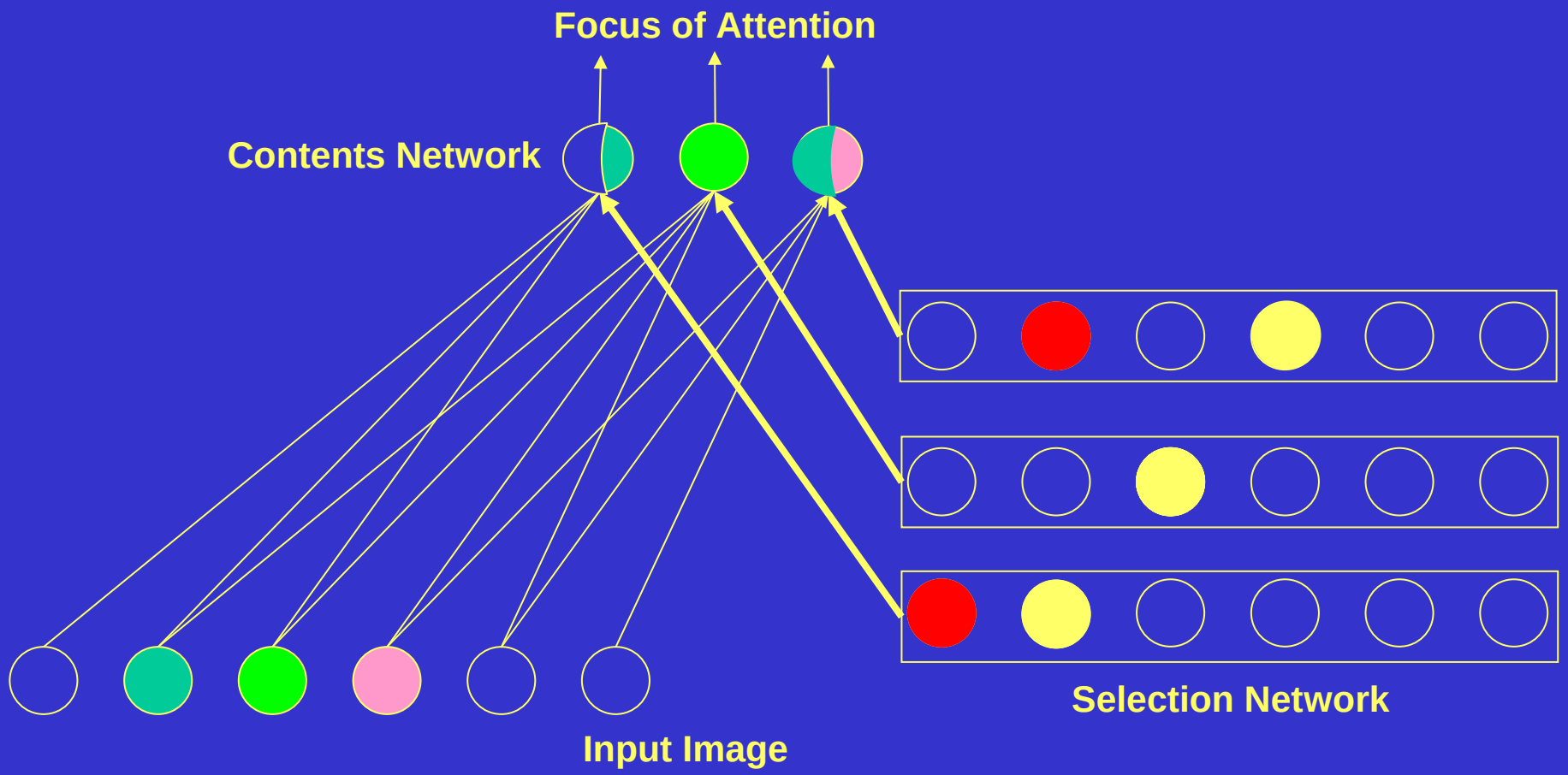


Contents Network



Selection Network

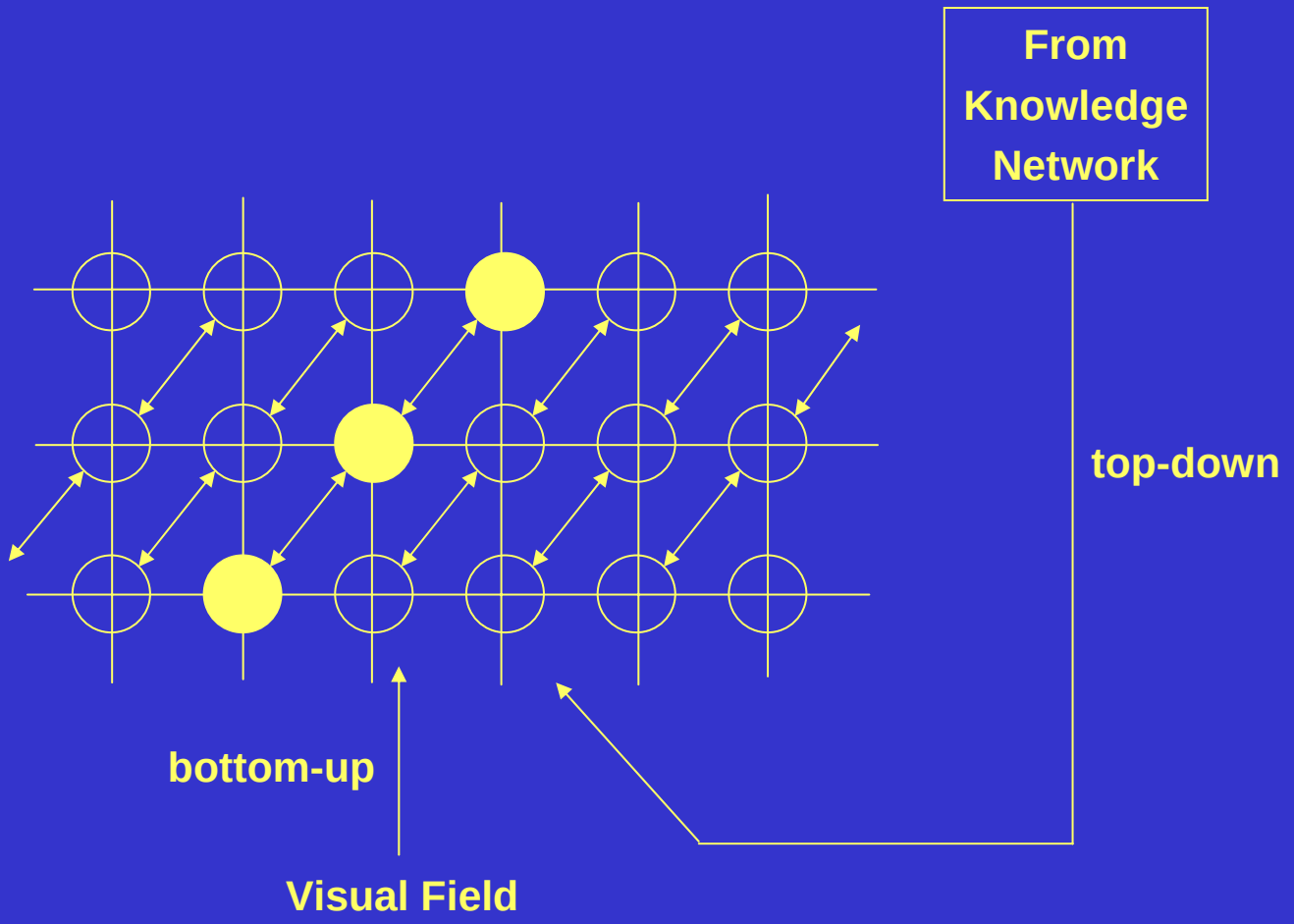
Goal: Correct mapping of contents network



Design of SAIM

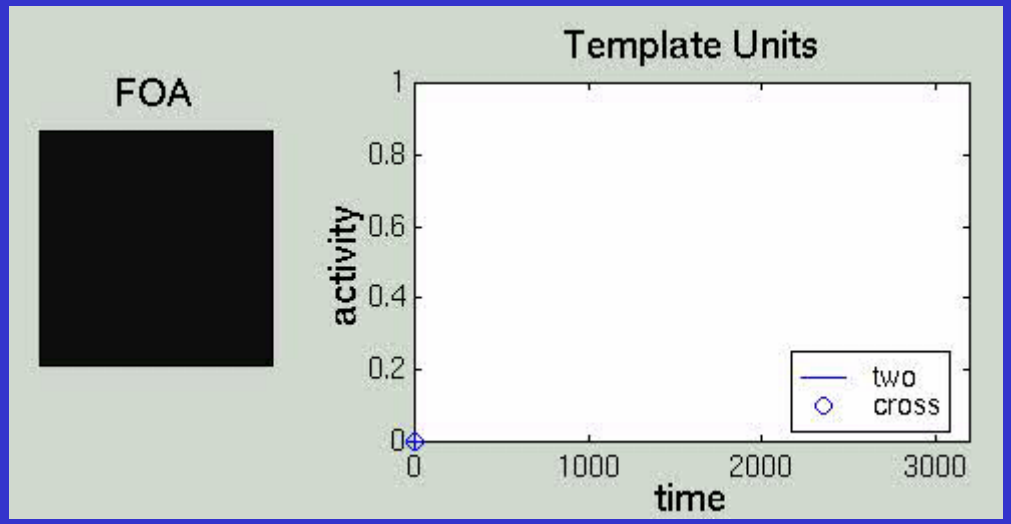
- Constraint satisfaction problem
- Construction of energy function (Hopfield & Tank 1985)
- Gradient descent
- Topology of connections
- Competitive and cooperative interactions

Topology in Selection Network

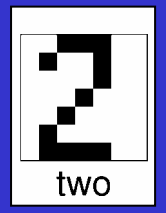


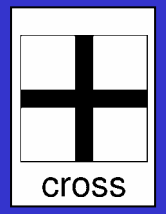
Knowledge Network

- Templates
- Template matching with scalar product
- Winner take all

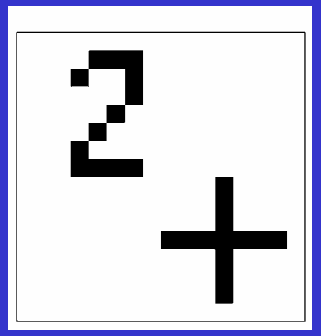


Templates





Stimulus



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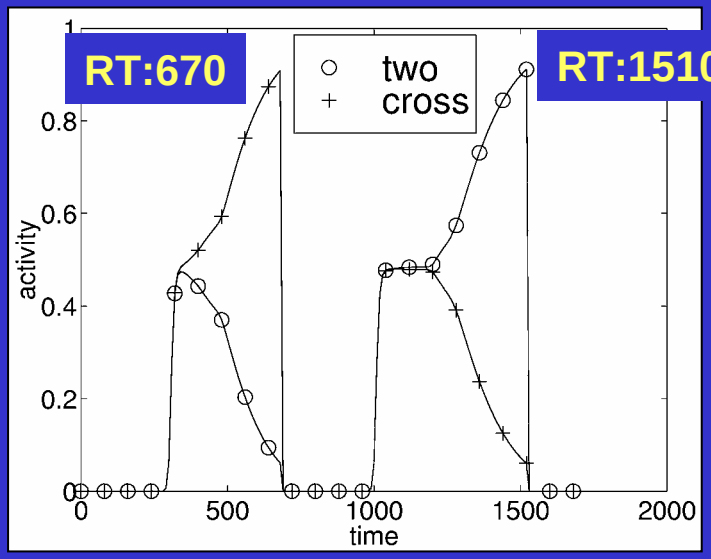
Knowledge Network



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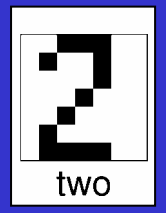

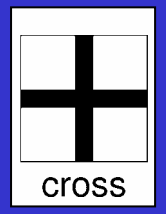

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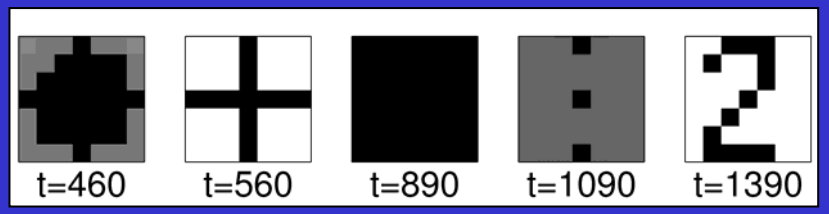
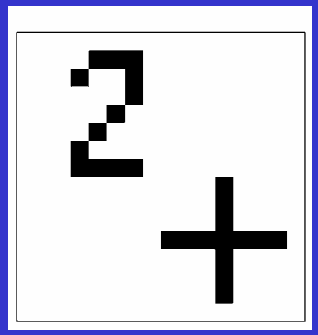


Stimulus



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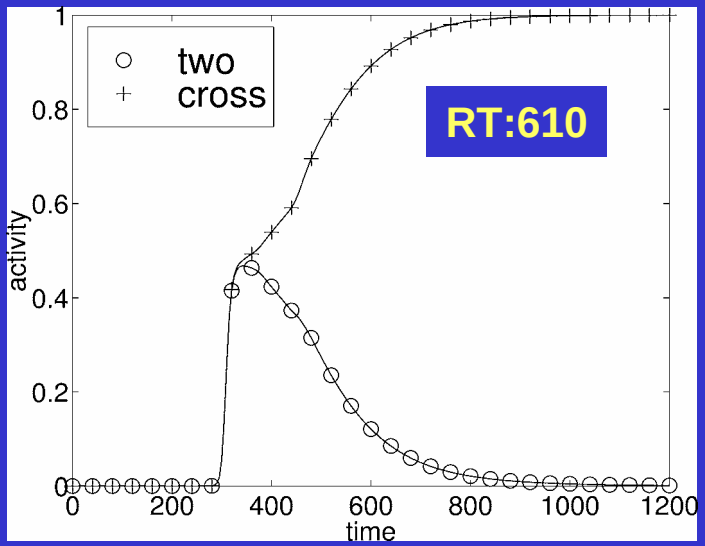

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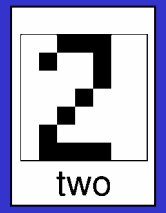

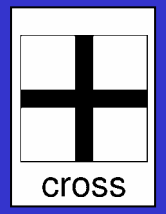

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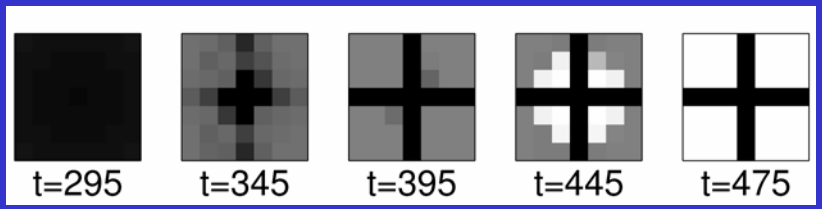

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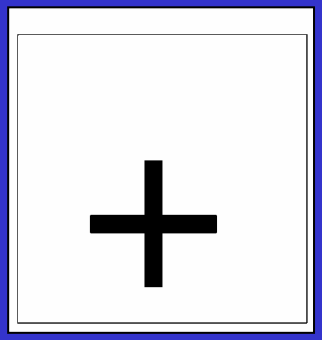


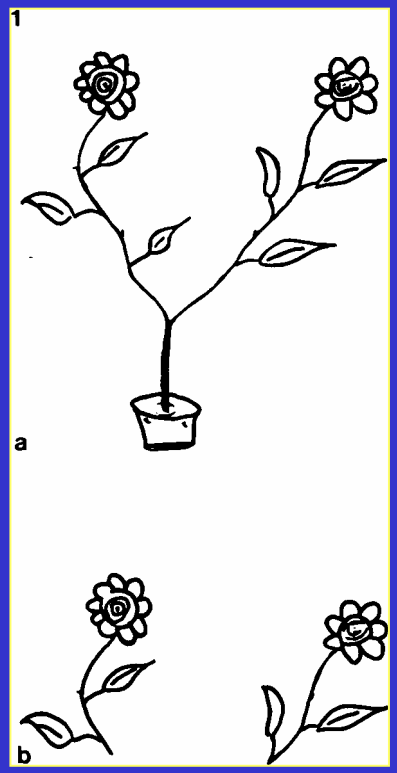
Heinke & Humphreys Psych. Review, 2003

- 2-object costs
- Effects of familiarity on selection
- Spatial cueing
- Inhibition of return
- Object-based effects

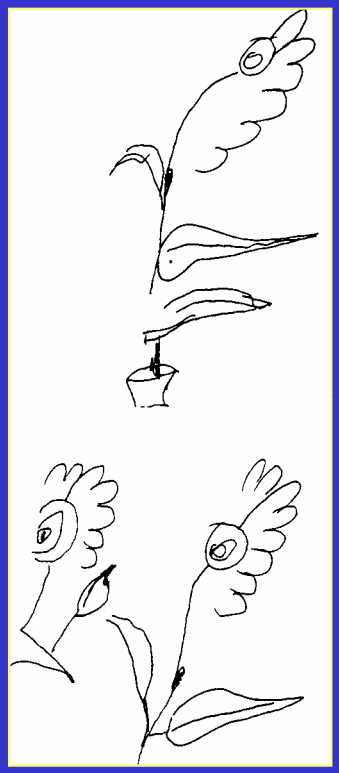
Heinke & Humphreys Psych. Review, 2003

- Spatial extinction
- View-centred neglect
- Object-centred neglect

Visual Neglect

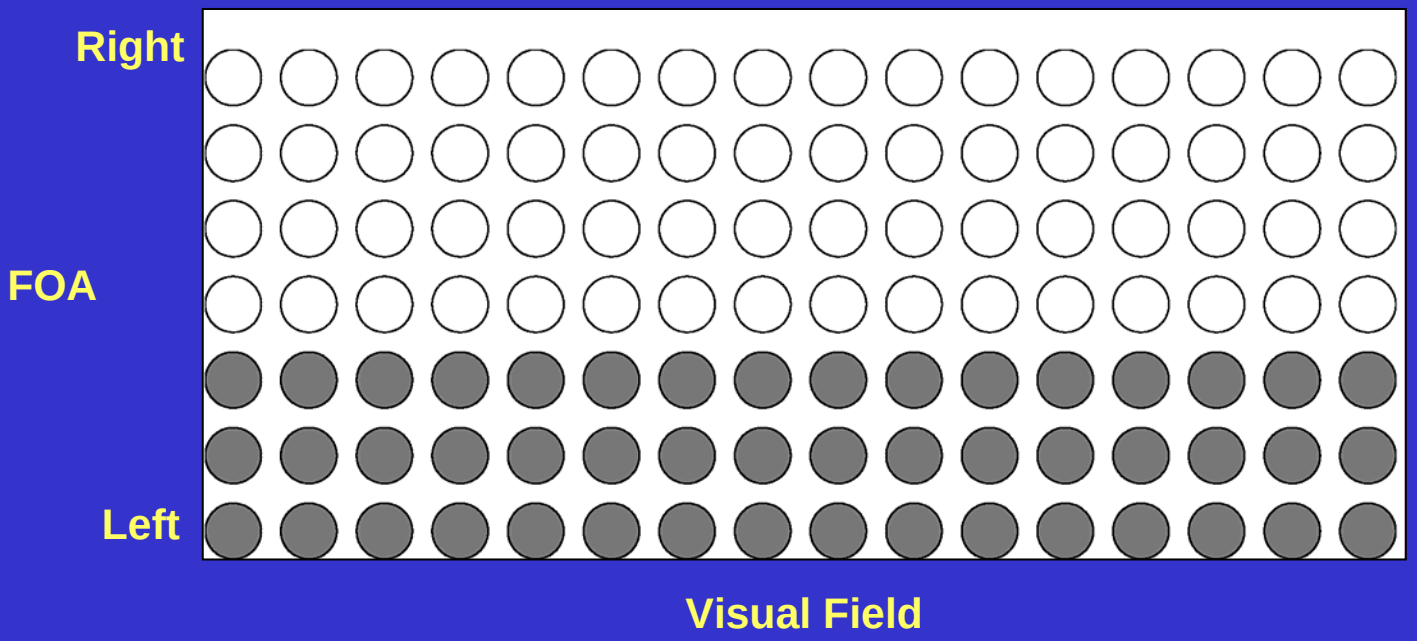


Original

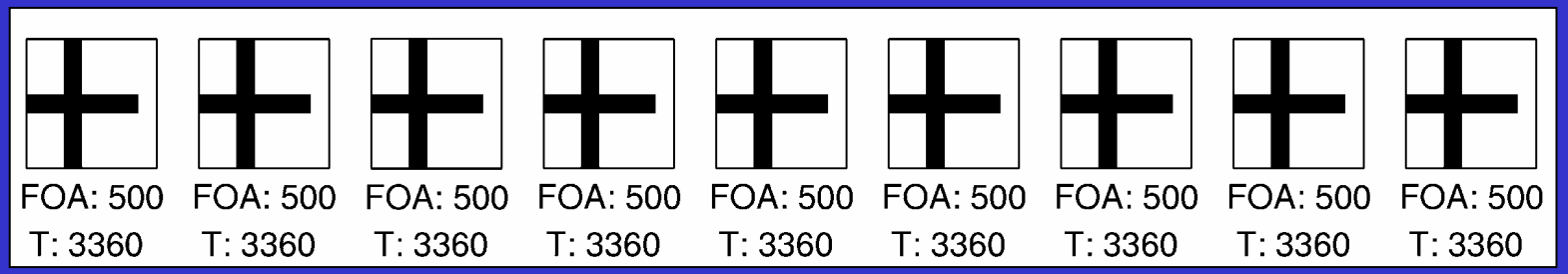


Object-based neglect

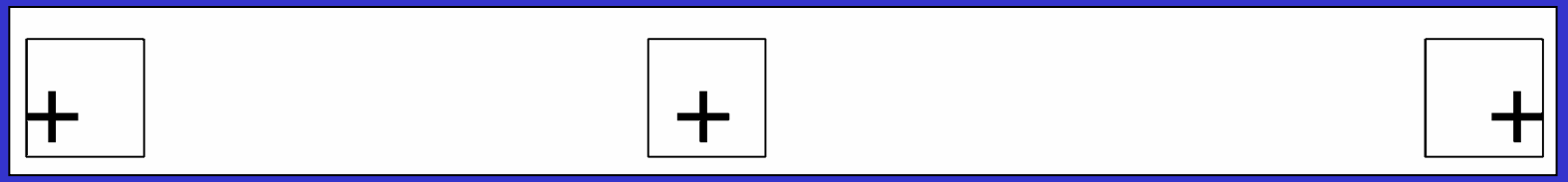
Lesion



Visual neglect



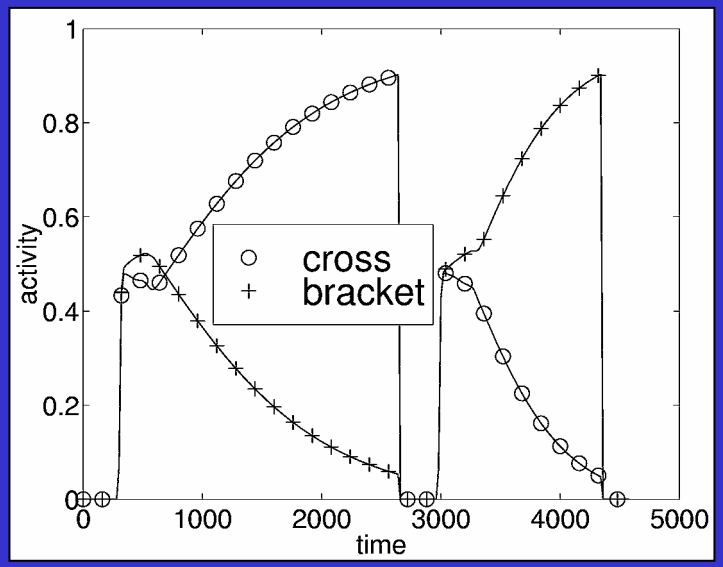
Focus of attention for different locations



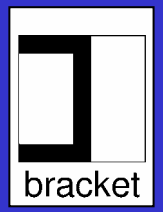
Stimuli: Cross at different locations

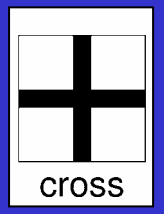
Visual neglect

Knowledge Network

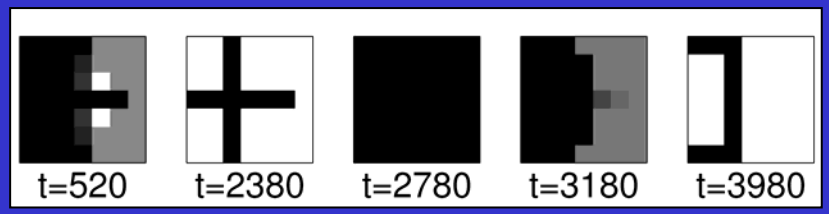


Templates

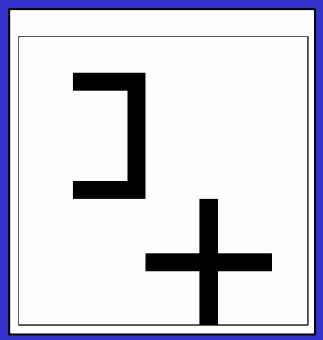




Focus of Attention

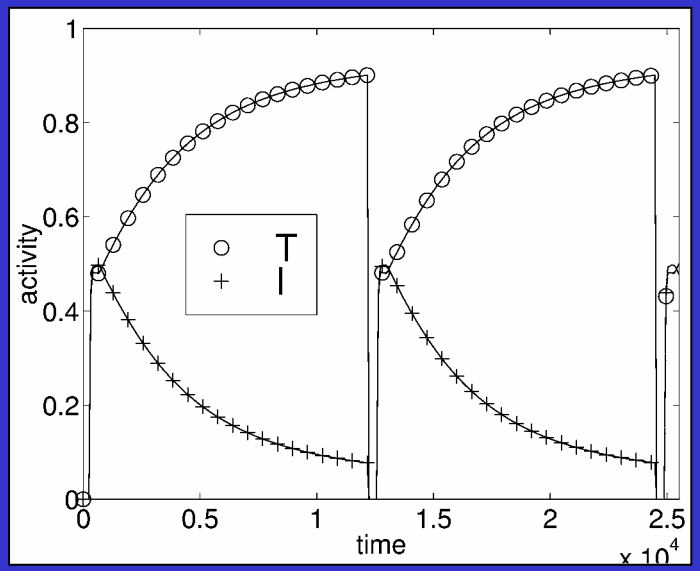


Stimulus

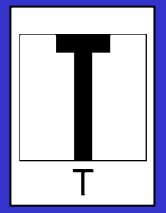


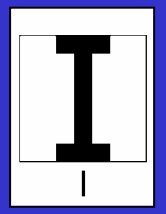
Influence of Knowledge in Neglect

Knowledge Network



Templates





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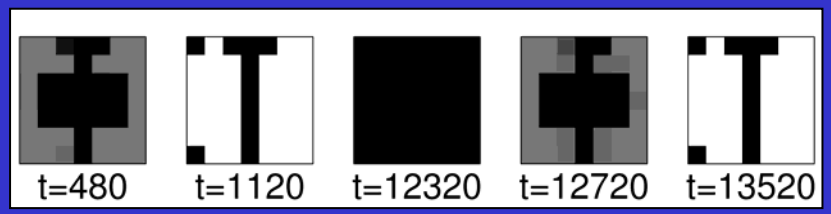
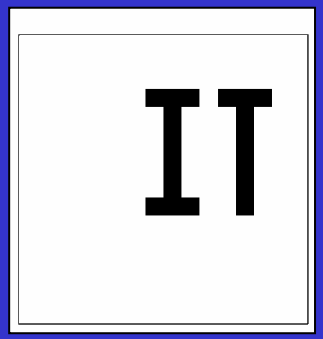
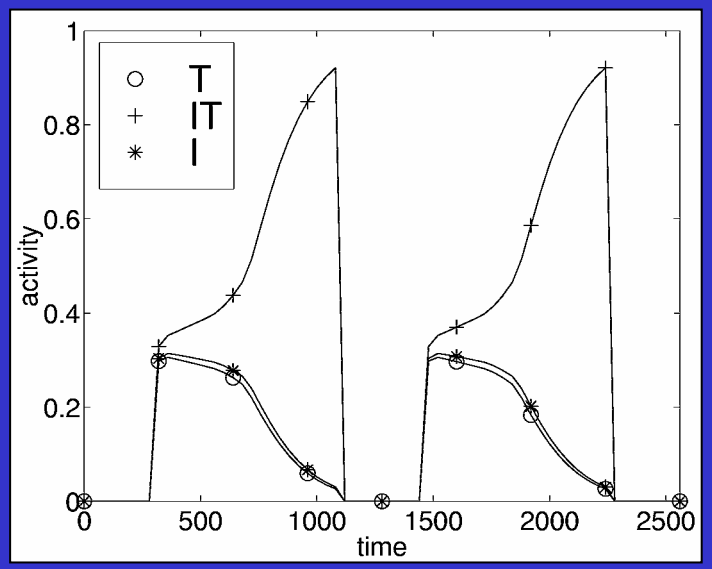


Stimulus



Influence of Knowledge in Neglect

Knowledge Network



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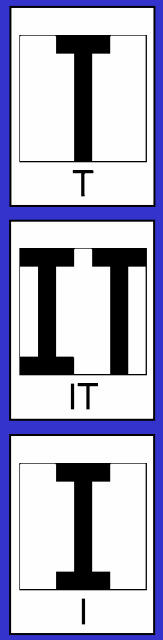

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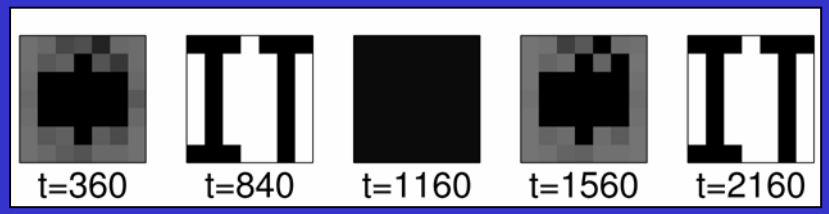

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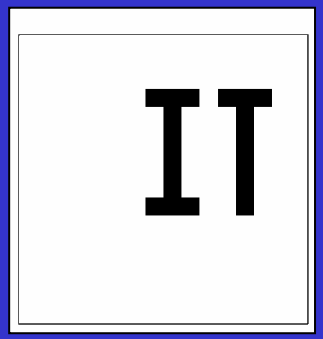
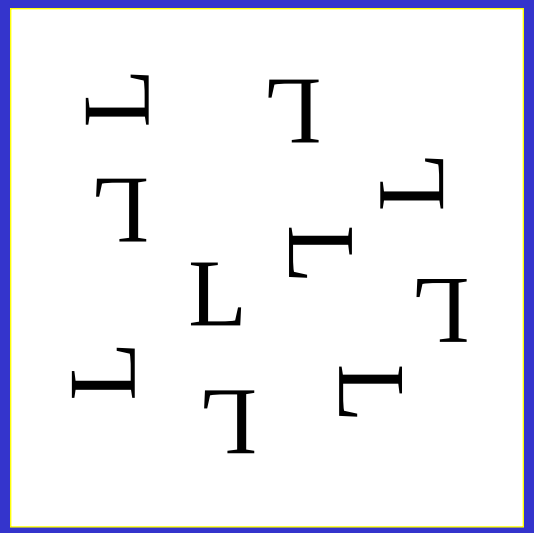


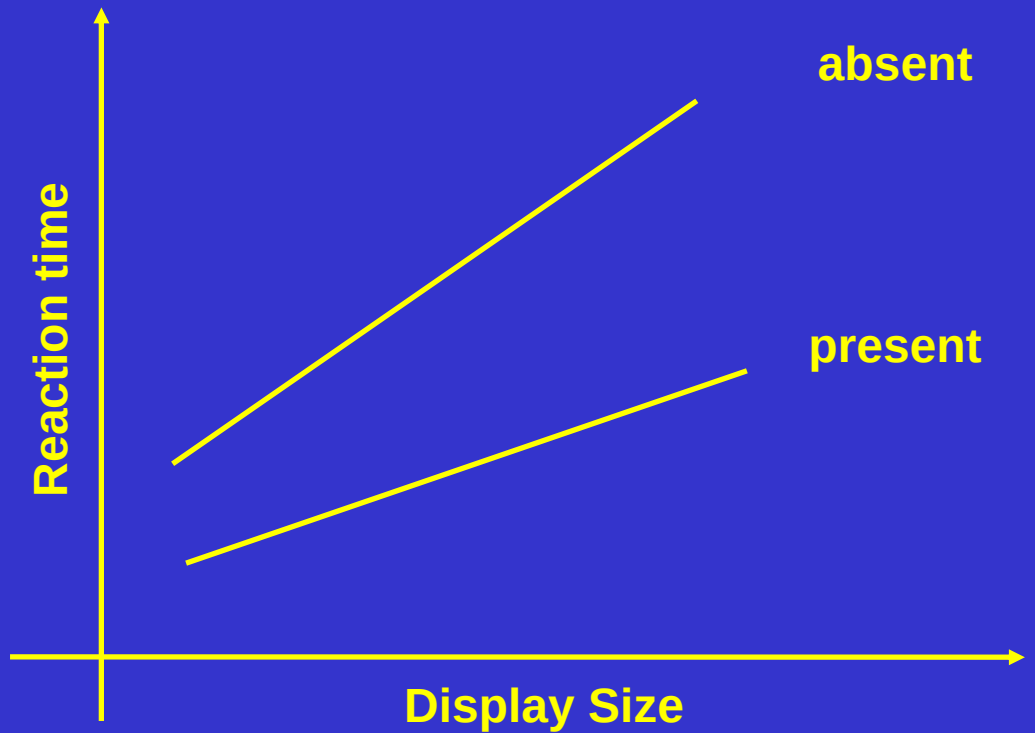
Psych. Review: Summary (1)

- SAIM: No ‘’attentional’’ module
- Normal attention
  - Multiple object cost
- Disordered attention
  - Imbalanced selection process in translation-invariant co-ordinates
  - Influence of object knowledge

Visual Search

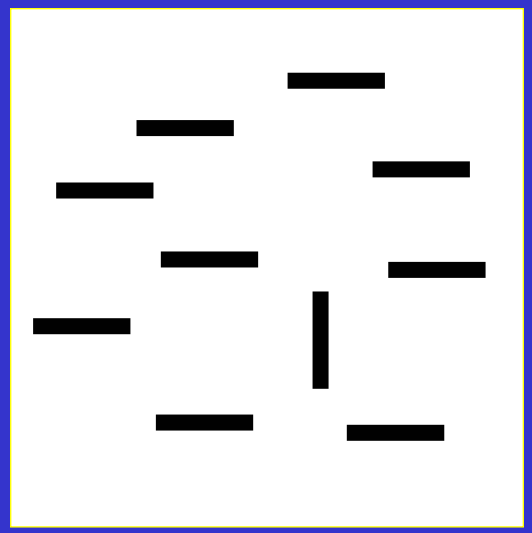
- **Is there a L?**

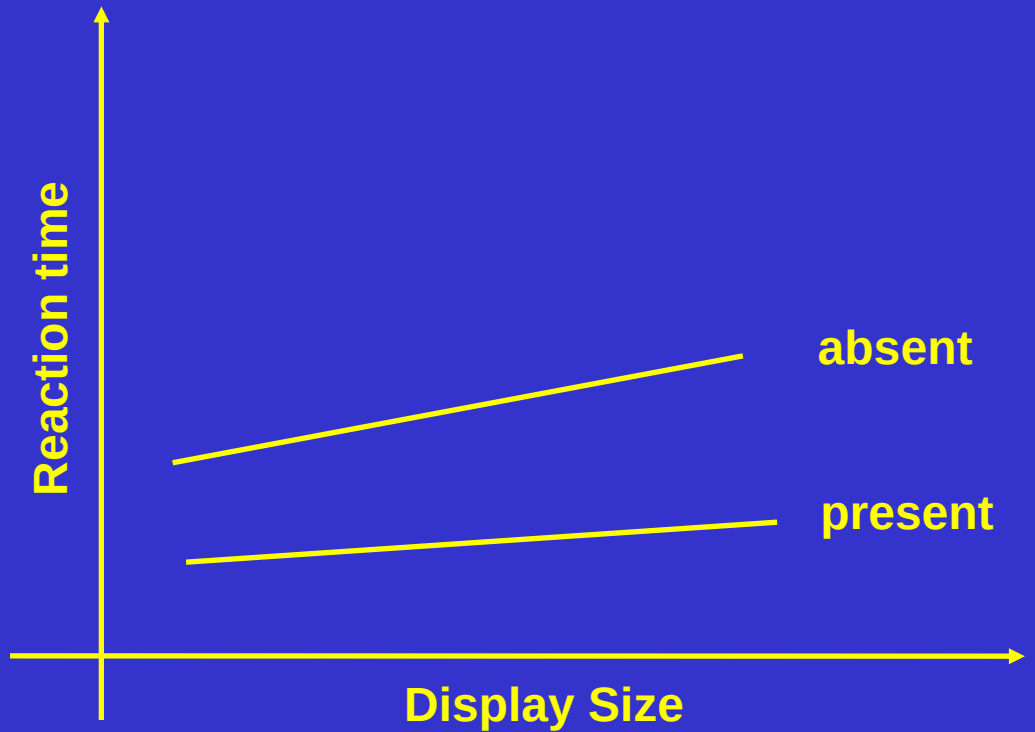




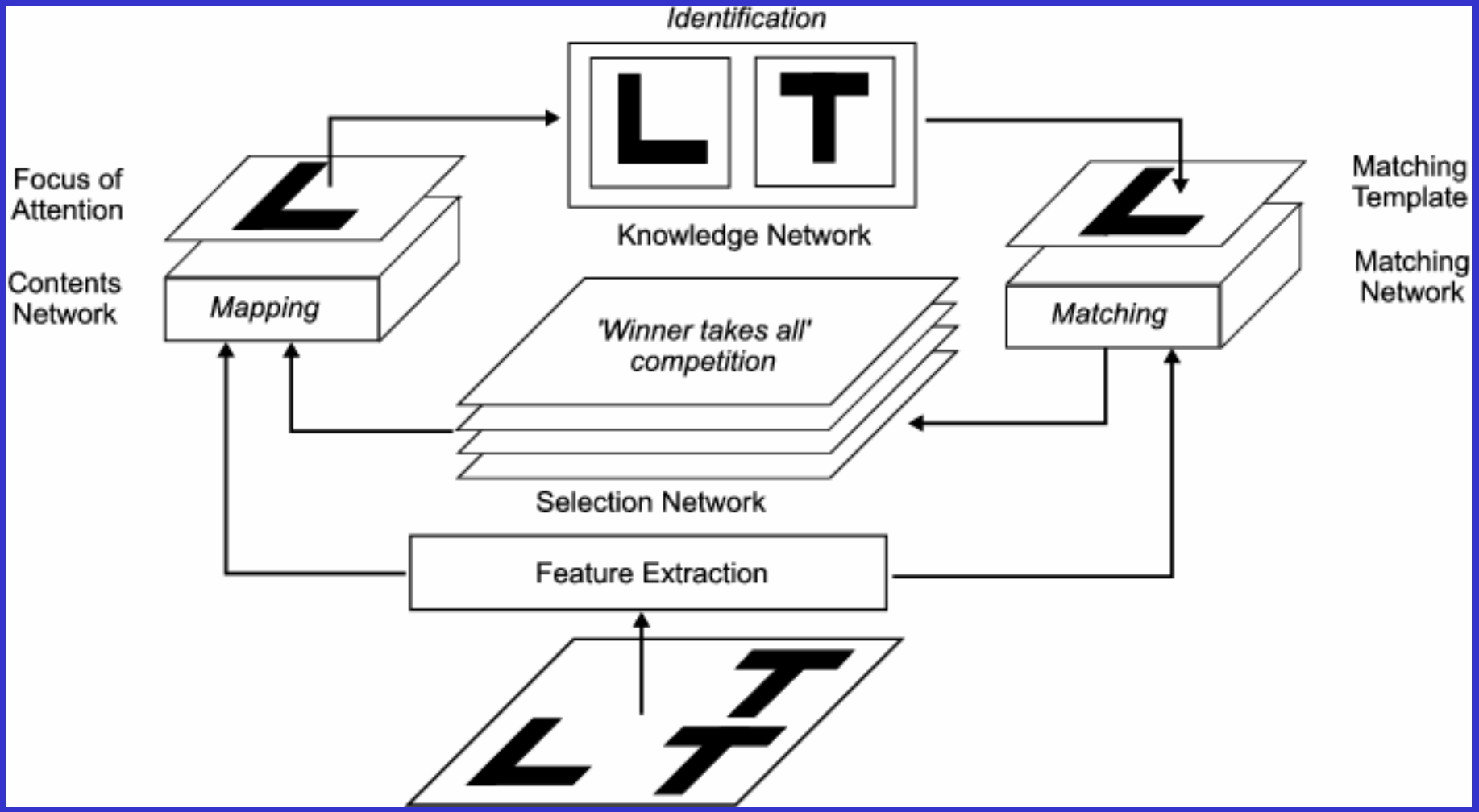
Visual Search

- **Is there a horizontal line?**





SAIM

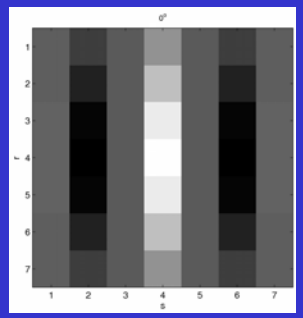

Identification
Knowledge Network
Focus of Attention
Contents Network
Mapping
Matching
Matching Template
Matching Network
'Winner takes all' competition
Selection Network
Feature Extraction

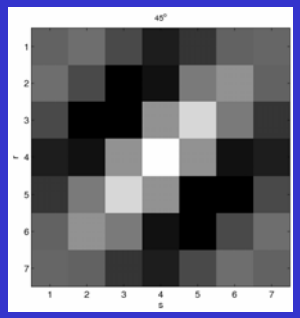
Modifications

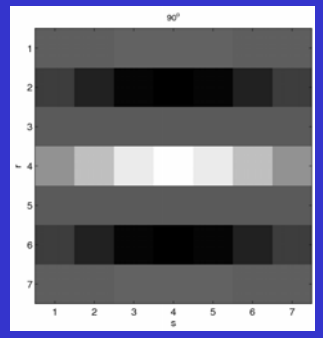
- **Knowledge Network**
  - **Euclidian distance**
- **Selection Network**
  - **Speed of selection depends on contrast produced in Matching Network**

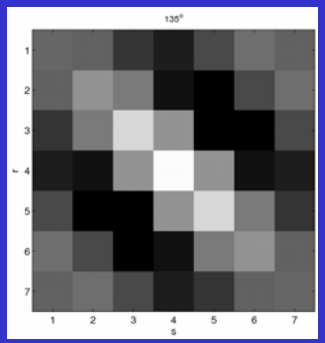
Feature extraction

- HSV Colour space
- Gabor filter: 0° 45° 90° 135°





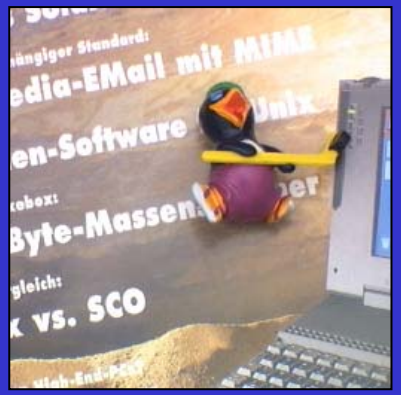




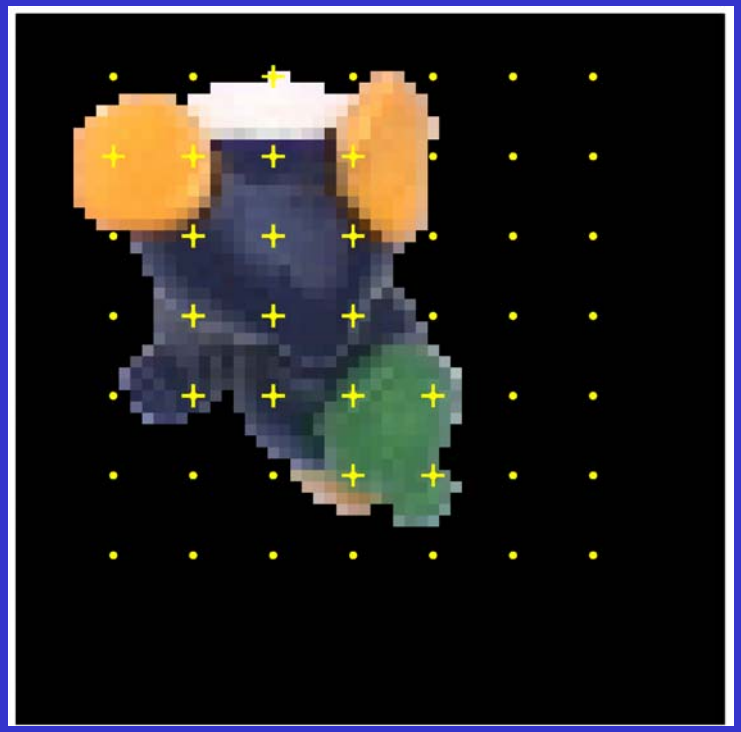
Matching Network

- Linear combination of templates from Knowledge Network
- Feature Extraction
- Euclidian distance
- Sliding window
- Output feeds into Selection Network

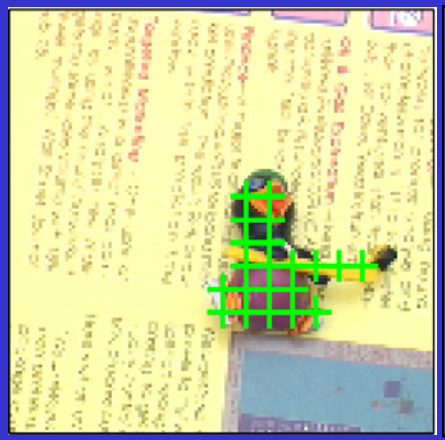
Natural images

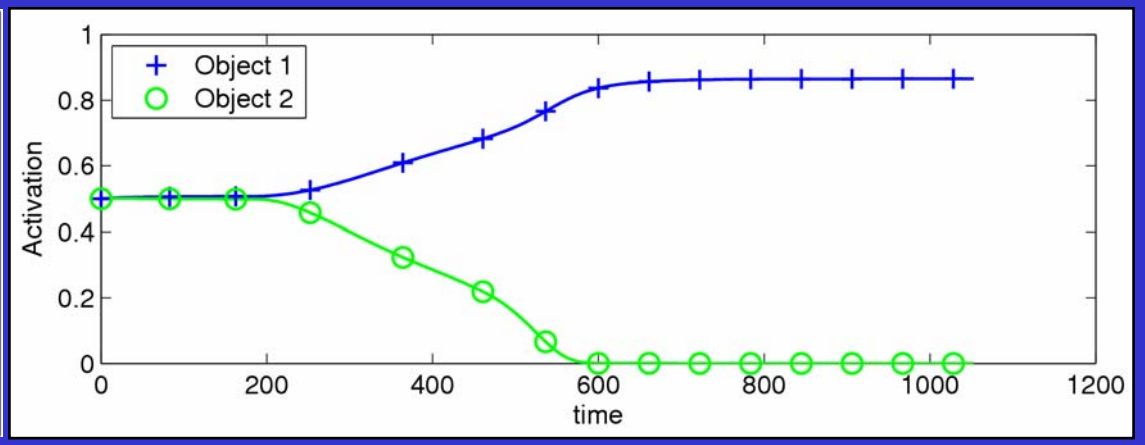


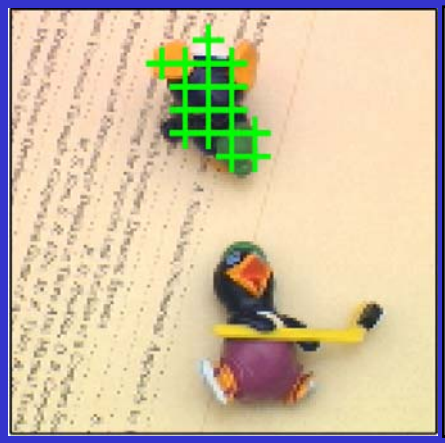
Templates

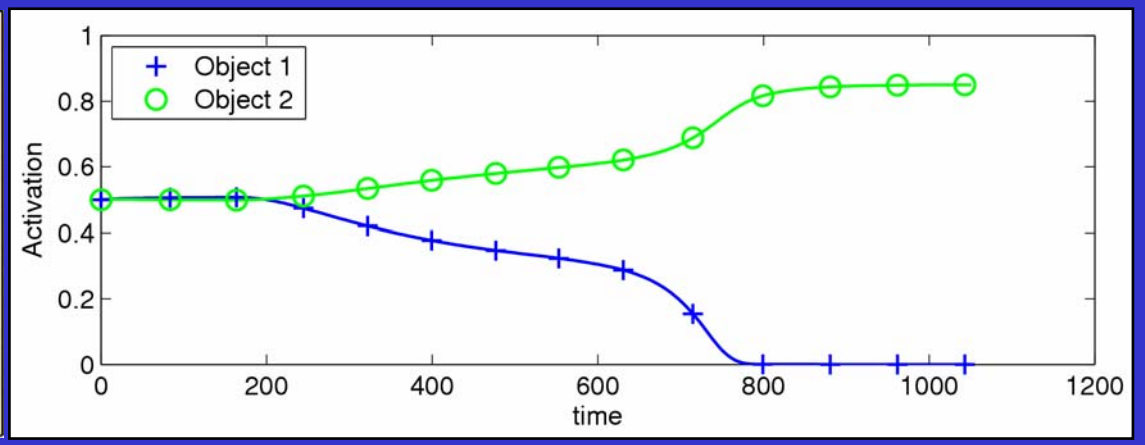


Results

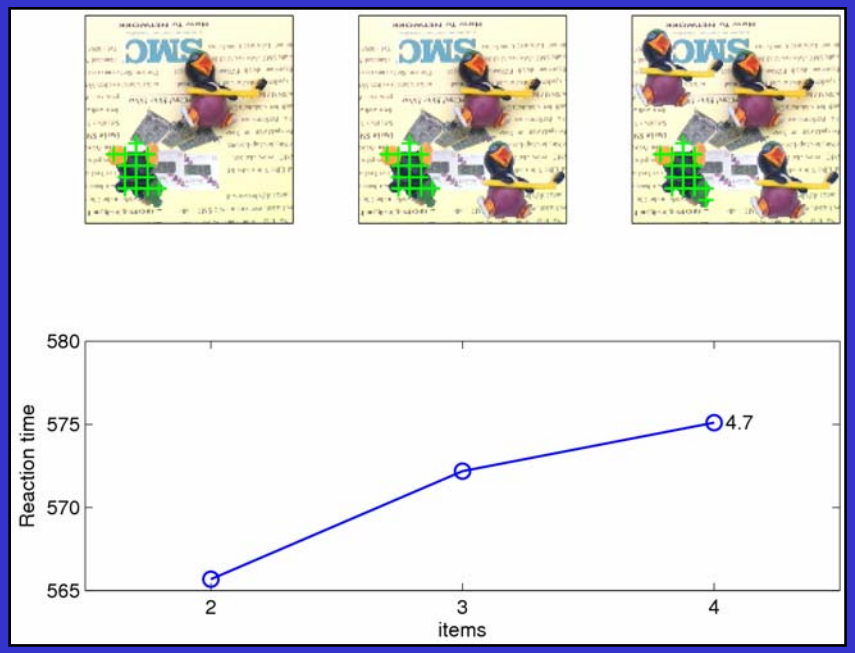


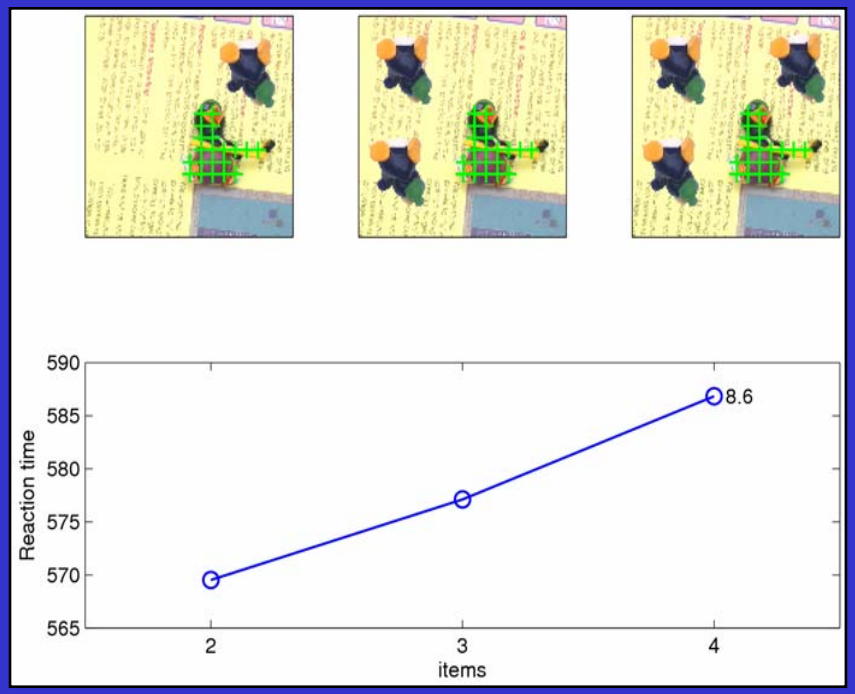

Object 1
Object 2
Activation
time
0
0.2
0.4
0.6
0.8
1
0
200
400
600
800
1000
1200



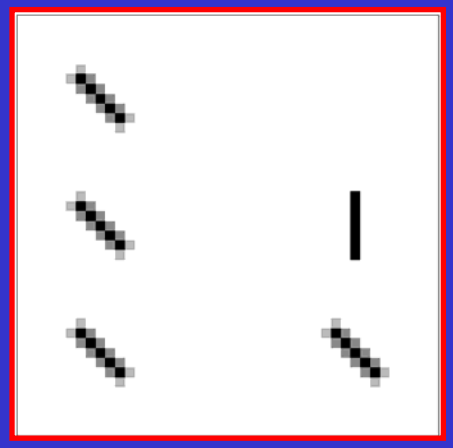

Object 1
Object 2
Activation
time
0
0.2
0.4
0.6
0.8
1
0
200
400
600
800
1000
1200

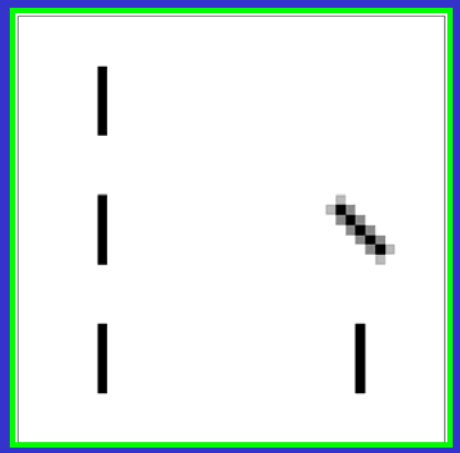
Visual search in natural images

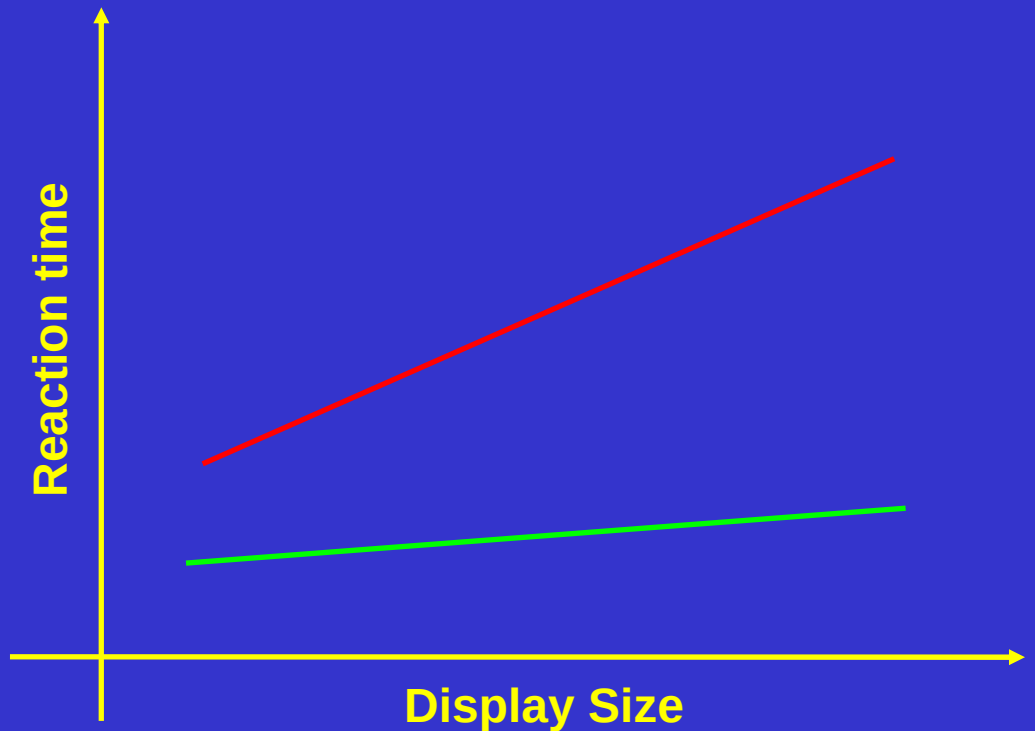




Asymmetry



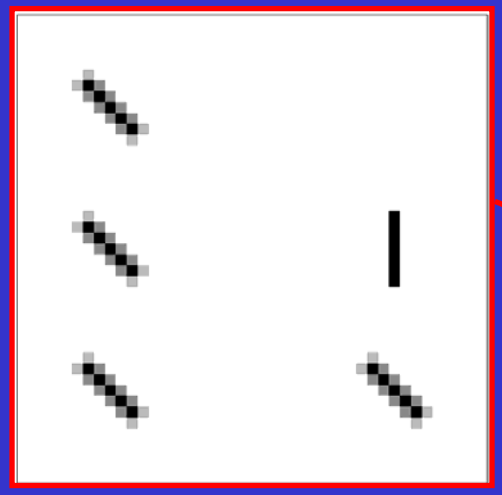


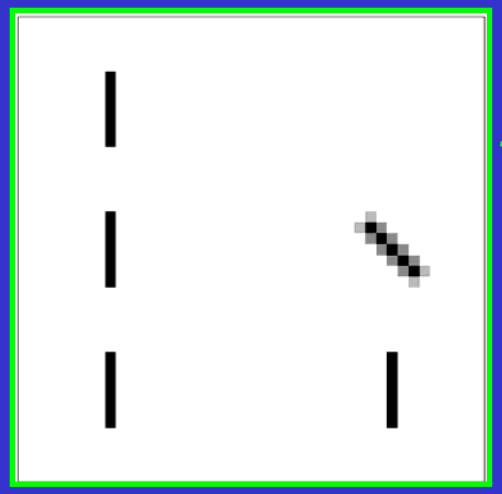


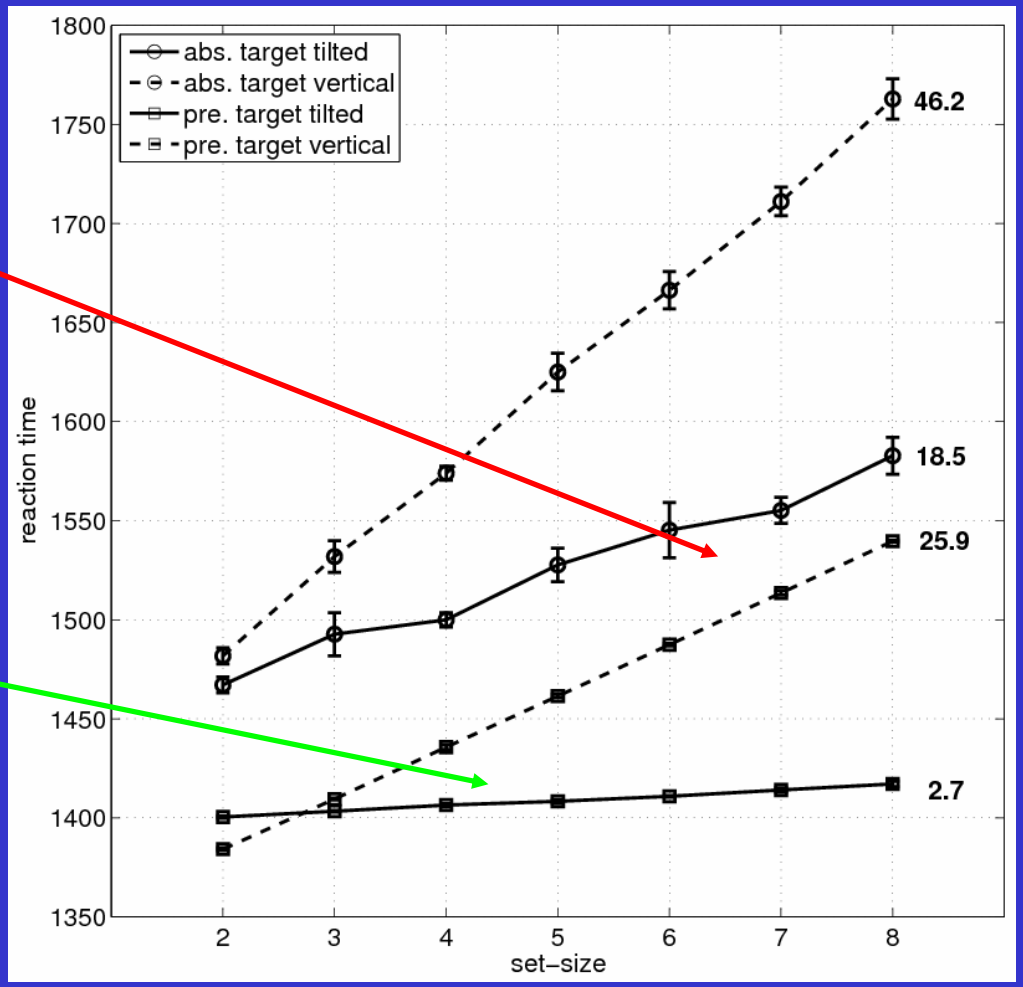
Simulation method

- Templates = items
- Cuing of target template
- Display size: 2, 3, 4, 5, 6, 7, 8
- Trials: 5
- Present/absent
- Decision by passing threshold

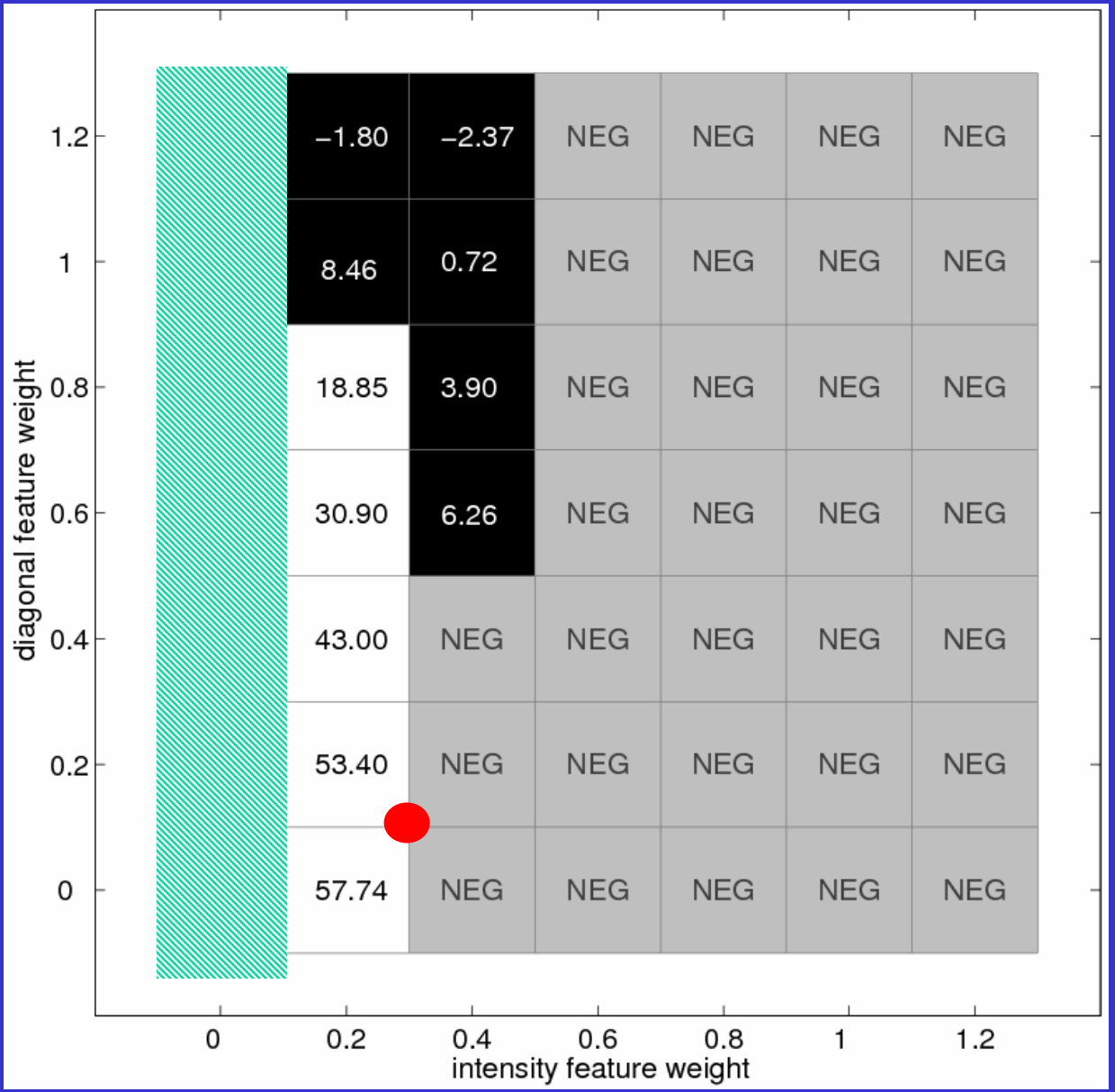
Simulation results: 45-Line-orientation



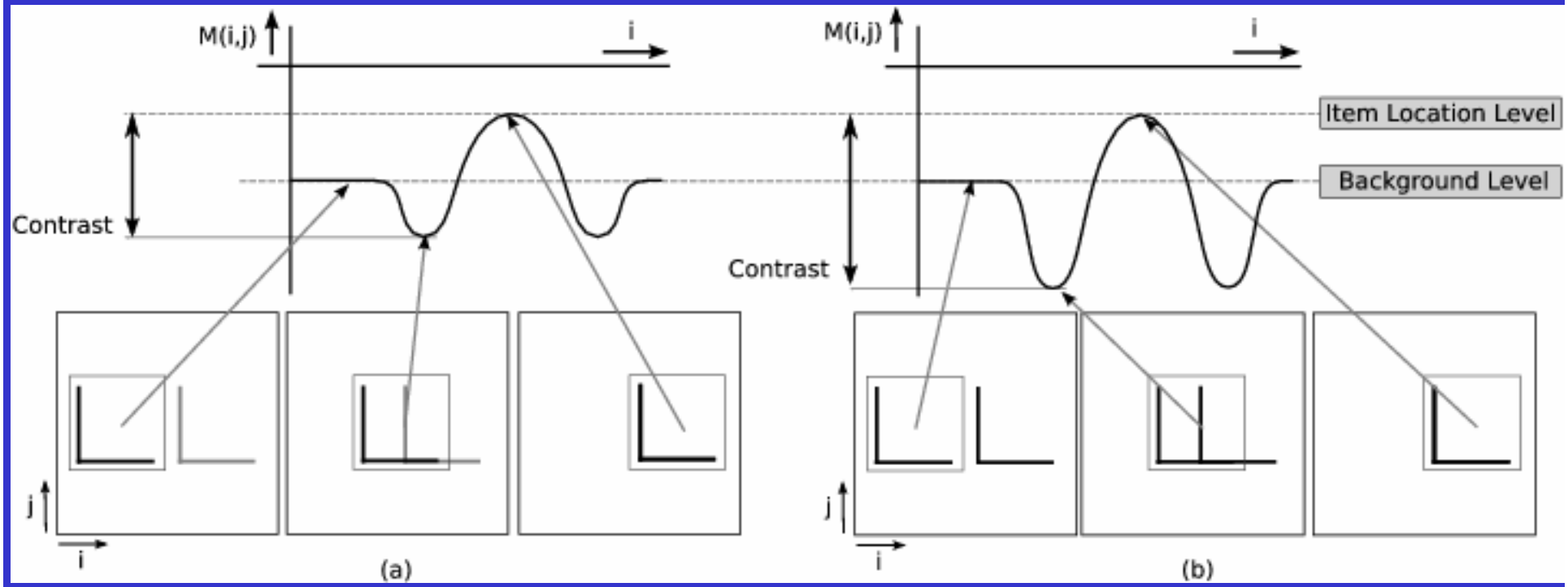




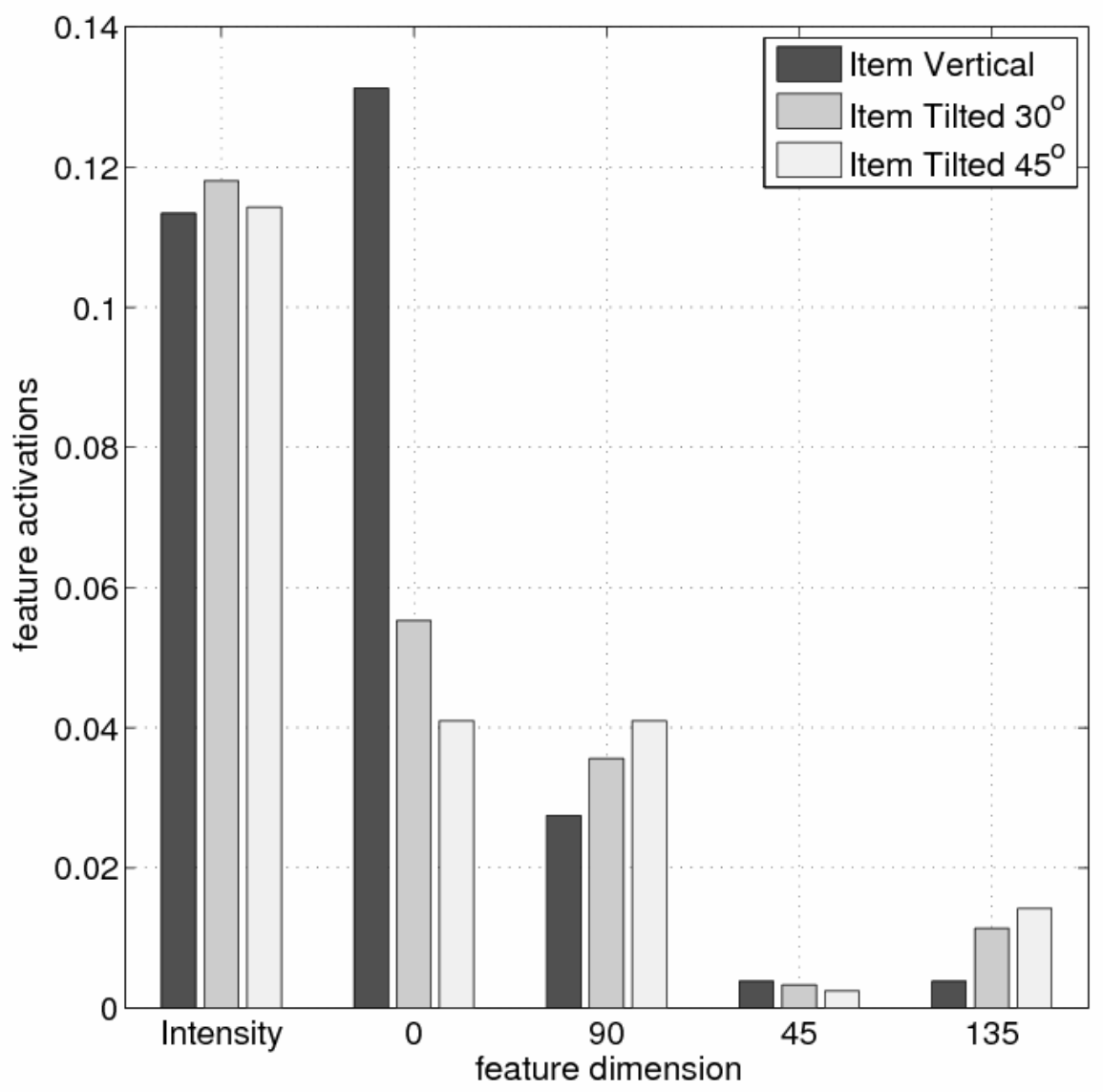
Parameter analyse



On-centre off-surround



Maximal feature activation

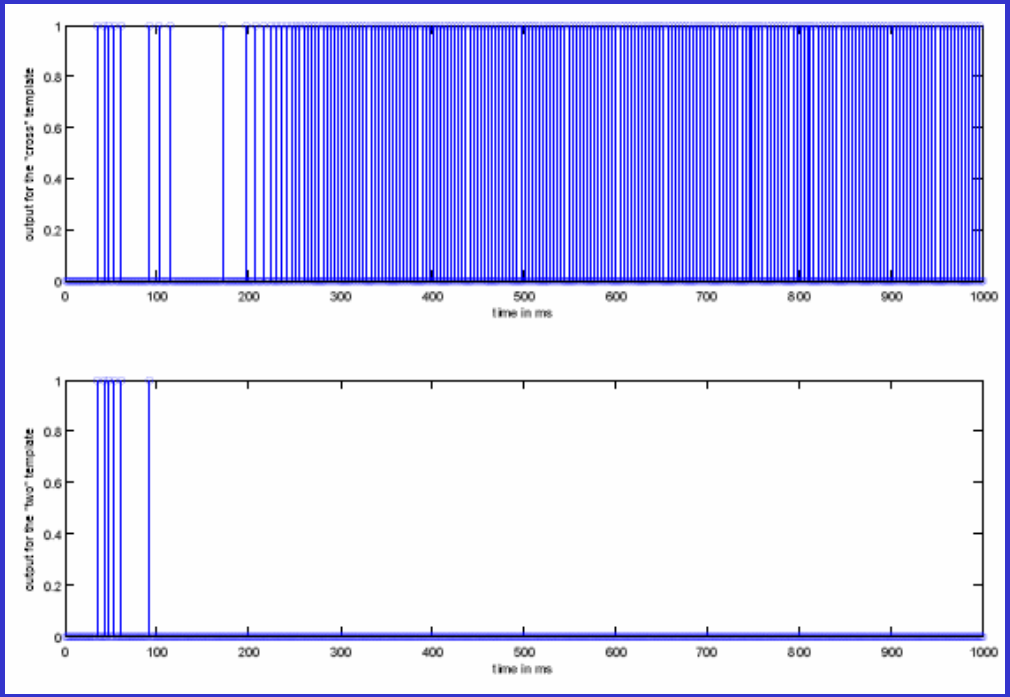


Reasons for line asymmetry

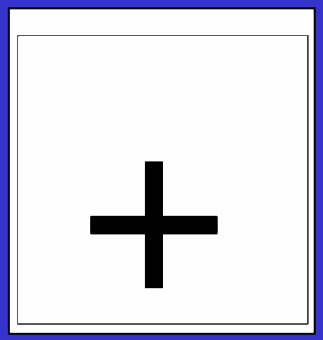
- Horizontal/Vertical features > diagonal features
  - Physiological evidence (e.g. Kennedy & Orban, 1979)
  - Psychophysical result (Carrasco et al.)
- Properties of distractors important factor in search
  - Rauschenberger & Yantis (2006)
- On-centre off-surround “matching” field
  - ??

Spiking neuron: SRM

Knowledge Network

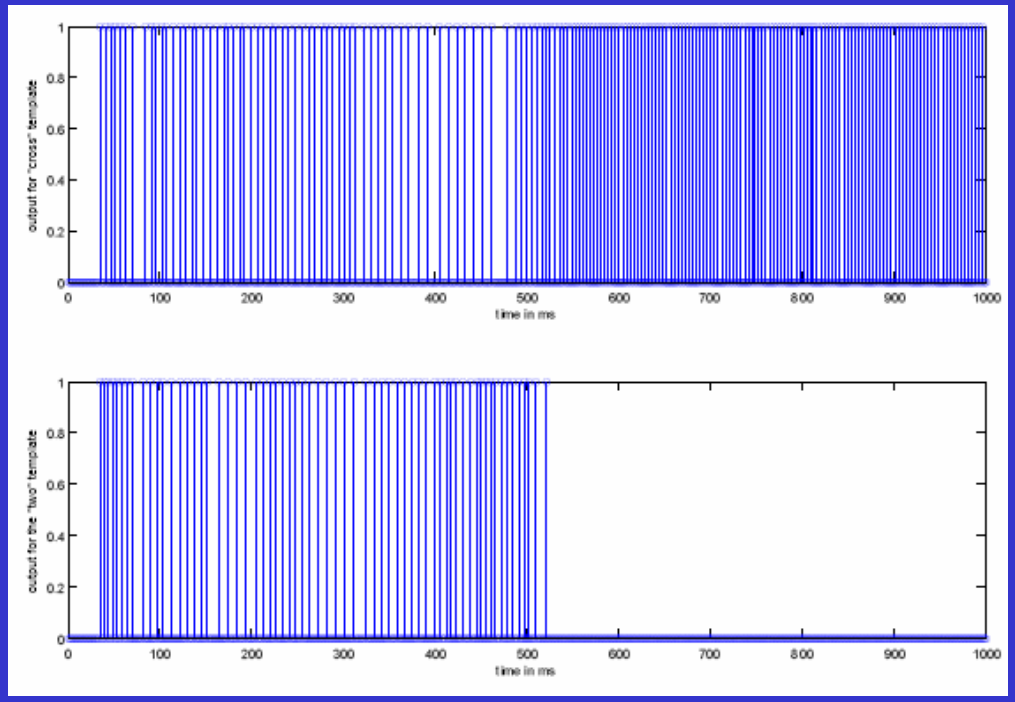


Input Image

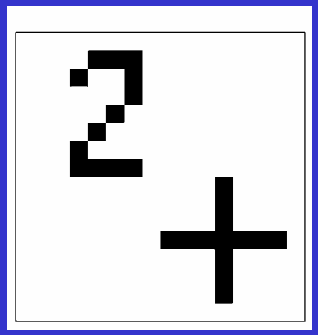


Spiking neuron: SRM

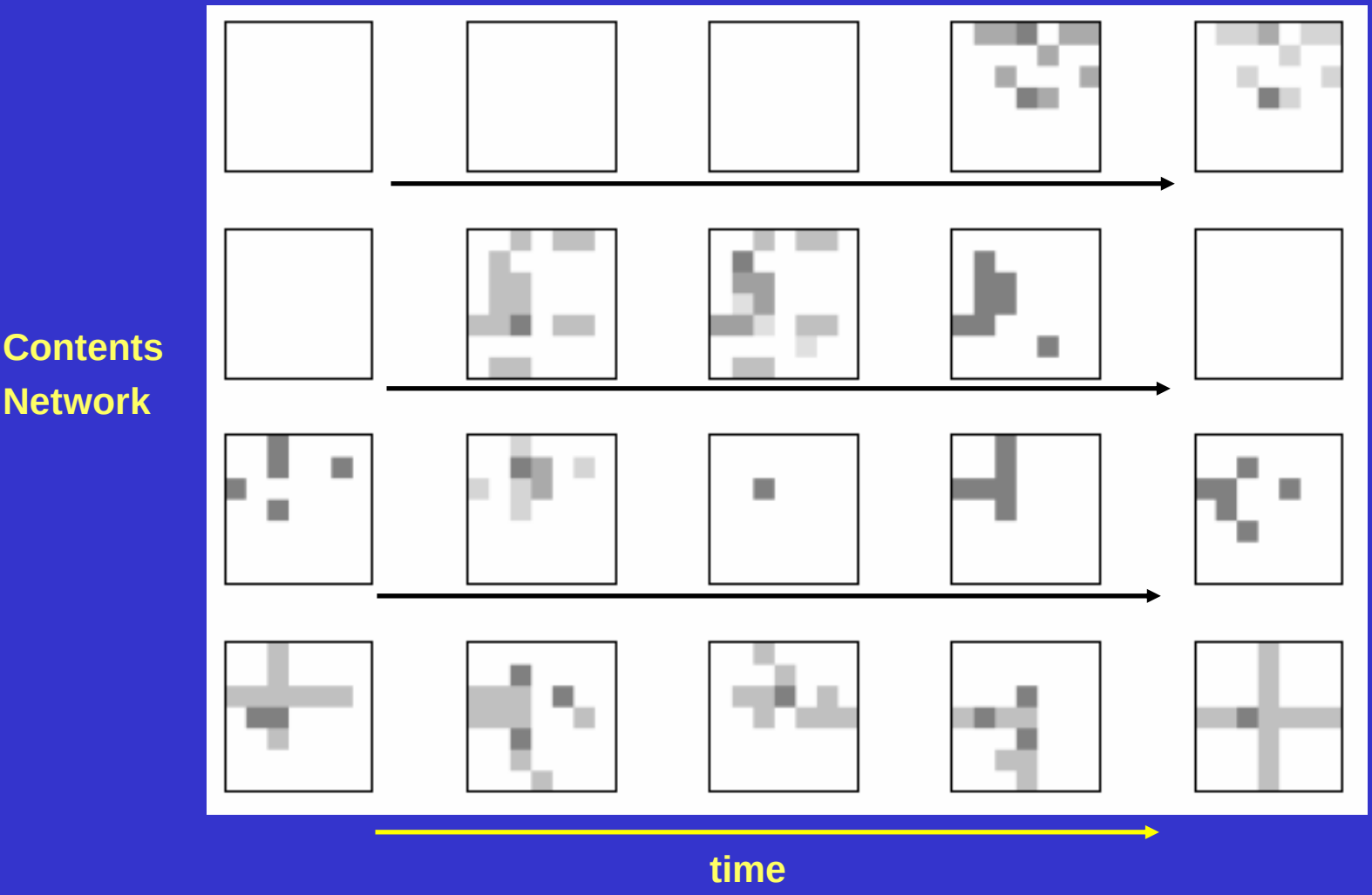
Knowledge Network



Input Image



Spiking neuron: SRM



Lessons

- **Attractor maintained**

- **Relationship between neurophysiological level and human behaviour**

Summary

- SAIM
- Attention as emergent property of competition
- Explanation of neuropsychological findings
- Search in natural scenes
- Explanation of search asymmetry
- Spiking version