The effects of transient attention on spatial and temporal aspects of perception

Yaffa Yeshurun
Institute of Information Processing and Decision Making
University Of Haifa

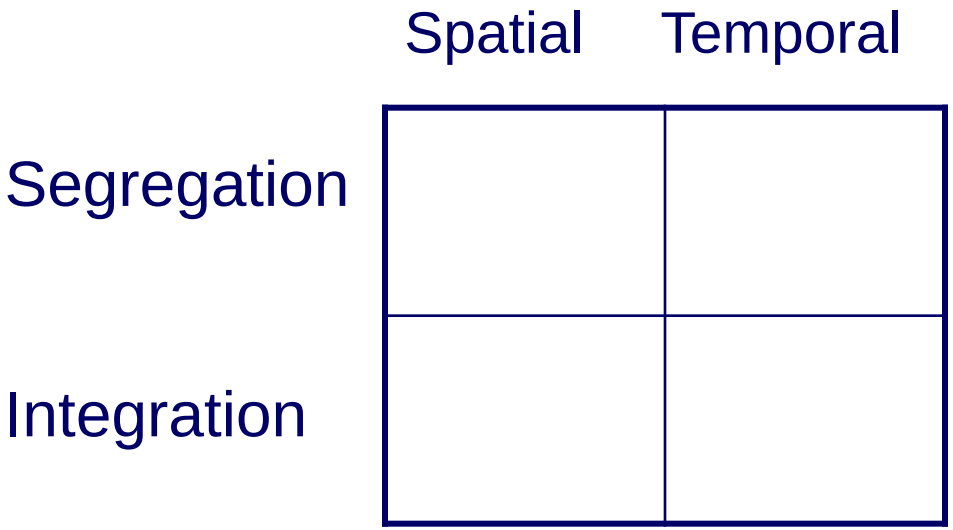
Definition

- **Spatial covert attention:** the selective processing of information at a given location.

- **Transient attention:** the involuntary, stimulus-driven component of spatial attention.

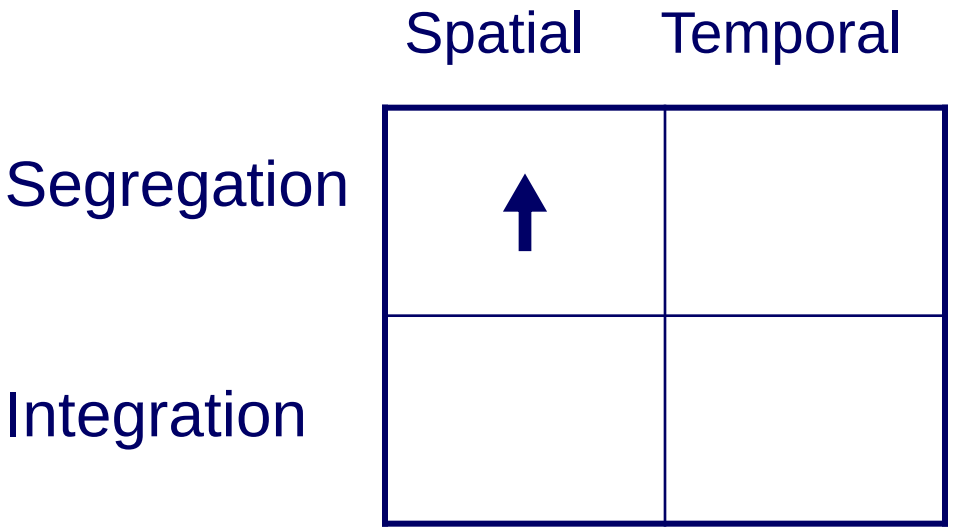
Working hypothesis

Transient attention facilitates spatial segregation and temporal integration but impairs spatial integration and temporal segregation.



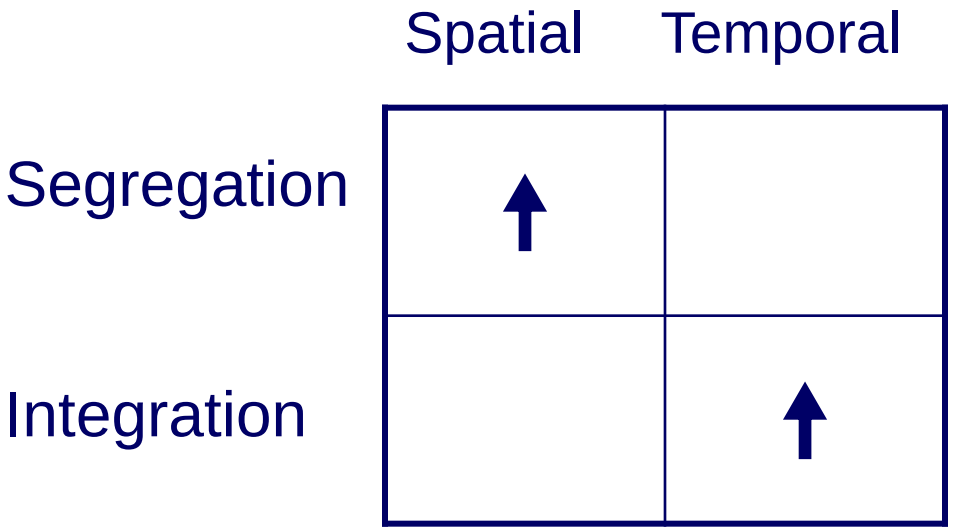
Working hypothesis

Transient attention facilitates spatial segregation and temporal integration but impairs spatial integration and temporal segregation.



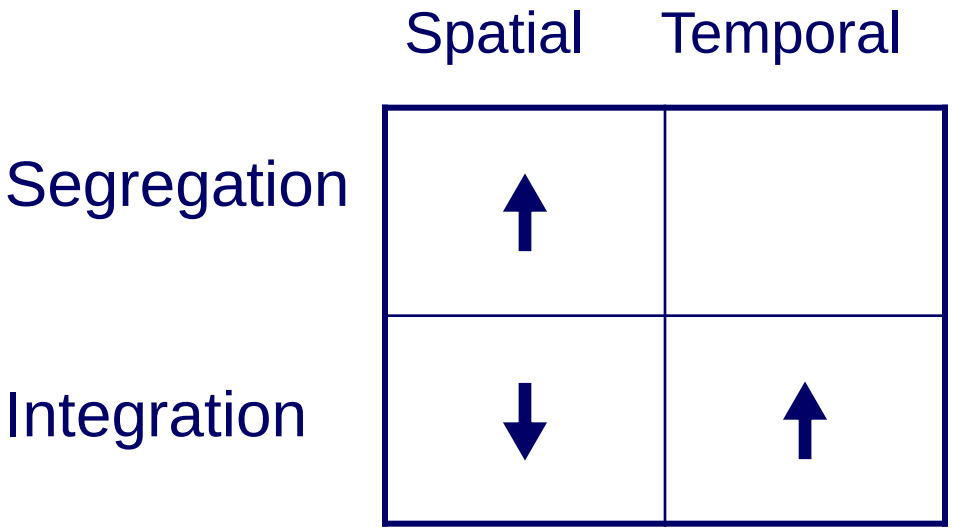
Working hypothesis

Transient attention facilitates spatial segregation and temporal integration but impairs spatial integration and temporal segregation.



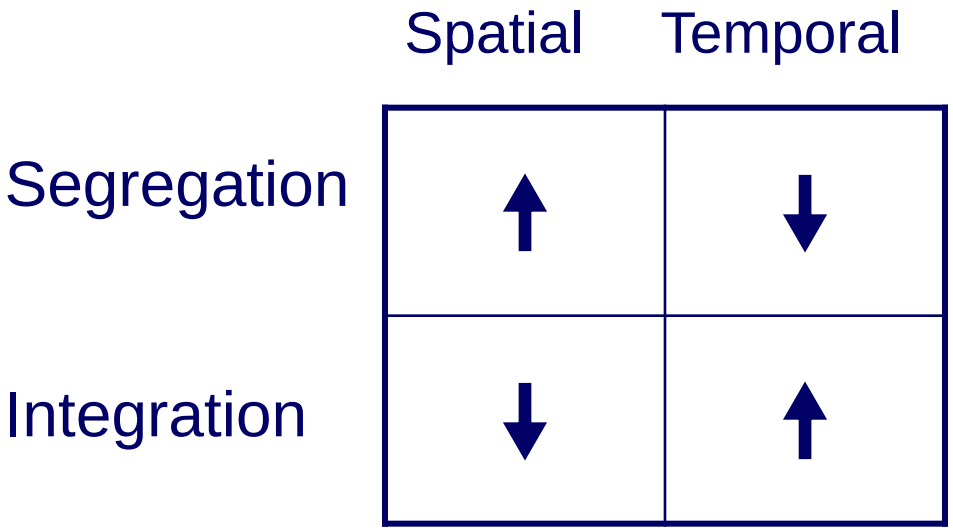
Working hypothesis

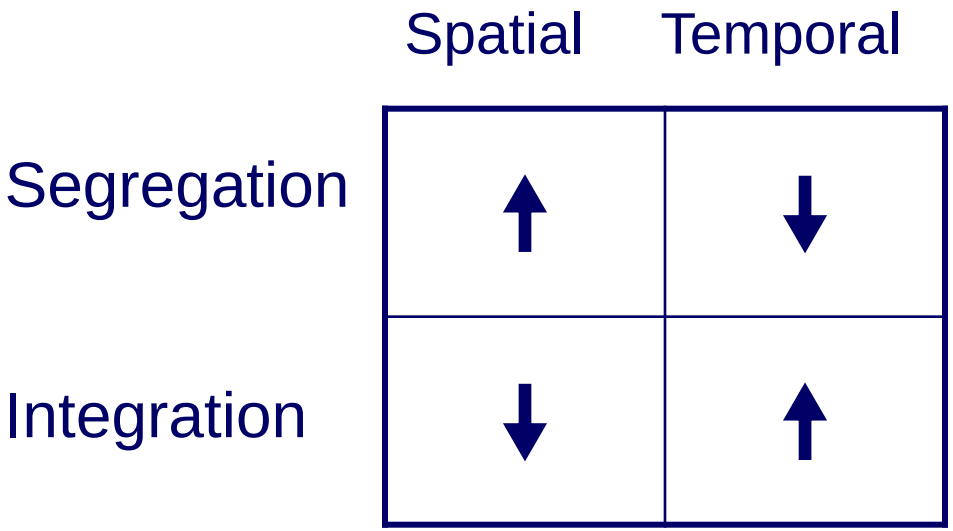
Transient attention facilitates spatial segregation and temporal integration but impairs spatial integration and temporal segregation.



Working hypothesis

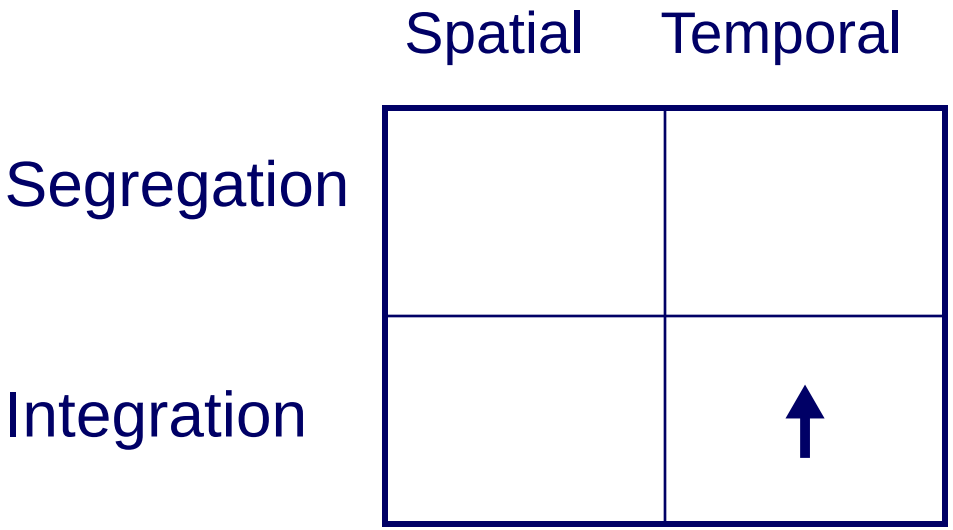
Transient attention facilitates spatial segregation and temporal integration but impairs spatial integration and temporal segregation.





Possible physiological implementation:

Transient attention favors **parvocellular** over **magnocellular** neuronal activity.



The integration of information over time

I. Visible persistence

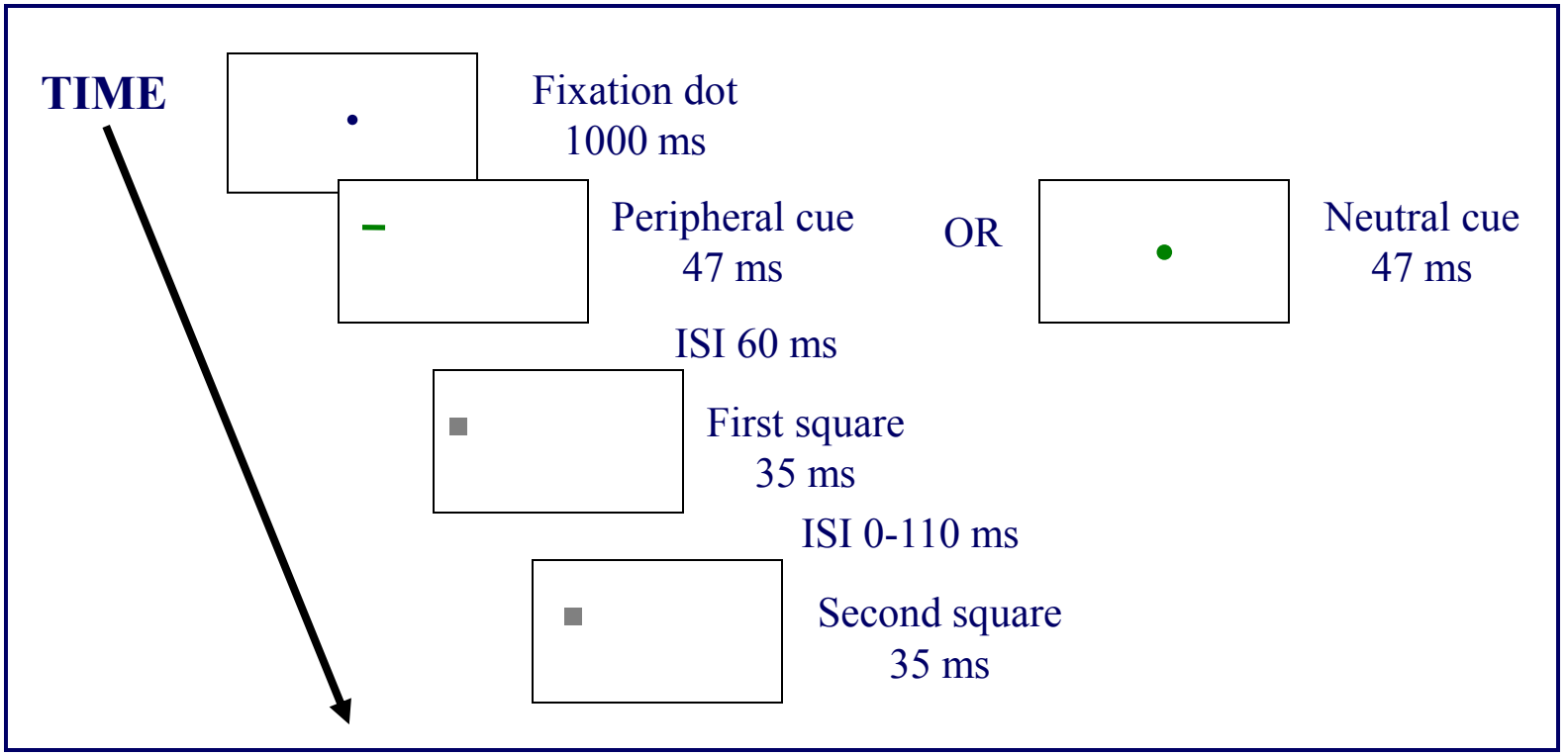
II. Perceived duration (Golan Marom)

Temporal integration - Visible Persistence

Method

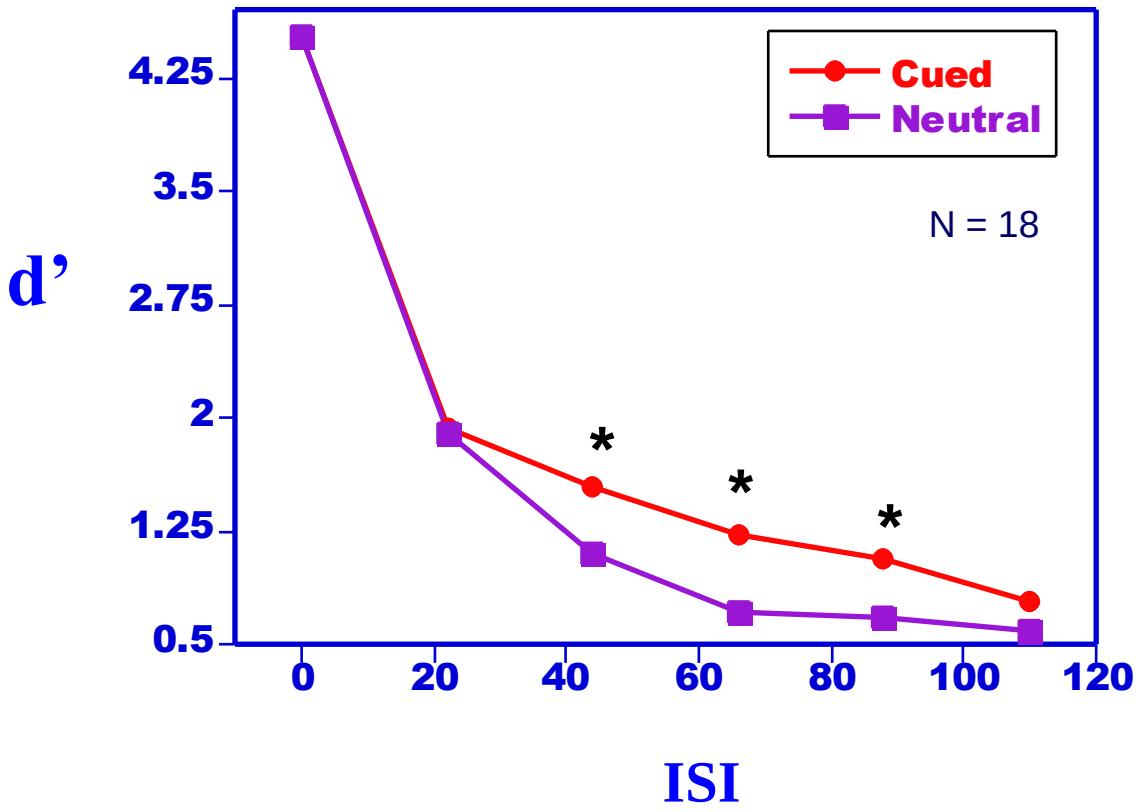
- **Target**:  Vs.

- **ISI**: 0 - 110 ms

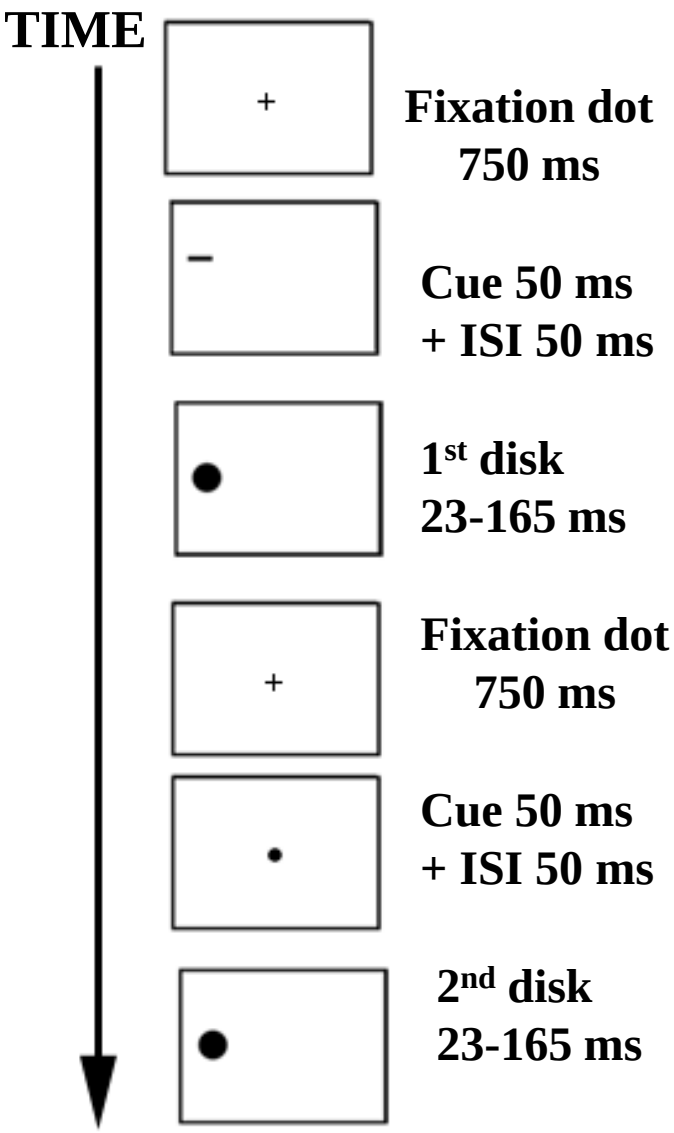


Attending the target location improves observers ability to detect the spatial gap:

=> Attention prolongs visible persistence



Perceived duration - Method

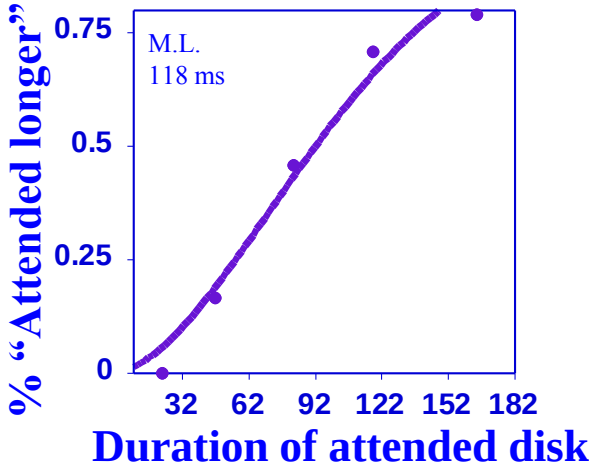


- **Target**: A disk of 3° diameter.
- **Disk Duration**: 23- 94 ms.

  23- 165 ms.
- **Task**: Which disk (1st or 2nd) had a shorter/longer duration?
- **Attentional Cueing**:

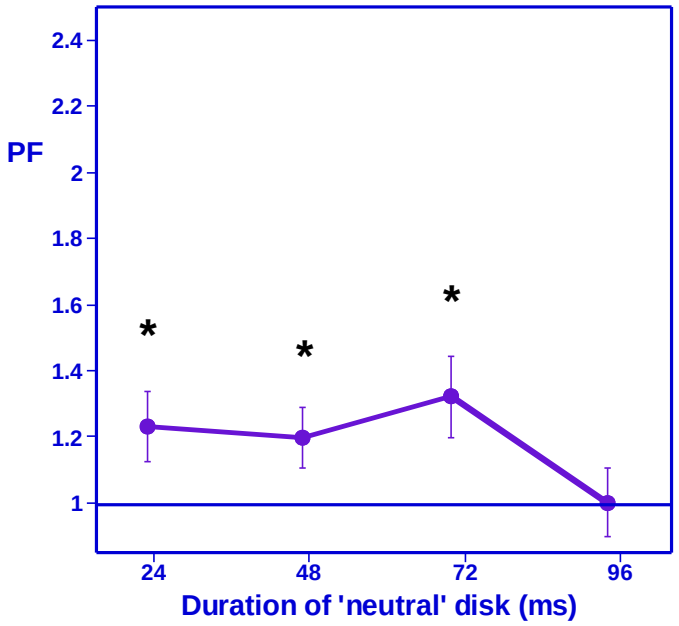
  50% 1st peripheral, 2nd neutral.

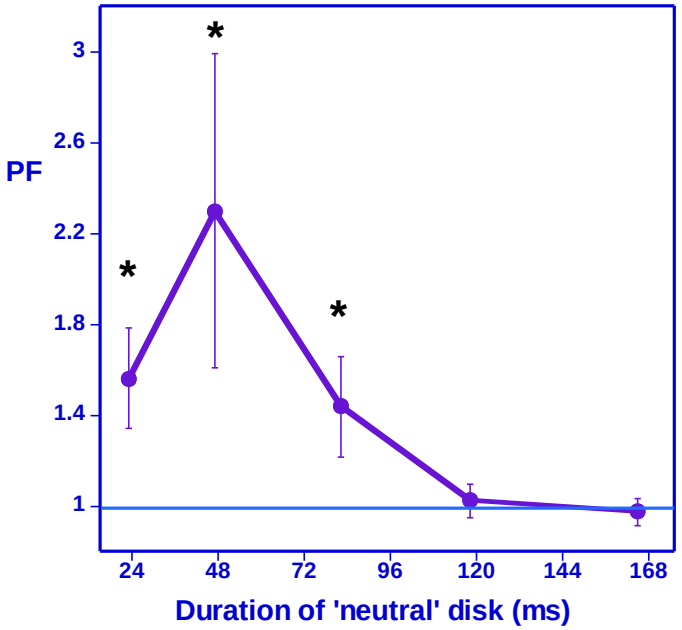
  50% 1st neutral, 2nd peripheral.



PSE = 50% "attended longer"

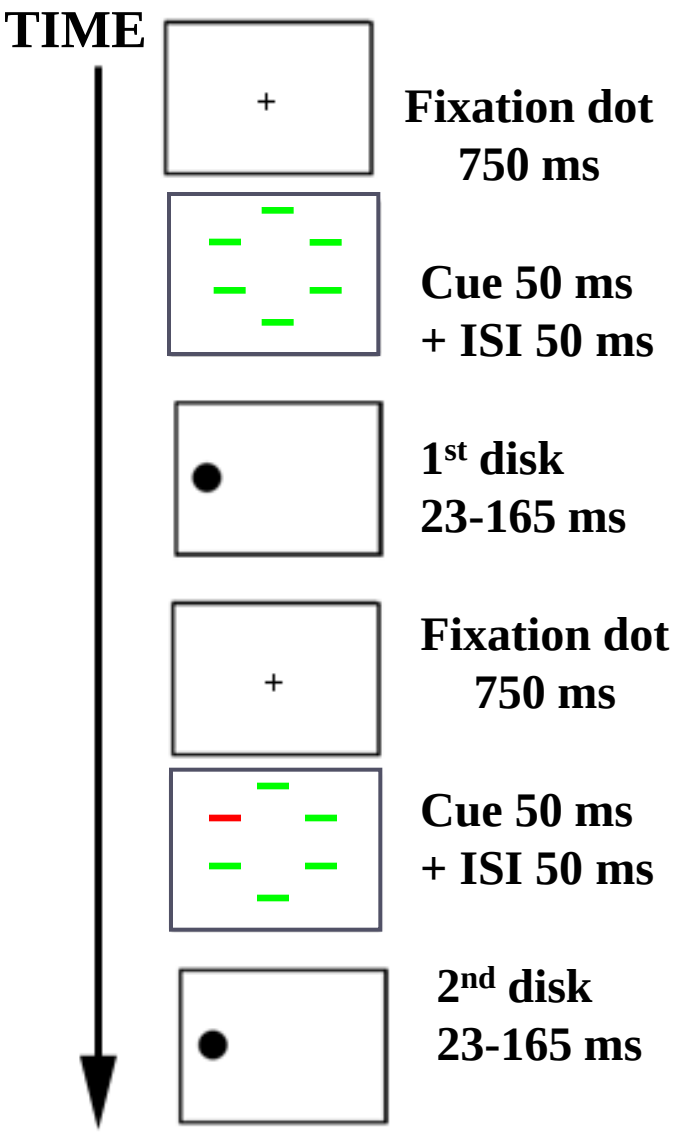
$$PF = \frac{\text{neutral disk duration}}{PSE}$$

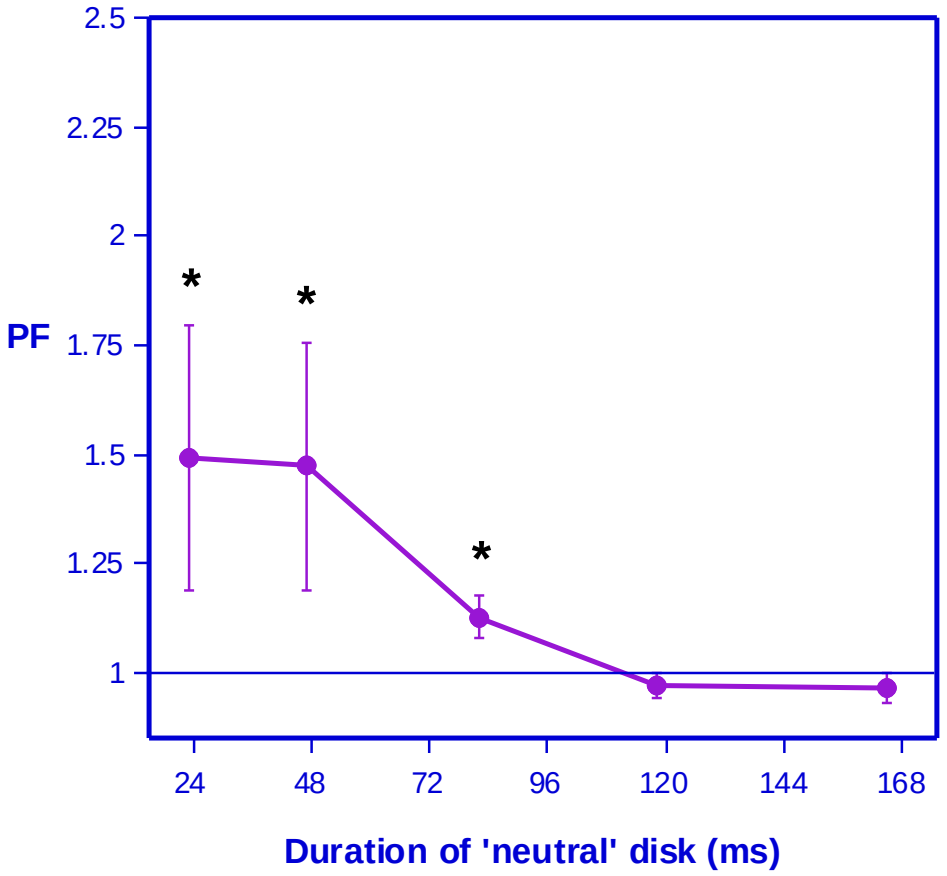




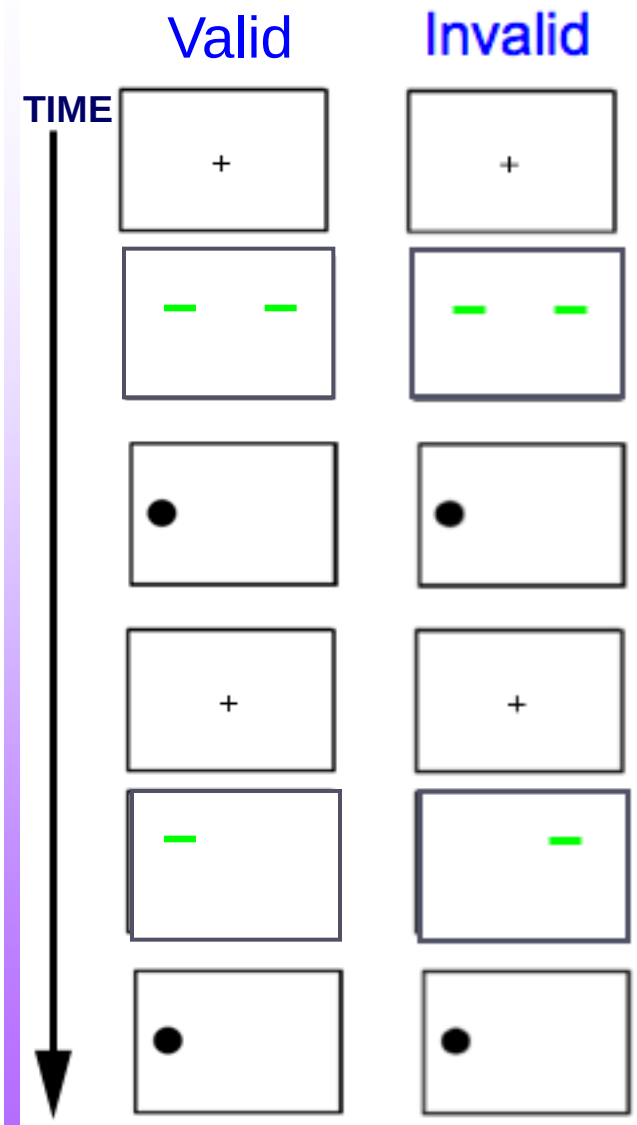
Transient attention prolongs the perceived duration

Perceived duration - Singleton control

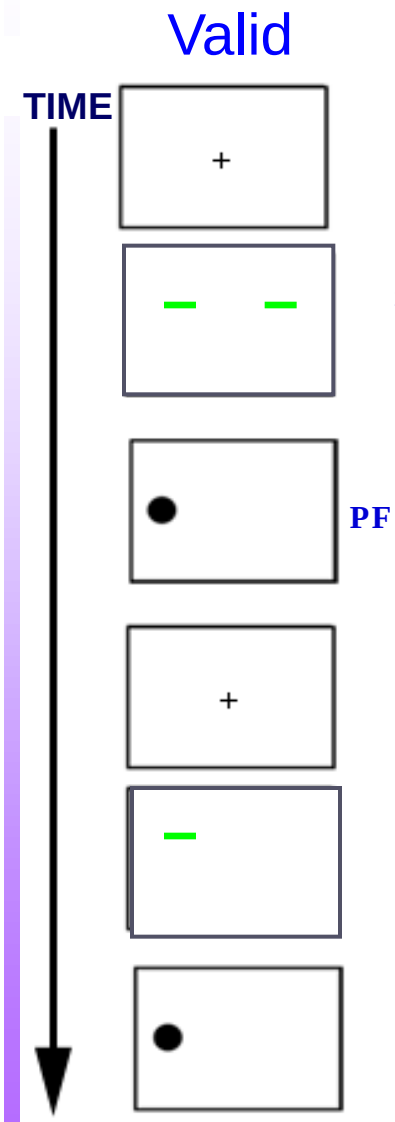


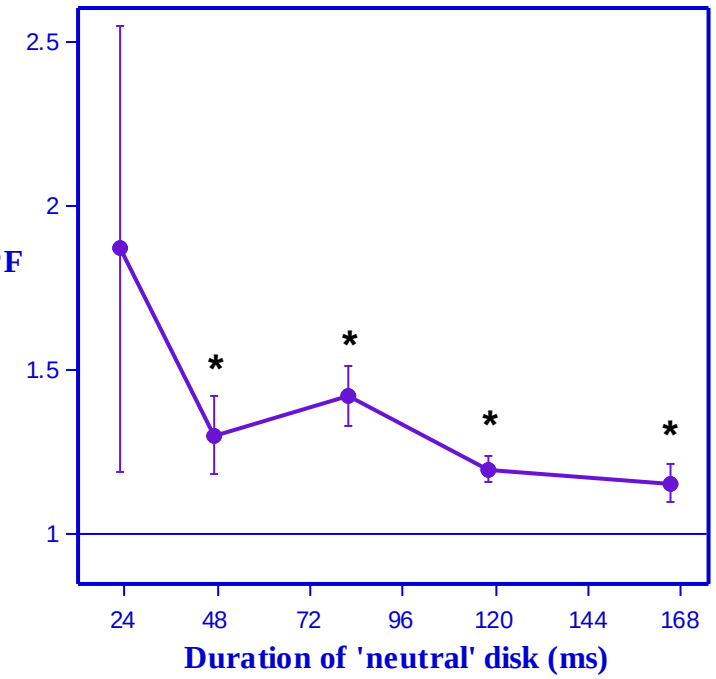


Perceived duration - Non-predictive cue:

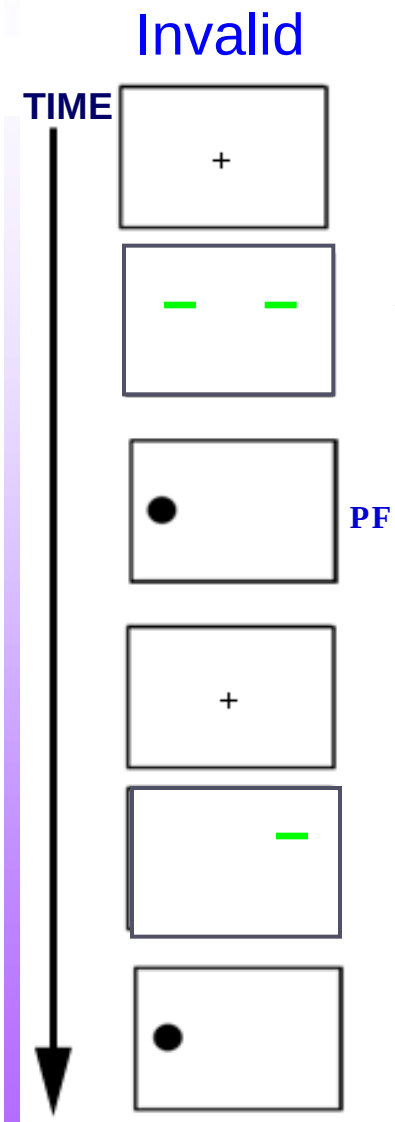


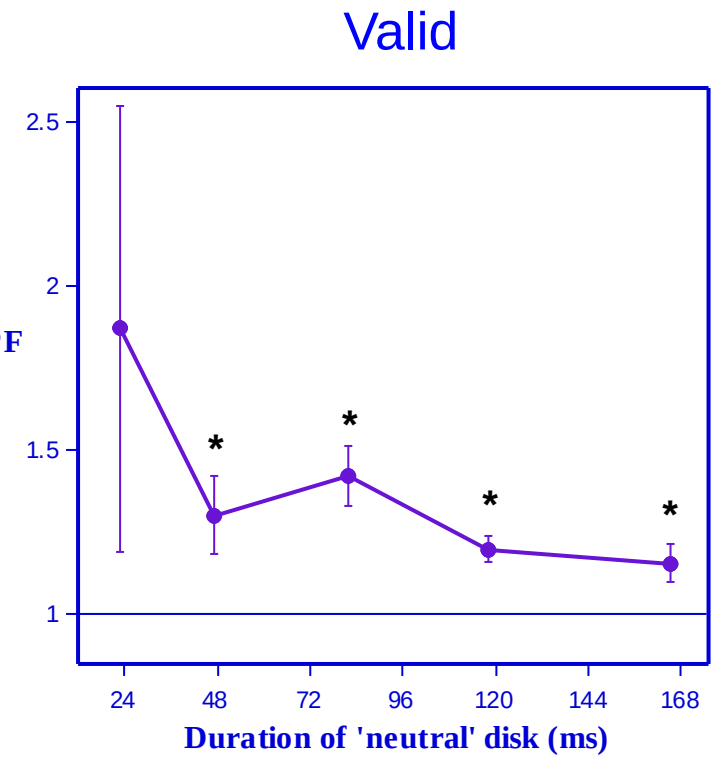
Perceived duration - Non-predictive cue:

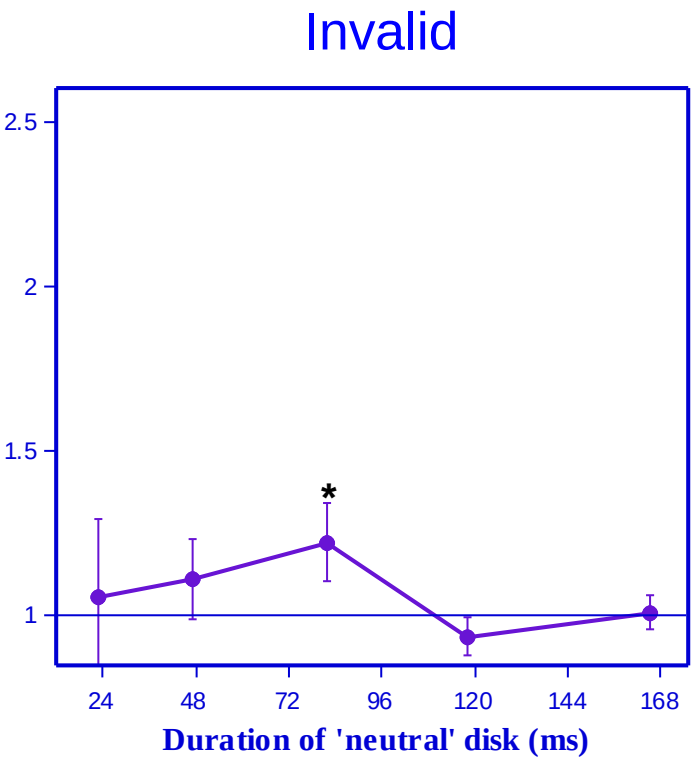


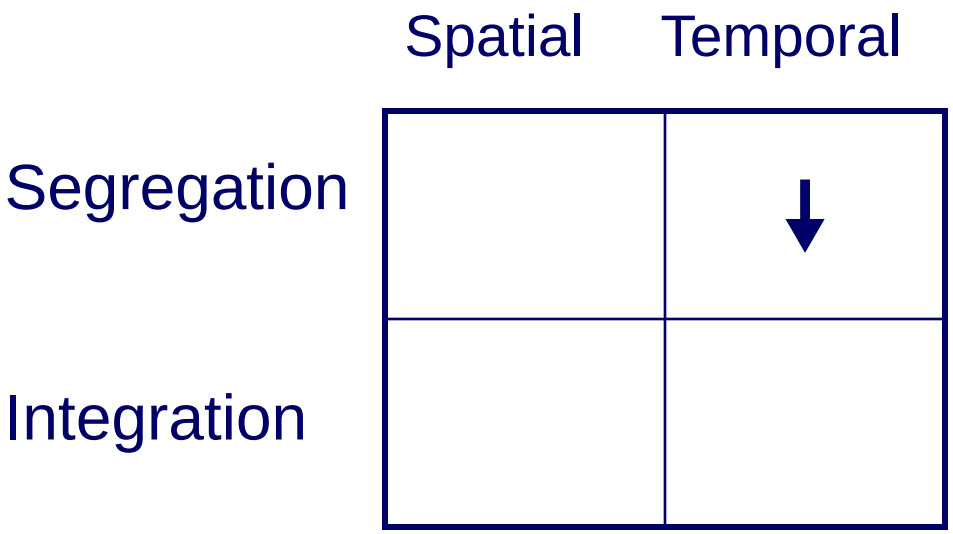


Perceived duration - Non-predictive cue:







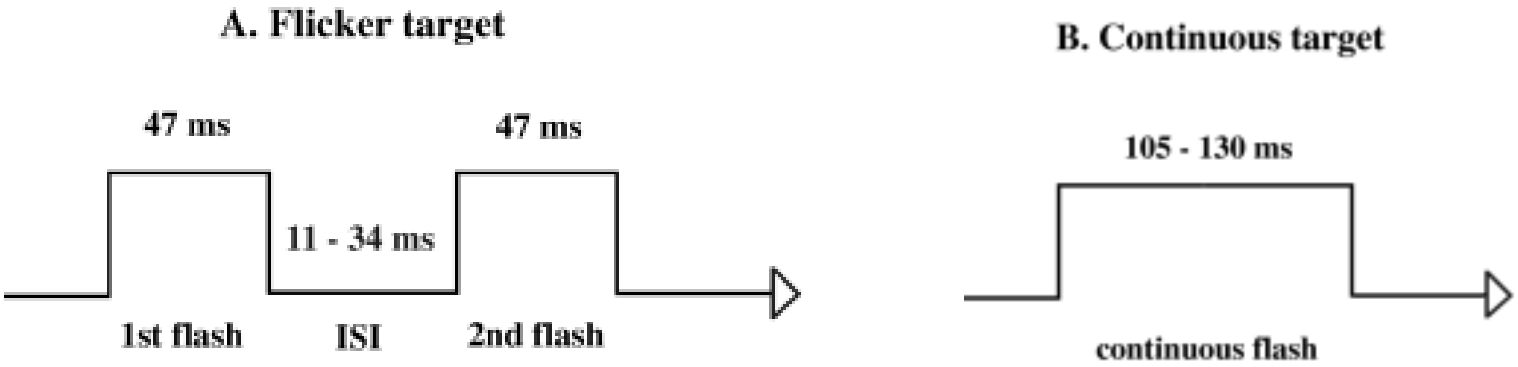


I. Temporal Resolution:

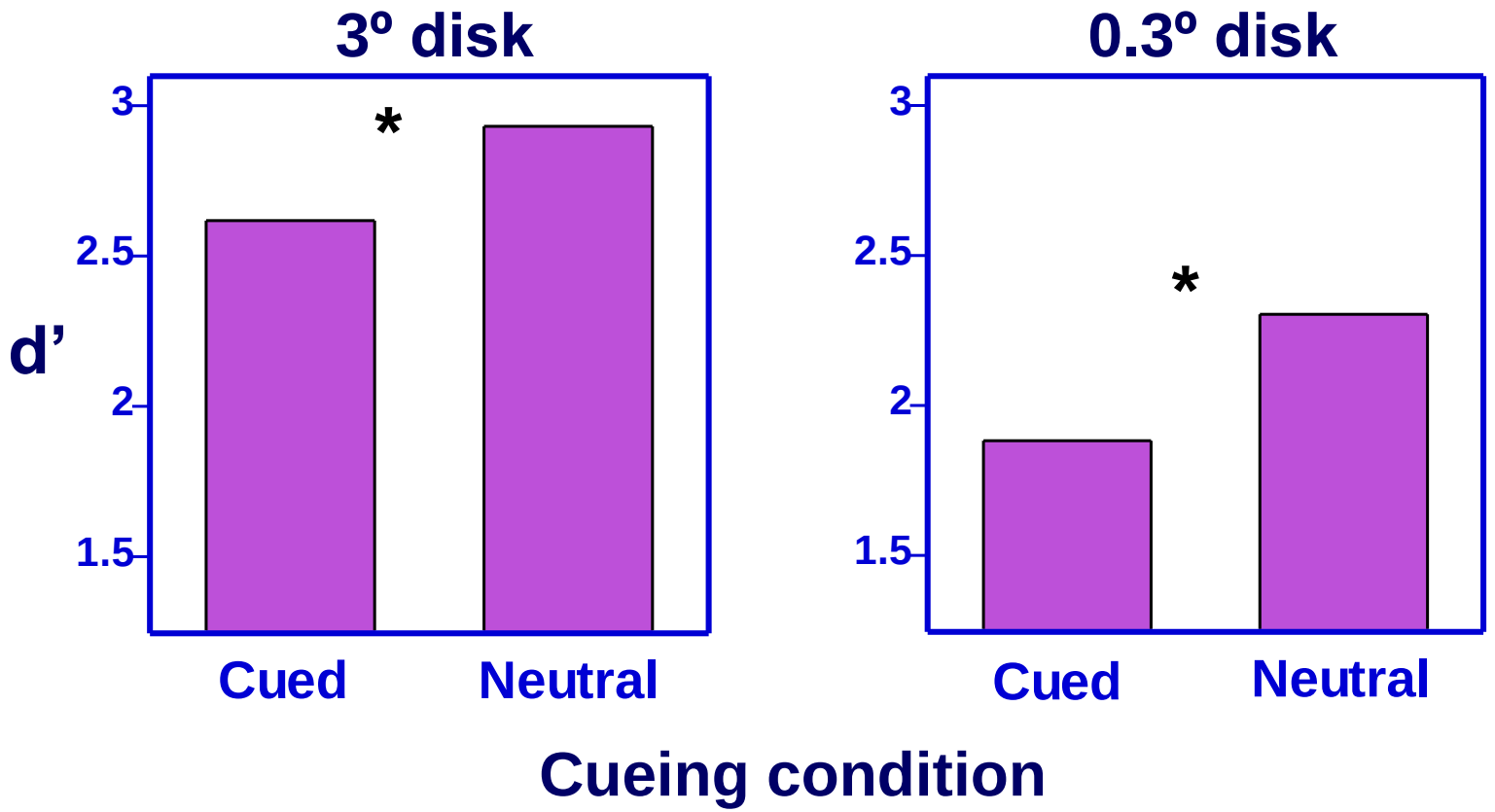
The ability to resolve rapid changes in light intensity over time.

II. Apparent Motion (Elisabeth Hein)

Temporal resolution - Method



- **Task**: flickering vs. continuous target
- **Target**: A disk of 3° or 0.3°diameter.
- **Cued trials** - a small bar indicating the target location.
- **Neutral trials** - two horizontal lines above and below the entire display.



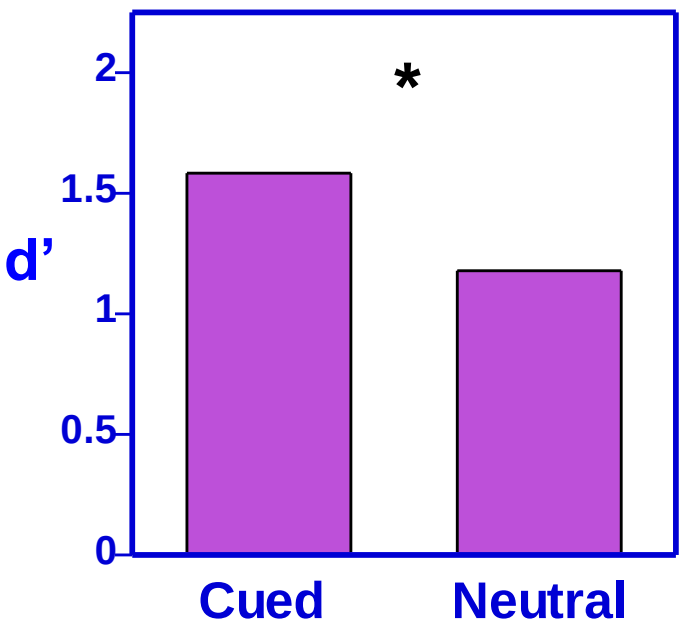
Attending the target location ***degrades*** temporal resolution

Could this performance decrement simply be an artifact of the cueing manipulation?

=> NO

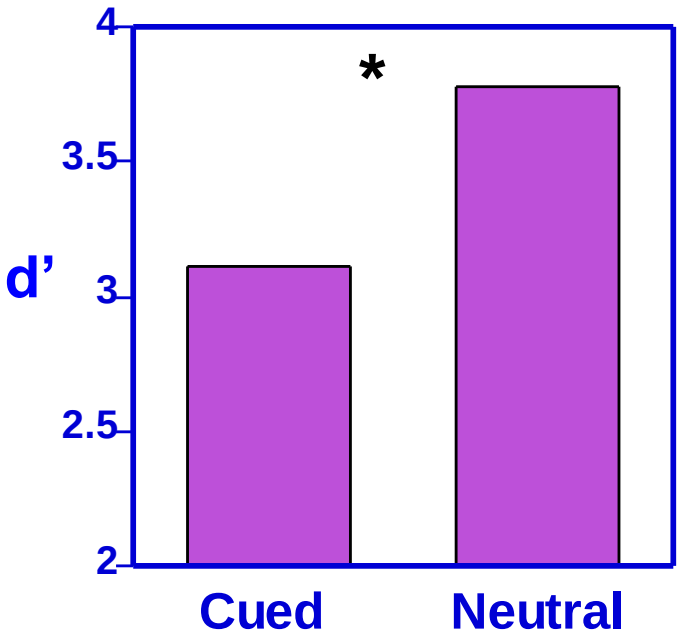
Same cueing manipulation

Detect a spatial gap



Detect a temporal gap

Multi-bar Neutral cue



Apparent Motion

Attention should impair the perceived apparent motion.

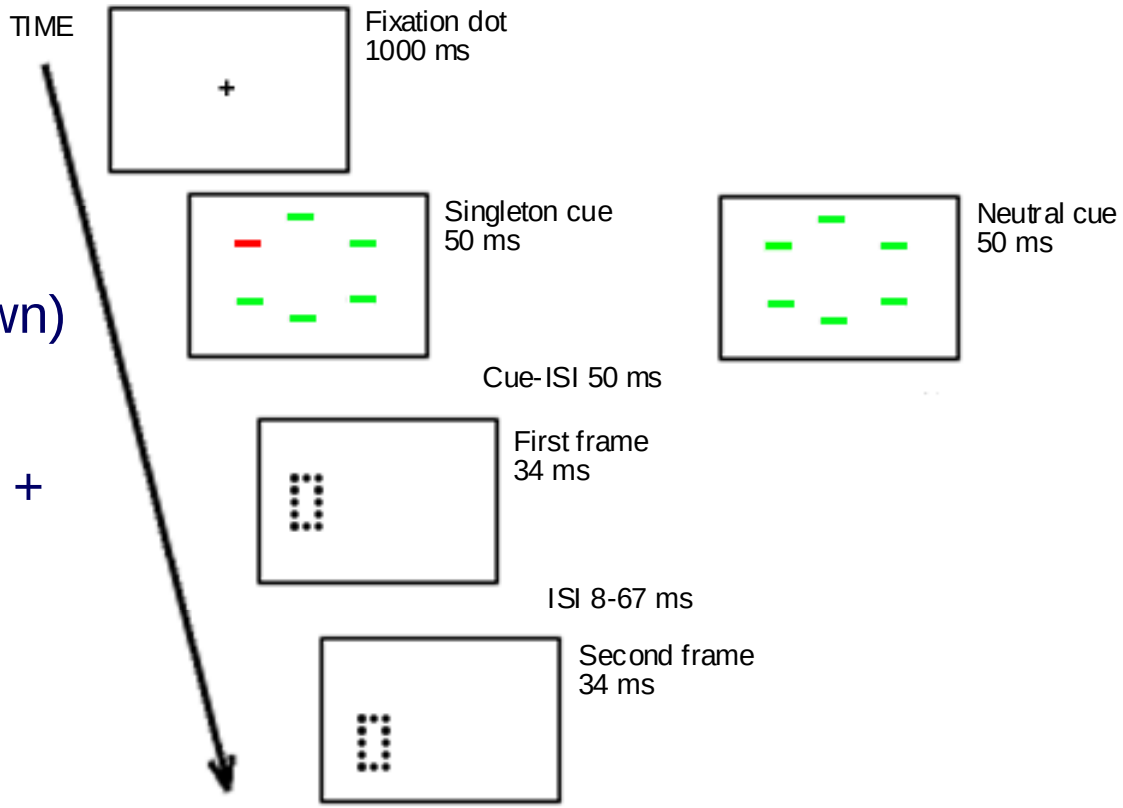
Apparent Motion: direction discrimination

- **Target**: a 3x2º rectangle composed of small dots
- **Eccentricity**: 6º - 6 possible positions
- **Task**: motion direction discrimination (up vs. down)
- **Cueing**:

  Singleton - 5 green bars + 1 red bar above target location.

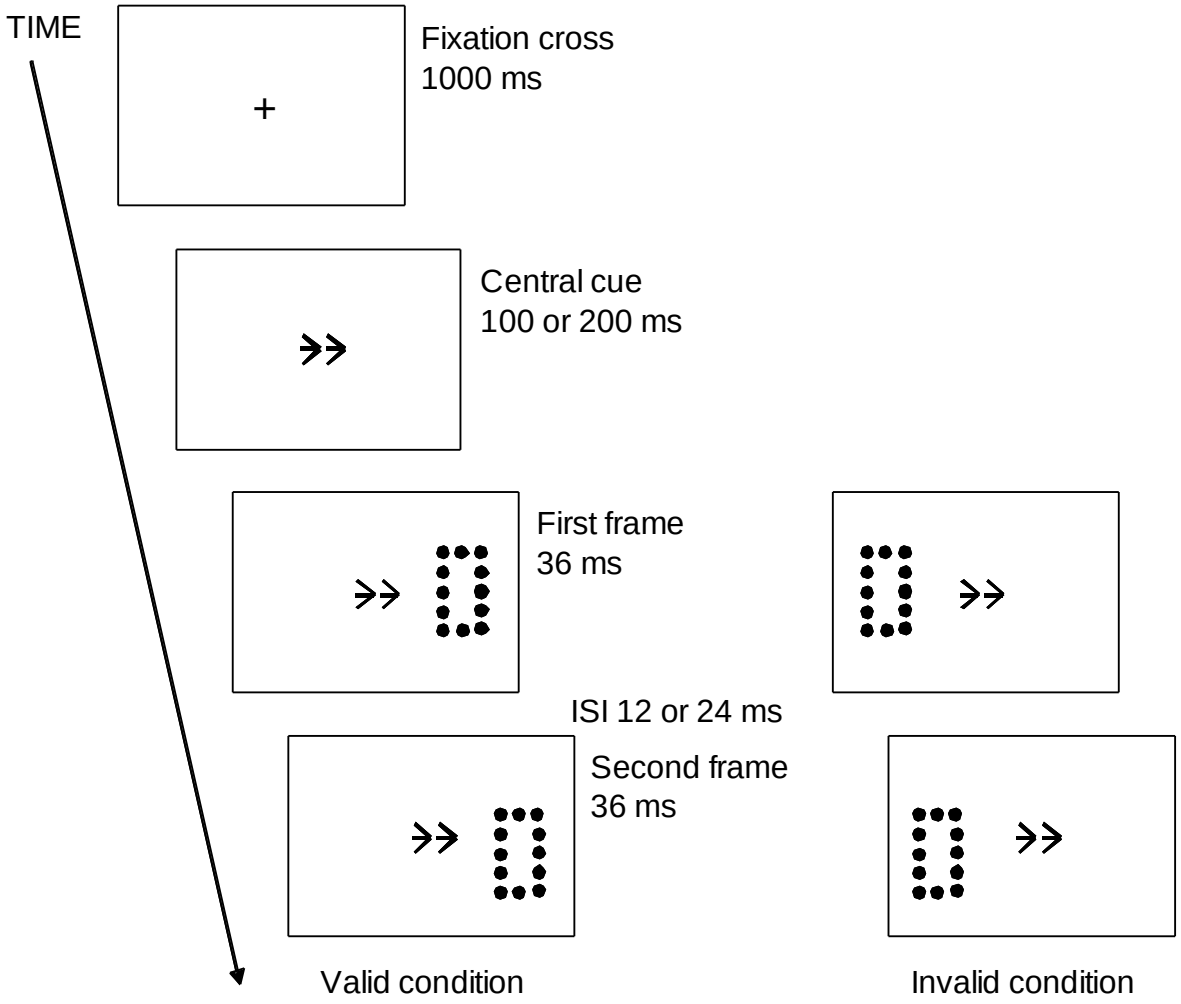
  Neutral - 6 green bars above each possible location

Singleton cue:



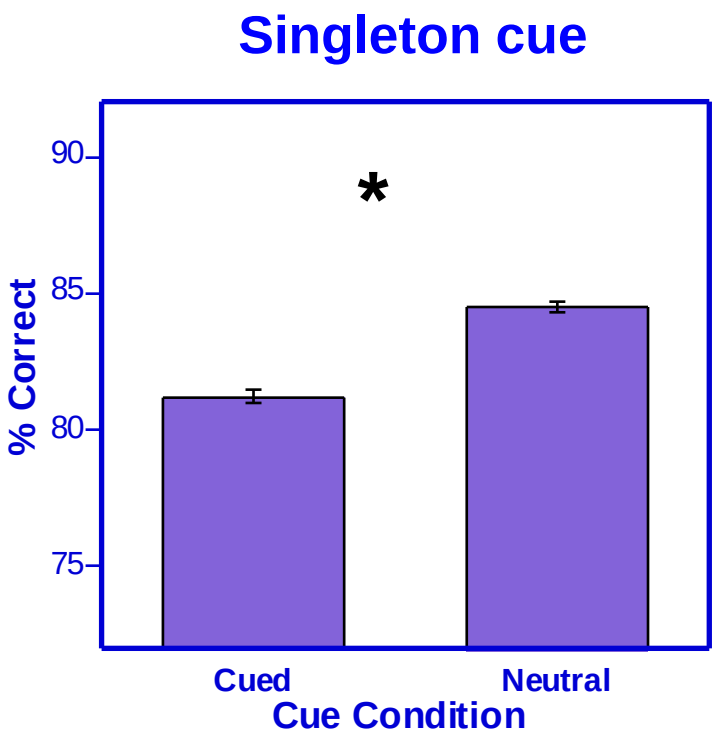
Uninformative central cue:

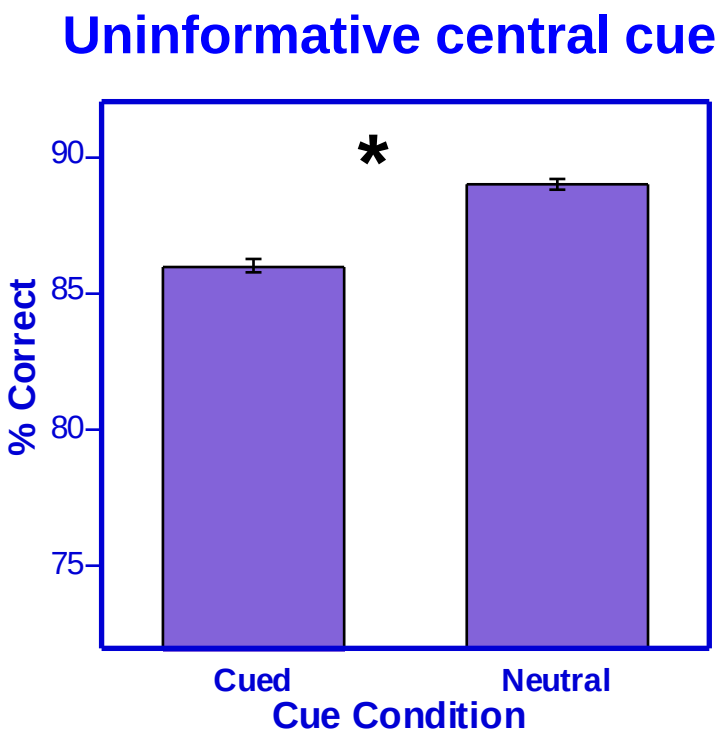
Hein, Rolke & Ulrich, 2006

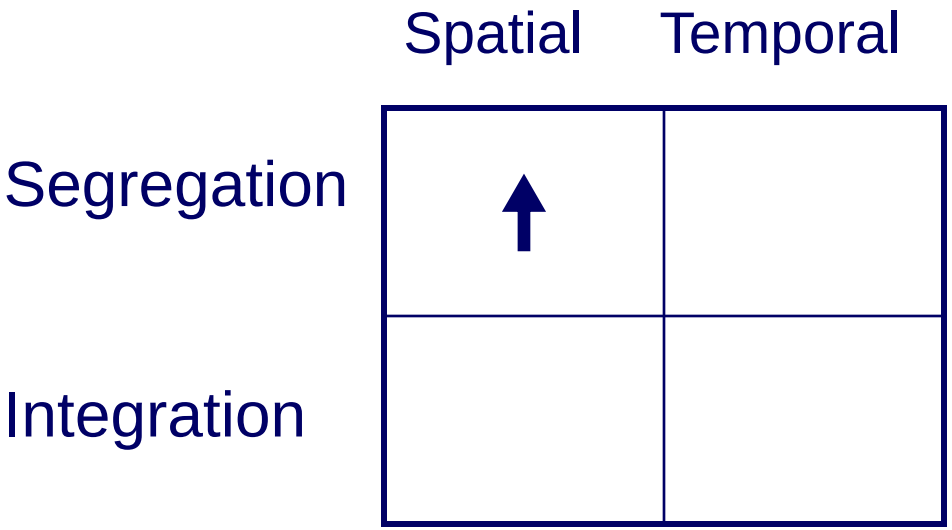


When target location was attended observers were less accurate in both experiments.

Attention degrades the perceived apparent motion



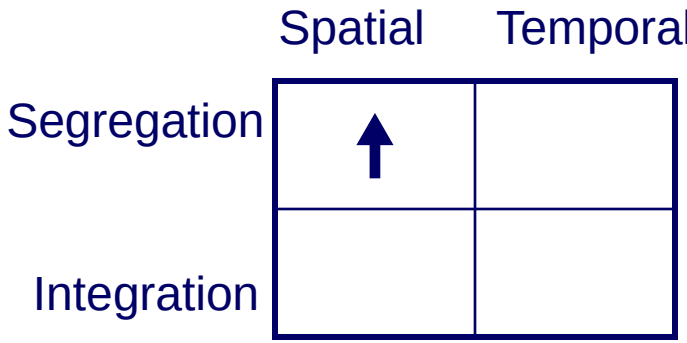




Spatial Resolution (Marisa Carrasco)

The ability to resolve fine details in the visual scene

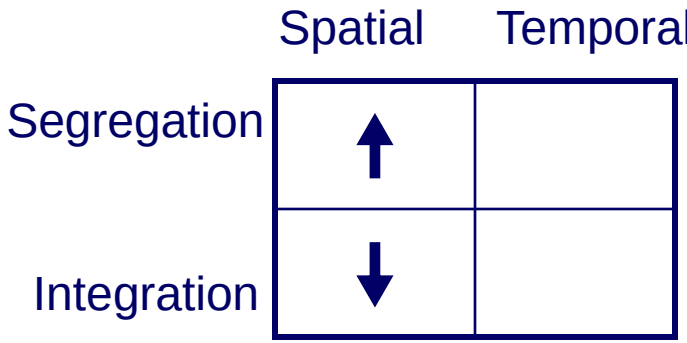
Transient attention enhances spatial resolution



Transient attention:

- Enhances gap resolution (acuity)
- Enhances vernier resolution (hyperacuity)
- Improves or impairs texture segmentation depending on eccentricity and texture scale.

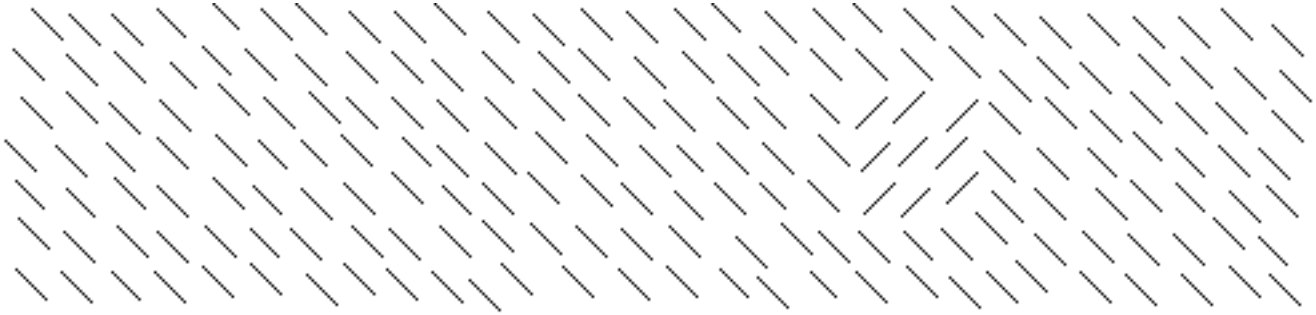
Transient attention enhances spatial resolution

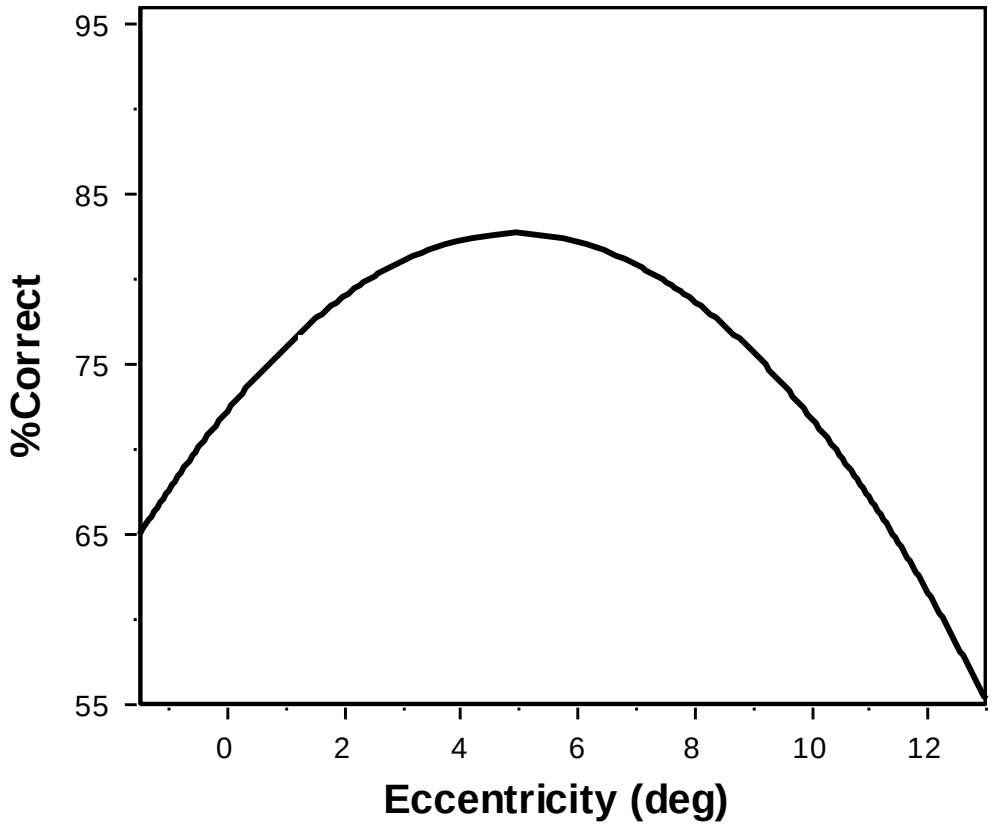


Transient attention:

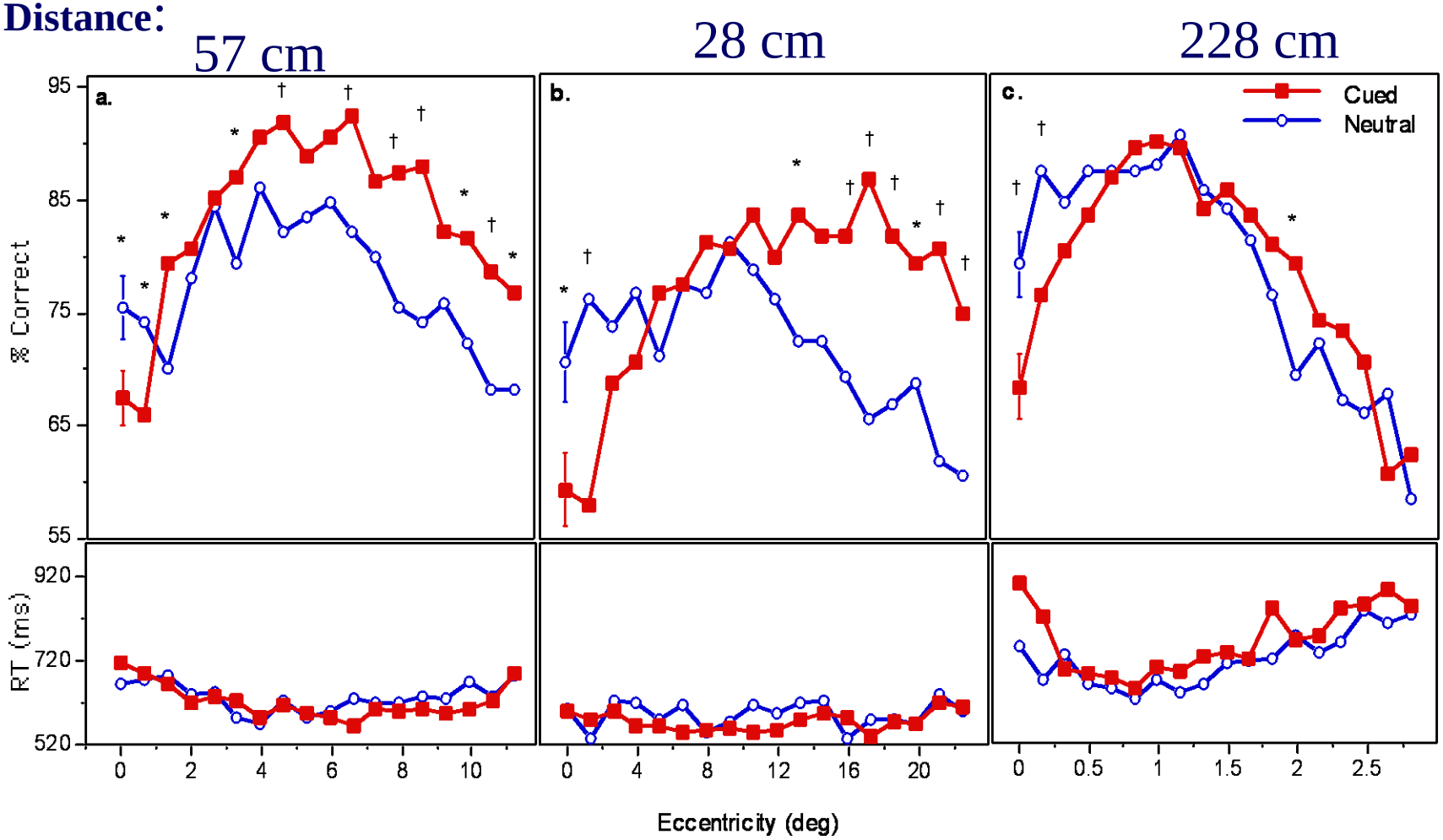
- Enhances gap resolution (acuity)
- Enhances vernier resolution (hyperacuity)
- Improves or impairs texture segmentation depending on eccentricity and texture scale.

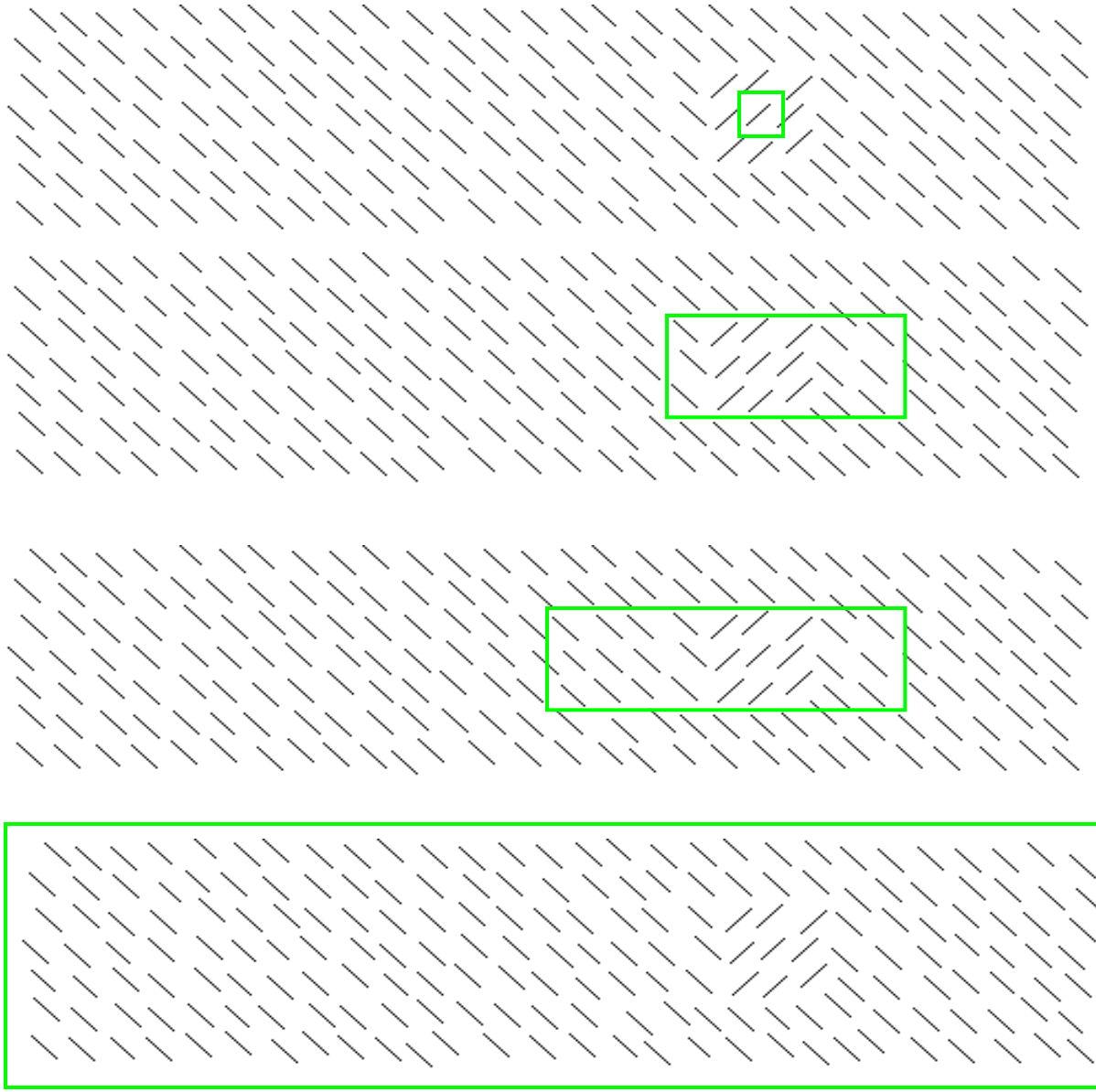
Texture segmentation task





Distance:


57 cm
28 cm
228 cm
a.
b.
c.
Cued
Neutral
% Correct
RT (ms)
Eccentricity (deg)

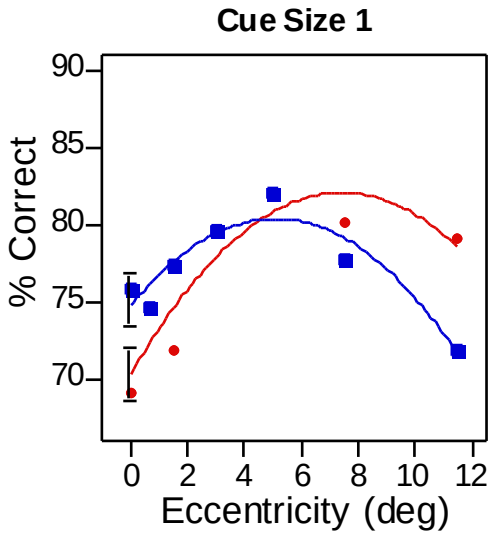


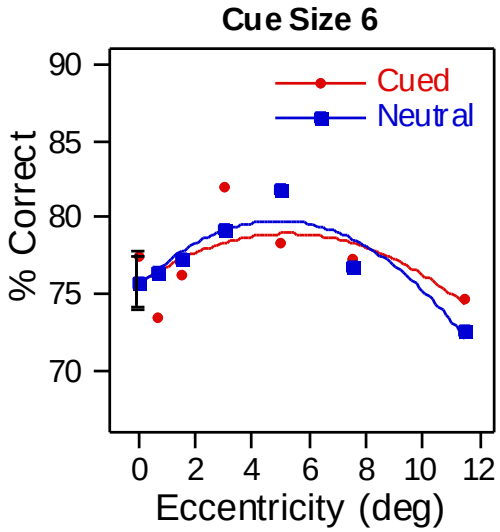
Cue size 1

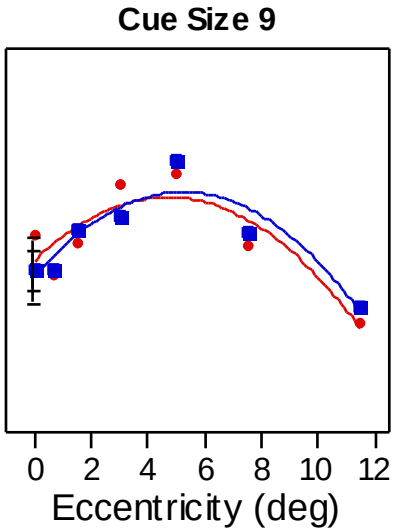
Cue size 6

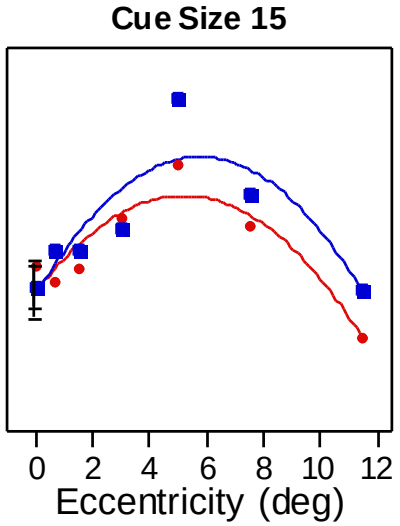
Cue size 9

Neutral cue


Cue Size 1
% Correct
90
85
80
75
70
0
2
4
6
8
10
12
Eccentricity (deg)


Cue Size 6
Cued
Neutral
% Correct
90
85
80
75
70
0
2
4
6
8
10
12
Eccentricity (deg)


Cue Size 9
0
2
4
6
8
10
12
Eccentricity (deg)


Cue Size 15
0
2
4
6
8
10
12
Eccentricity (deg)

Summary

	Spatial	Temporal
Segregation	↑	↓
Integration	↓	↑

Transient spatial attention:

- Prolongs visible persistence
- Prolongs the perceived duration
- Degrades temporal resolution
- Degrades the perceived apparent motion
- Enhances spatial resolution

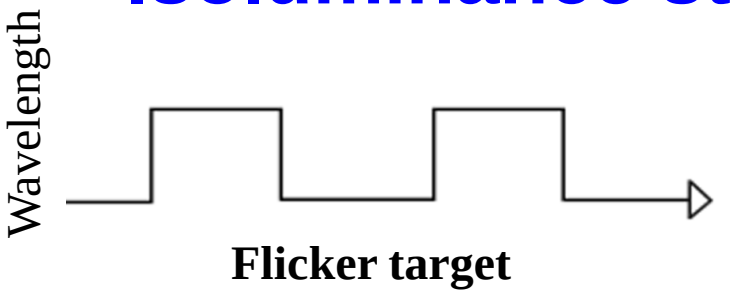
Possible physiological implementation:

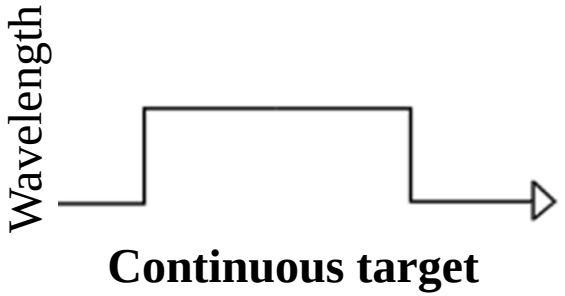
	Spatial	Temporal
Segregation	↑	↓
Integration	↓	↑

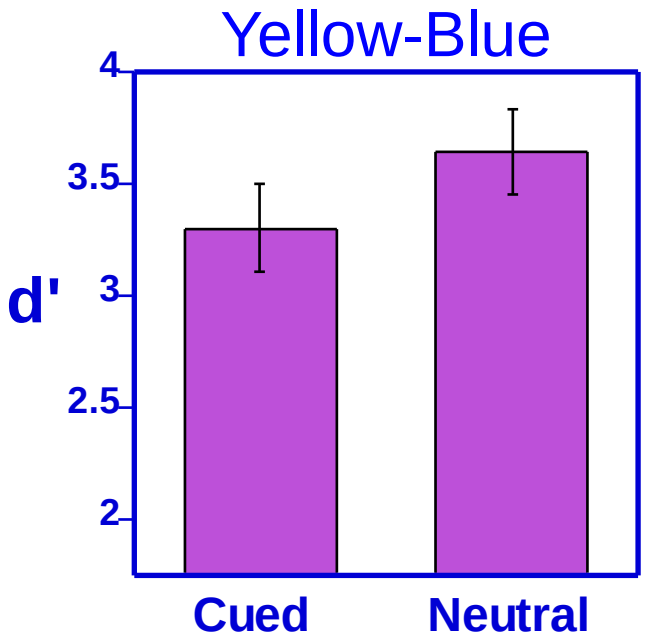
Transient attention favors **parvocellular** over **magnocellular** neuronal activity.

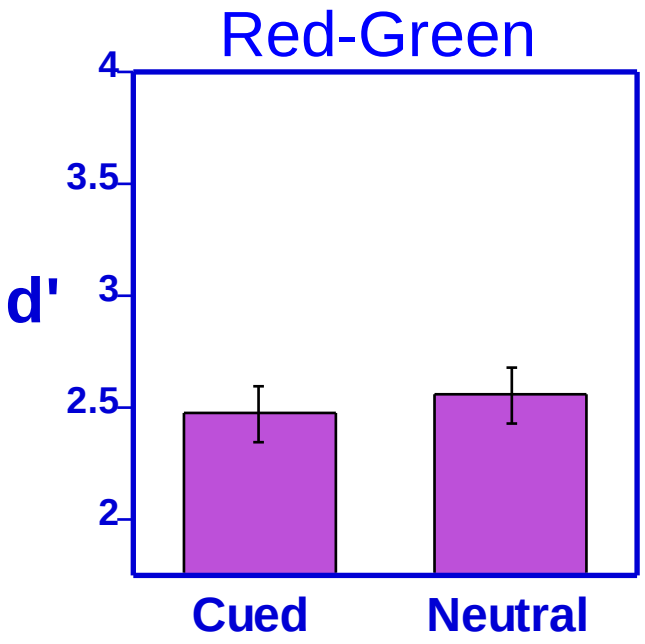
	Parvocellular	**Magnocellular**
receptive fields	small	large
sampling density	high	low
spatial resolution	high	low
response duration	long	short
Response decay	slow	fast
temporal integration	long	short
temporal resolution	low	high
Motion perception		
color discrimination		

Isoluminance stimuli





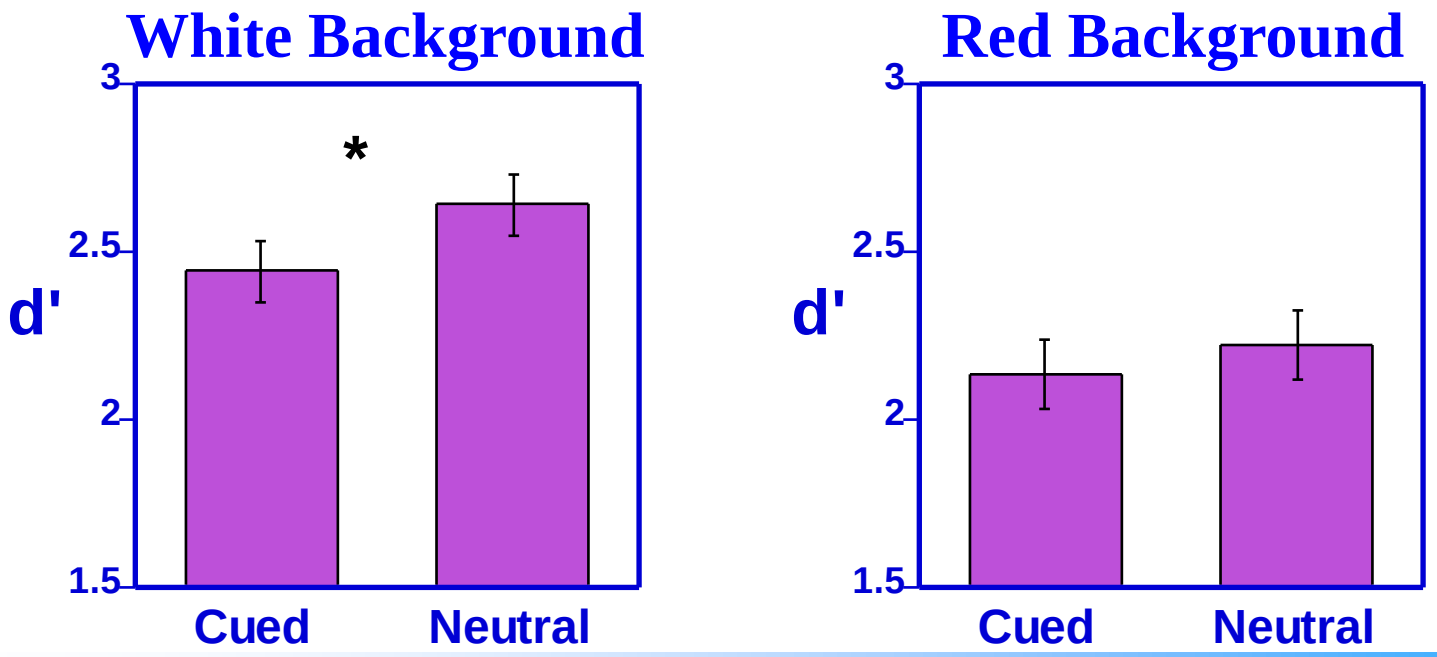




No significant difference between cueing conditions

Red background

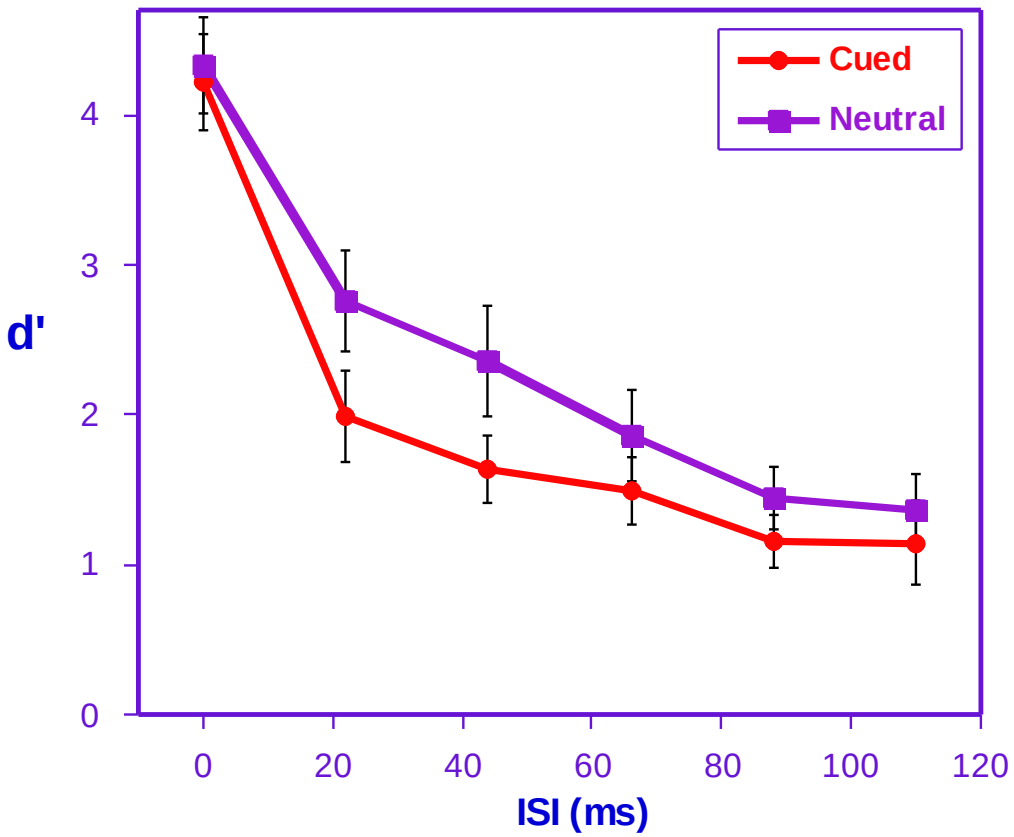
- Magnocellular neurons are inhibited by diffused red light (e.g., Livingstone & Hubel, ‘84; Van Essen, ‘85).
- Red background attenuates effects that might be due to magno-parvo inhibition (e.g., Breitmeyer & Williams, ‘90).



Low contrast

Visible persistence:  Vs.

Contrast - 2%



Transient attention did not prolong visible persistence

Transient spatial attention:

- Enhances spatial resolution
- Degrades temporal resolution
- Prolongs the perceived duration
- Prolongs visible persistence
- Degrades the perceived apparent motion

Transient attention facilitates spatial segregation and temporal integration but impairs spatial integration and temporal segregation.