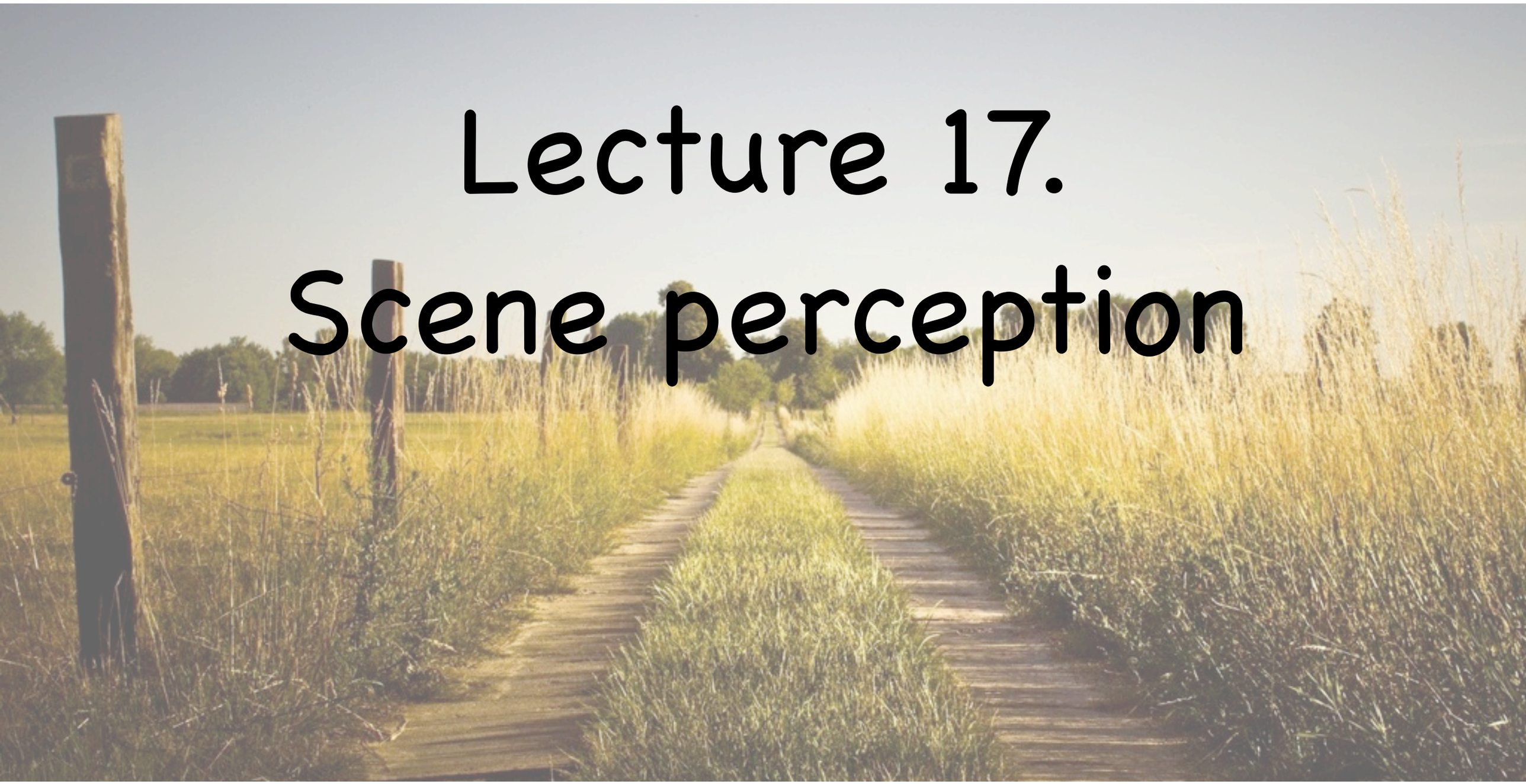
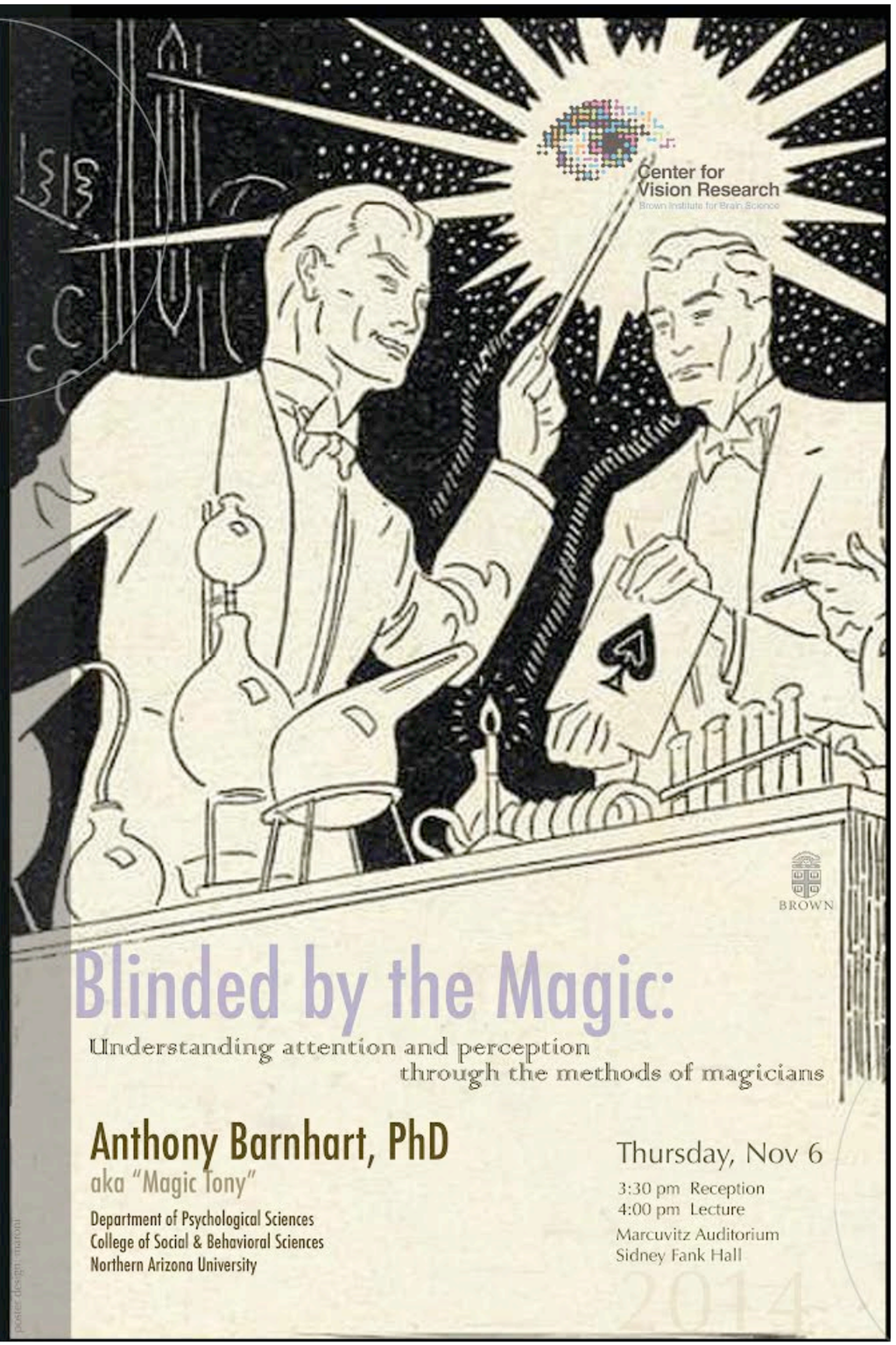


Lecture 17.

Scene perception



Center for Vision Research | Brown Institute for Brain Science
Thursday, Nov 6

Marcuvitz Auditorium, Sidney Frank Hall

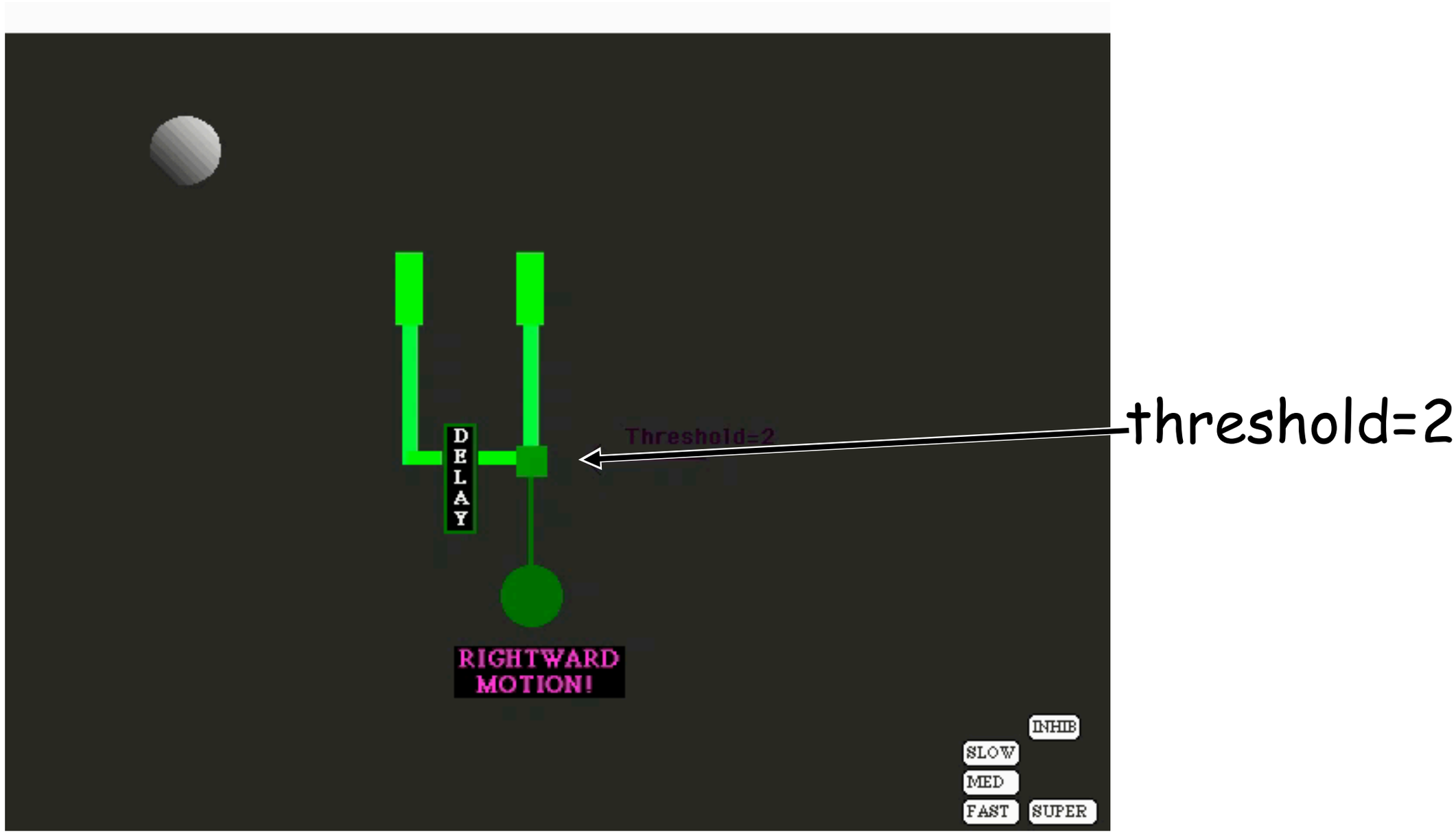
3:30pm reception | 4:00pm lecture

Anthony Barnhart, PhD
Department of Psychological Sciences
Northern Arizona University

Blinded by the Magic: Understanding attention and perception through the methods of magicians

From one min quiz

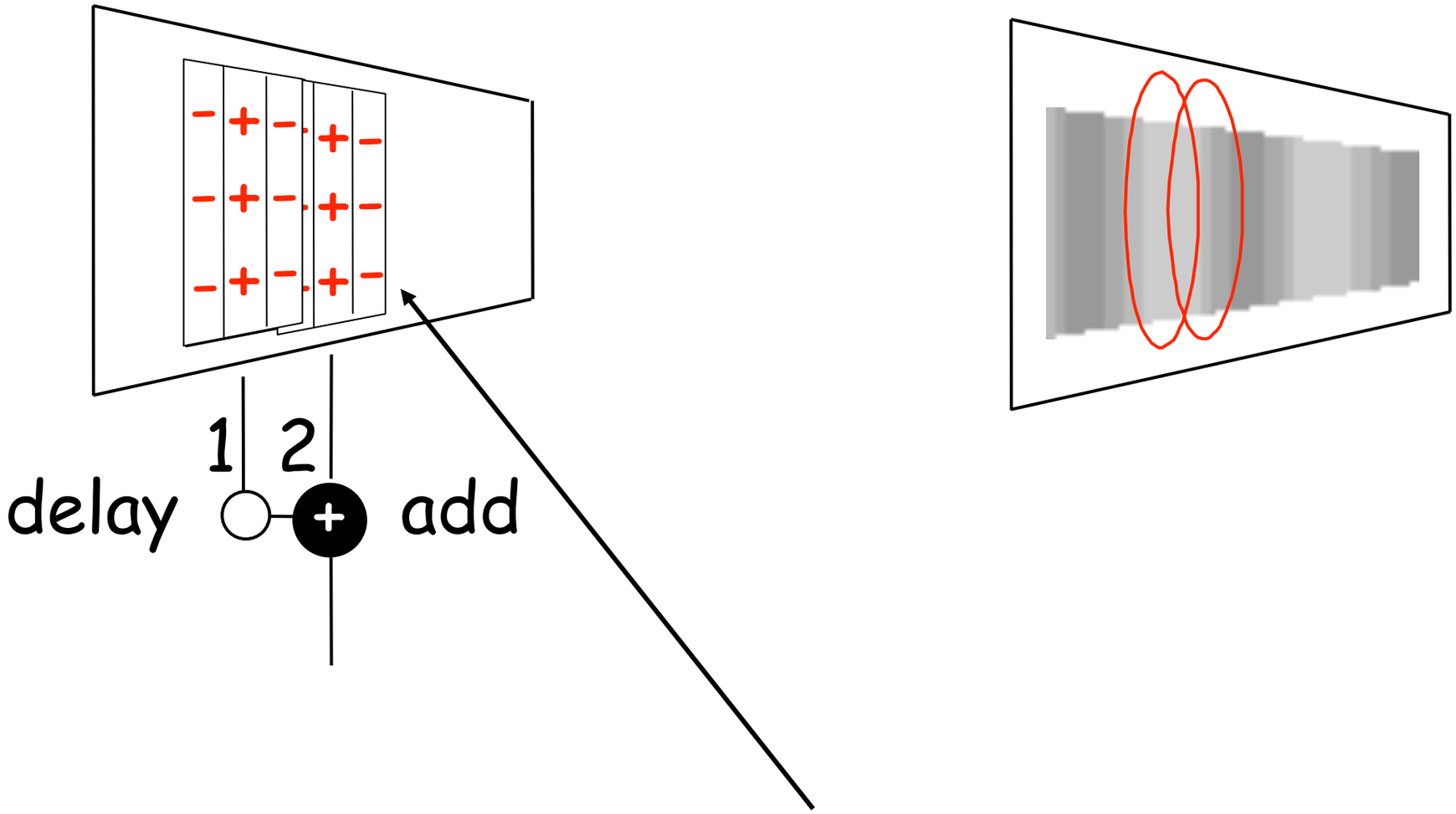
Q. Reichard detector



Reichardt detector

3

Rightward motion unit



- two simple cell receptive fields make up the "subunits" of the detector
- subunits offset in space and time

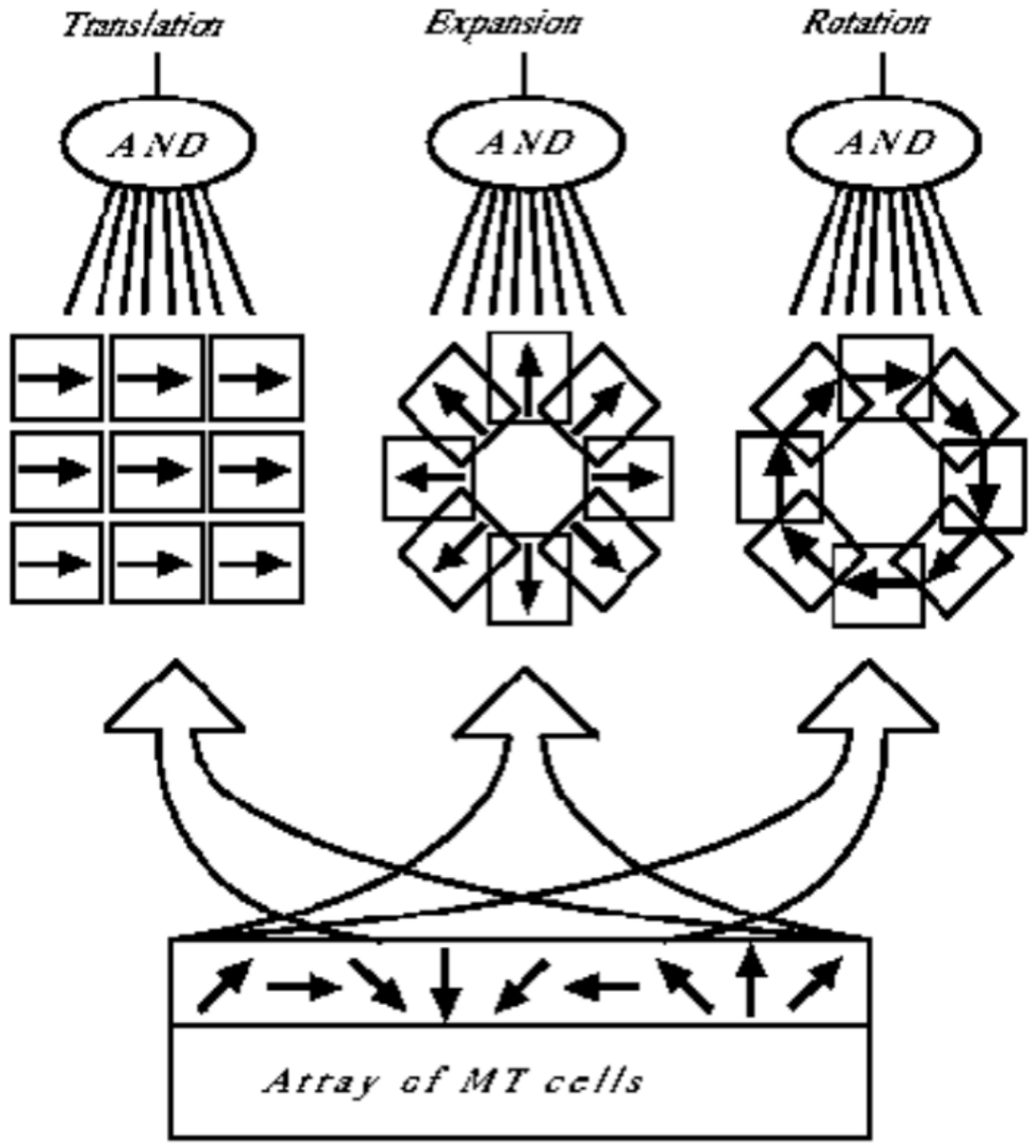
4

Q. MT vs MST

Q. Does MST get input from MT?

MST (V5a)

MT (V5)



Q. Mechanisms of akinetopsia?

Inconspicuous akinetopsia

Seeing motion as a cinema reel or multiple exposure photograph

Gross akinetopsia- Very rare

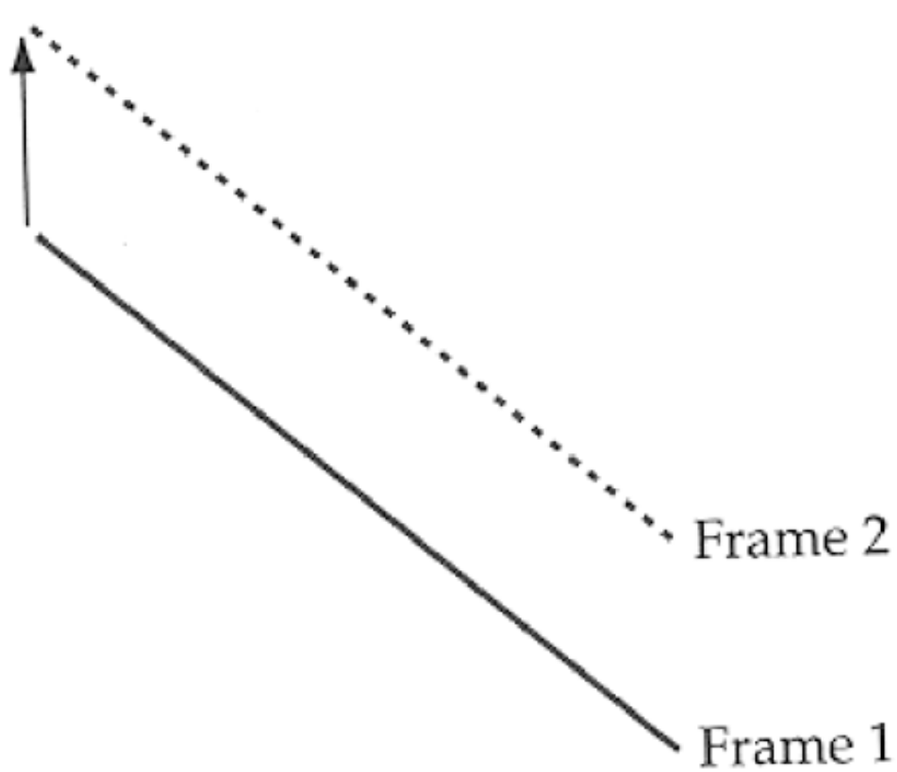
e.g., LM: described pouring a cup of tea or coffee difficult "because the fluid appeared to be frozen, like a glacier".

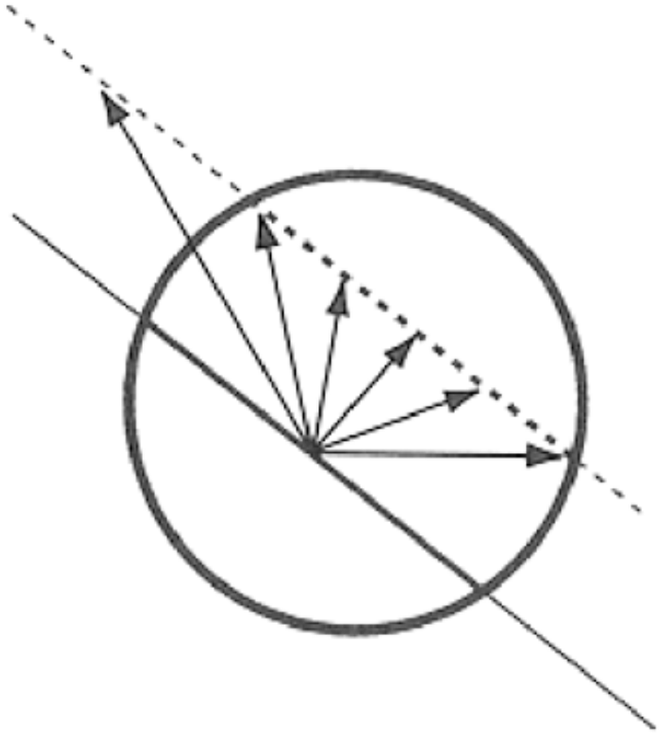
Zeki S.
Brain. 1991 Apr;114 (Pt 2):811-24. Review.

6

Q. Aperture problem

- The direction of motion of a straight line is ambiguous
- The visible displacement of the line can arise from an infinite set of possible physical motions

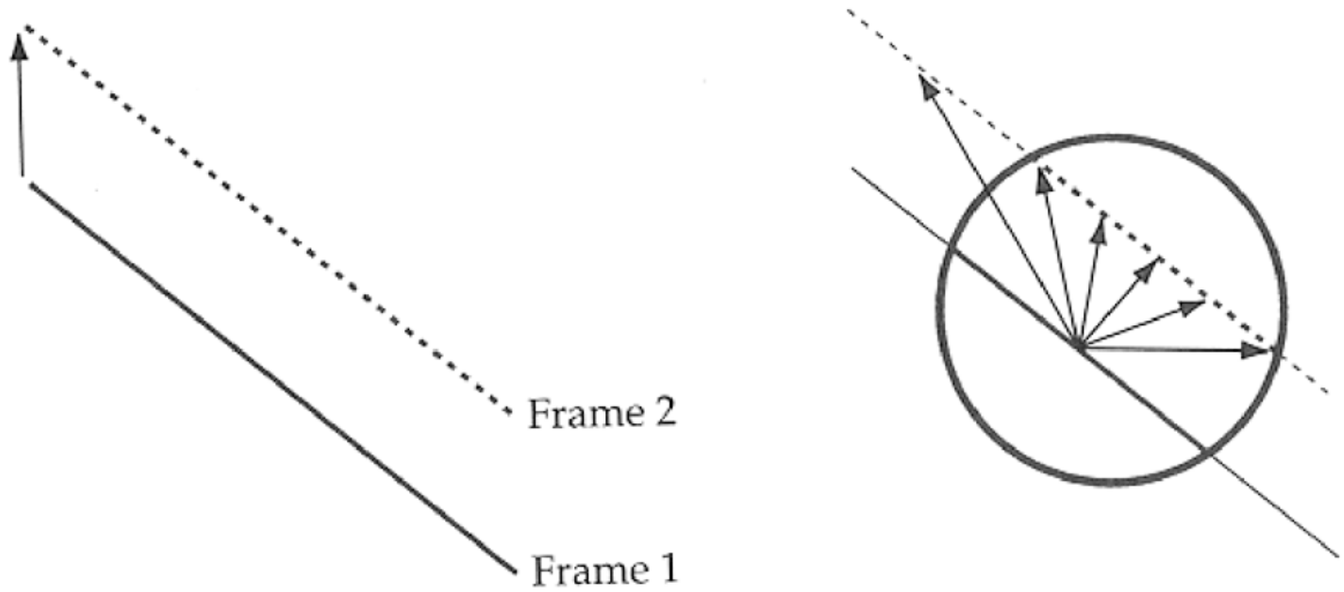




7

What does this have to do with motion detectors?

➔Receptive fields act as small windows hiding the end points



V1 Receptive Field

How to resolve this ambiguity?

One solution is to rely on local 2D features.

➔Line endings and corners

➔End stopped cells respond to line endings and corners

8

Motion measured within small local receptive fields is often different from actual (global) motion of object

Aperture problem

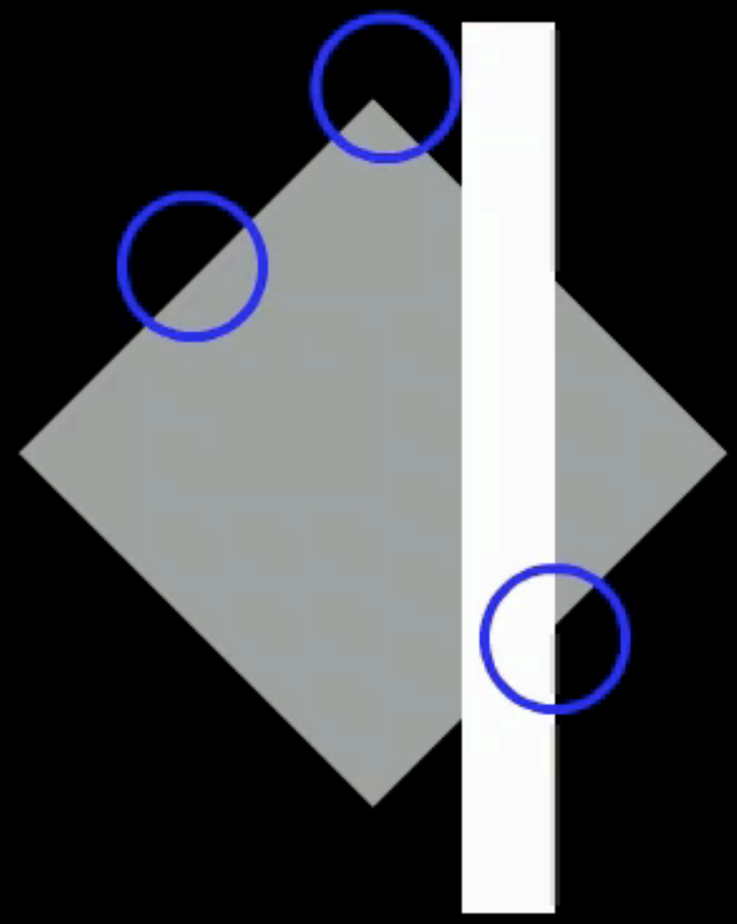
Motion measured within small local receptive fields is often different from actual (global) motion of object

Aperture problem

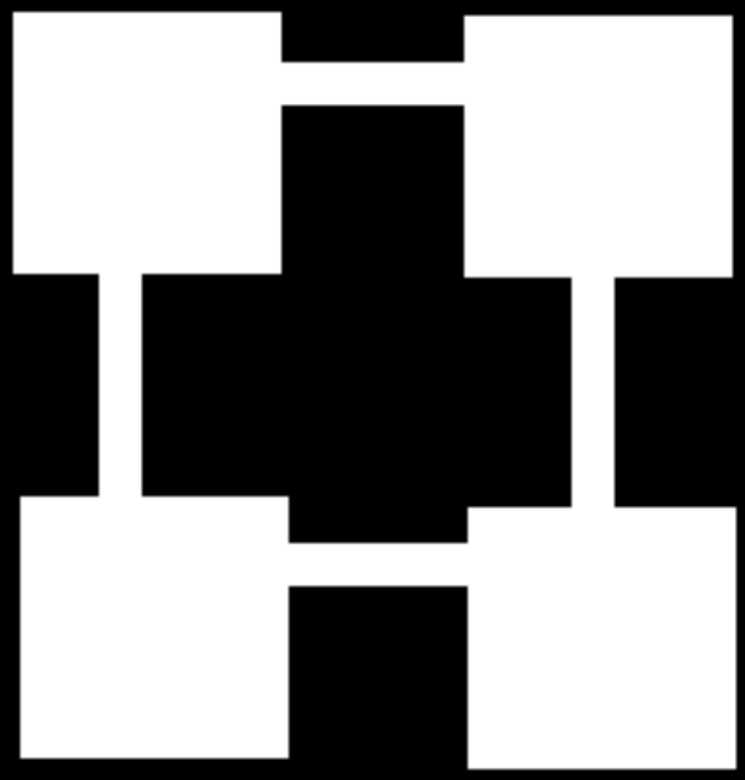
Motion measured within small local receptive fields is often different from actual (global) motion of object

Aperture problem

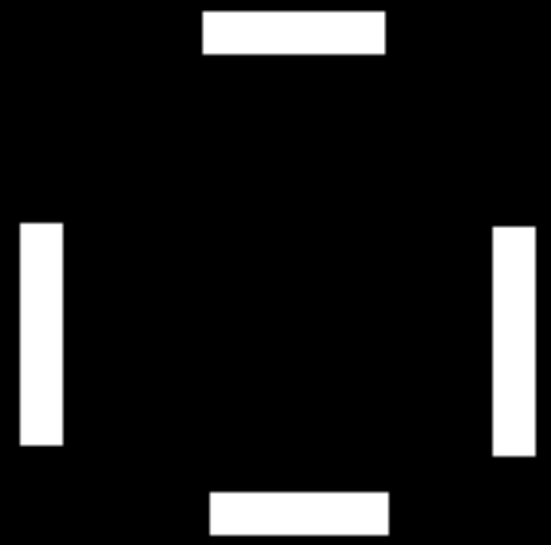
Motion measured within small local receptive fields is often different from actual (global) motion of object



But some parts of object give unambiguous cues to direction



Line endings attributed to overlying squares, lines can group into one object that moves independently of the line endings



Line endings belong to lines. Lines remain separate and motion is constrained by the endpoints to be horizontal or vertical

Outline

1] Conscious perception limited by attention and memory
- Motion-induced blindness
- Inattentional blindness & Change blindness

2] Limited capacity of visual working memory

3] The fate of unseen stimuli
- Influence by subliminal perception
- Invisible stimulus can attract attention

4] Understanding visual scenes
- Gist
- Spatial layout
- How can perceiving scenes be so fast?
- Guided search by global information of a scene
- Ensemble representations
- Memory for scenes
- Neural basis for scene perception

1. Conscious perception limited by attention and memory

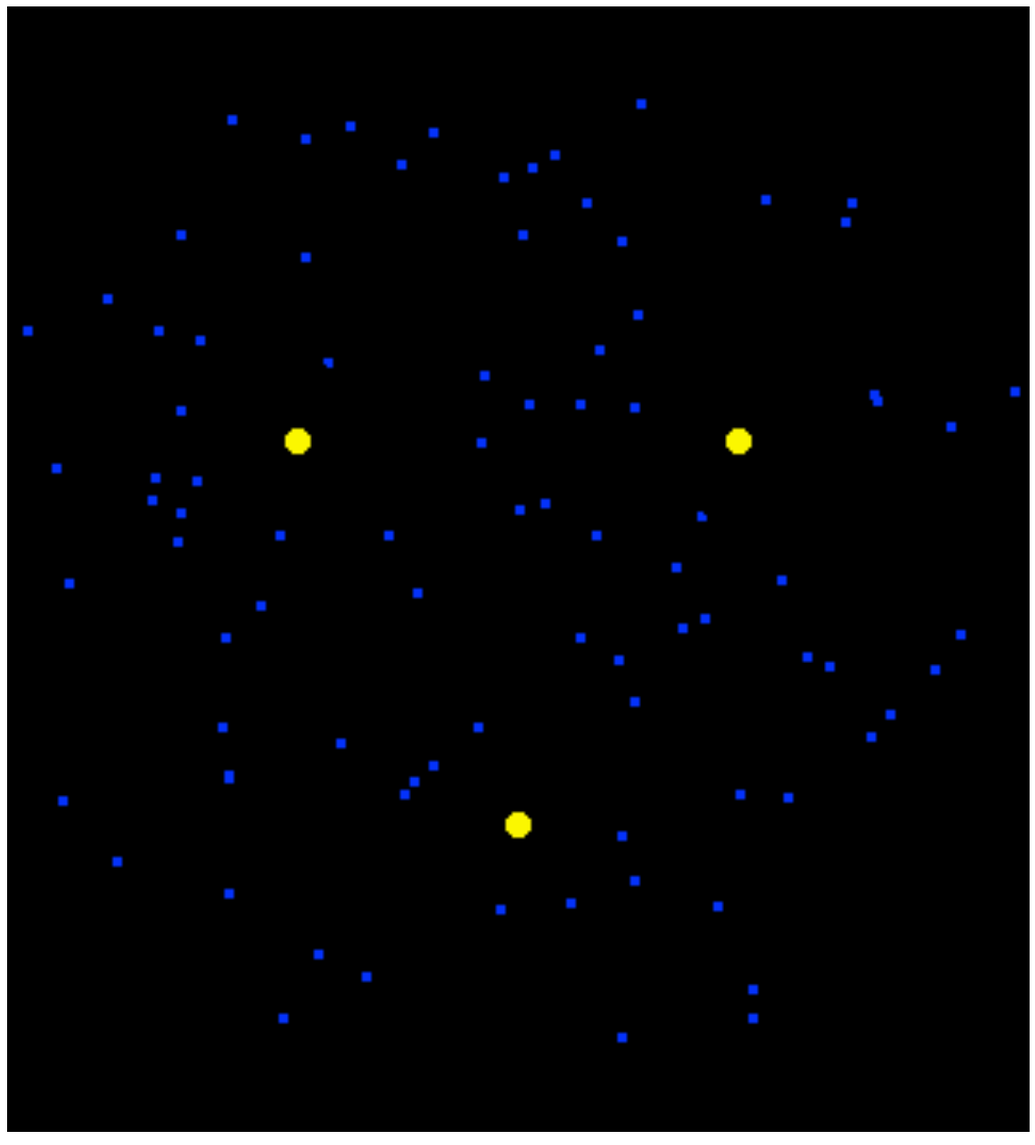
1. Conscious perception limited by attention and memory

Did he guess right? Or is it an illusion?

"We only see things we attend to"

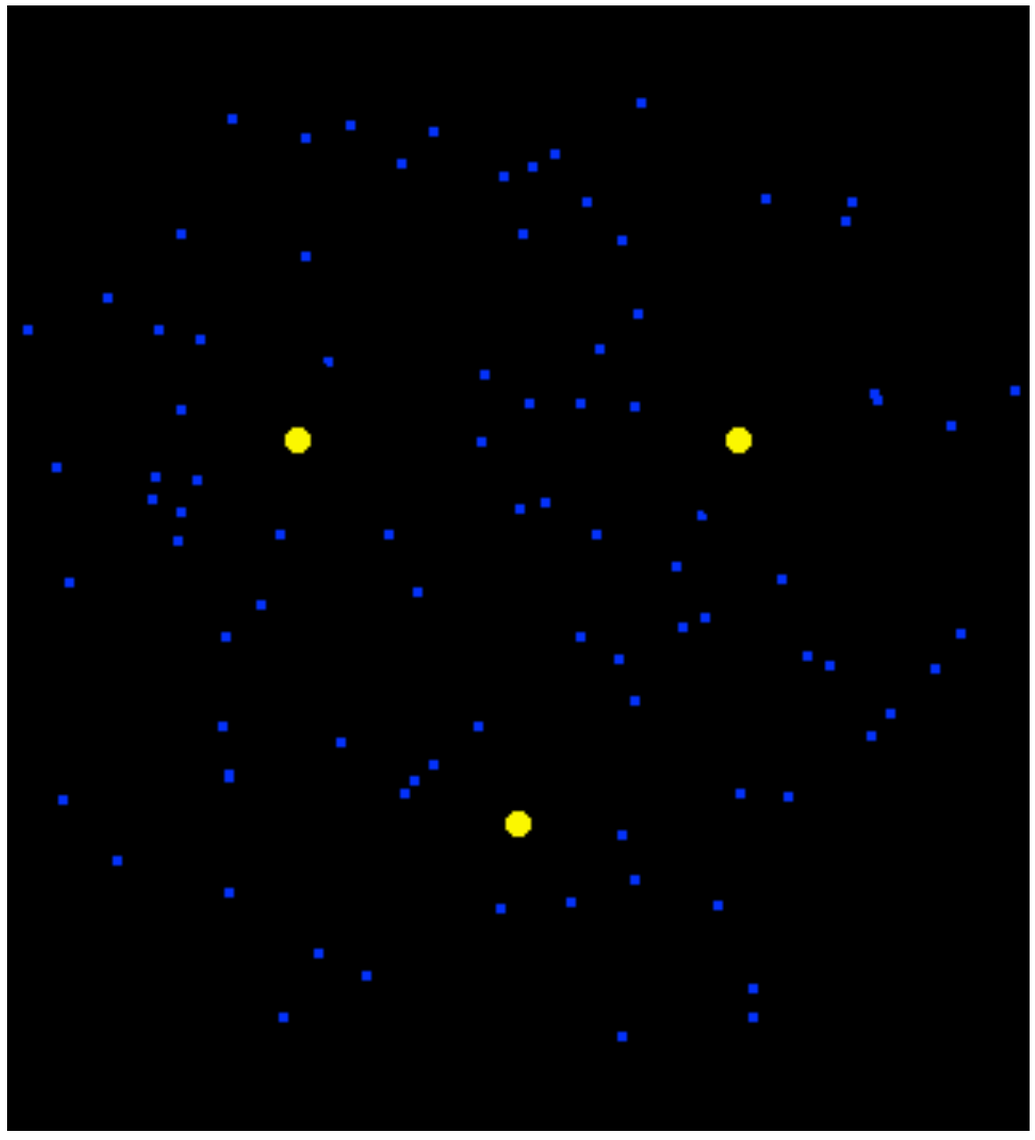
Motion-induced blindness

Stare in the middle of the display. After several seconds, yellow dots will begin to disappear



Motion-induced blindness

Attention for awareness:
Things may fade out of your attention, disappearing from awareness
(e.g., Concentrate on a book, and you are aware of little else)

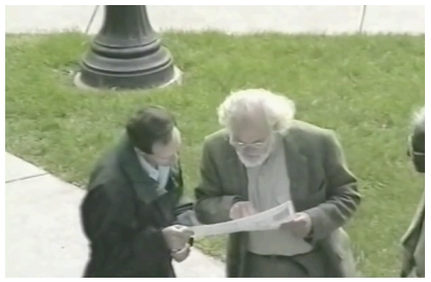


Inattentional blindness

Change blindness

"Perceiving things requires attention.
If attention is elsewhere, things can be missed"

Only attended items enter visual short-term memory



Sensory memory (Iconic memory)

- Only lasts for 200-500 msec
- A kind of photographic memory (no limit)

Attention

Access to awareness

Short-term memory (working memory)

- Lasts over many seconds
- Very limited capacity

Rehearsal

Long-term memory

- Capacity and duration unlimited

2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

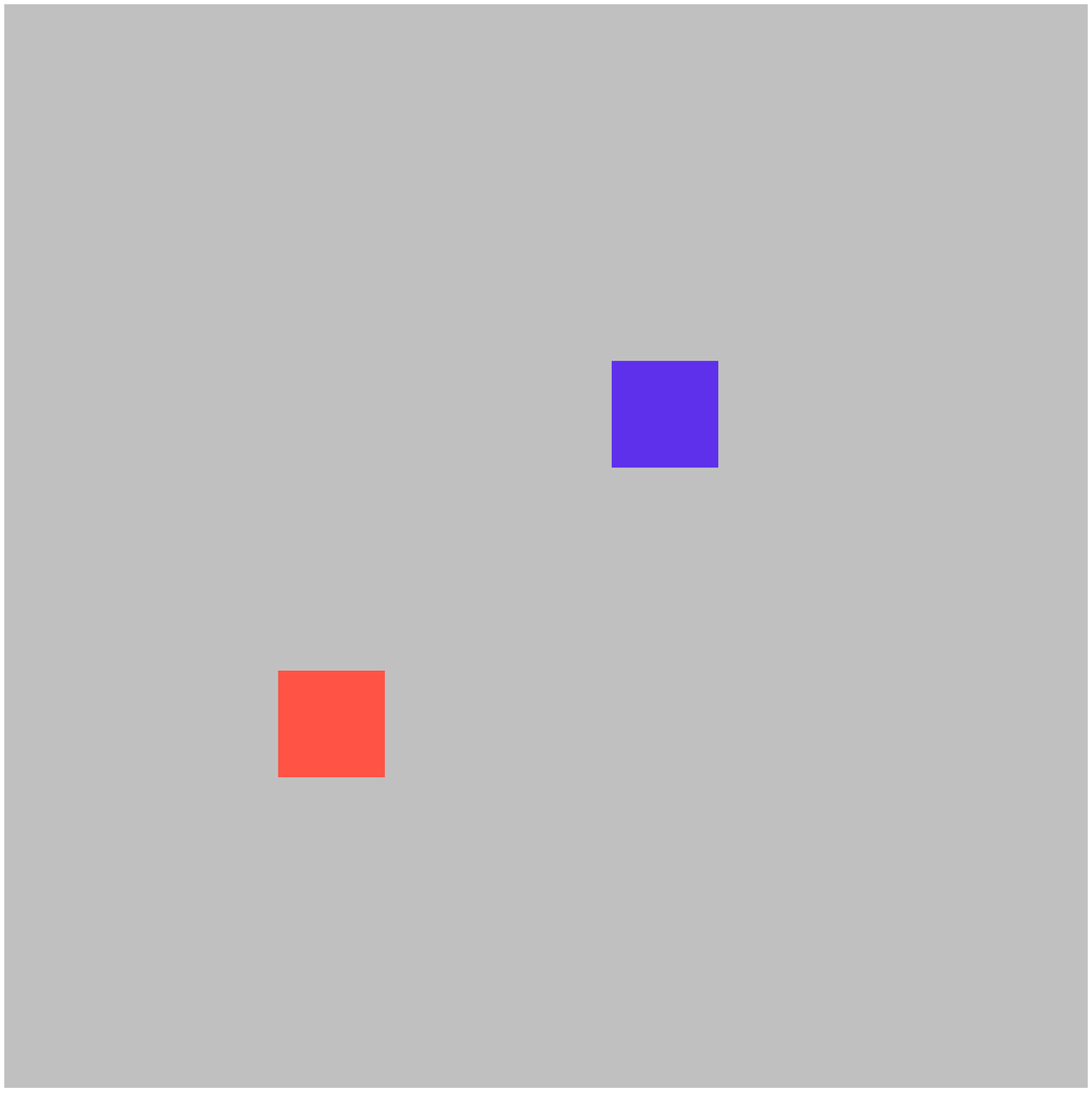
Trial #1

2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #1

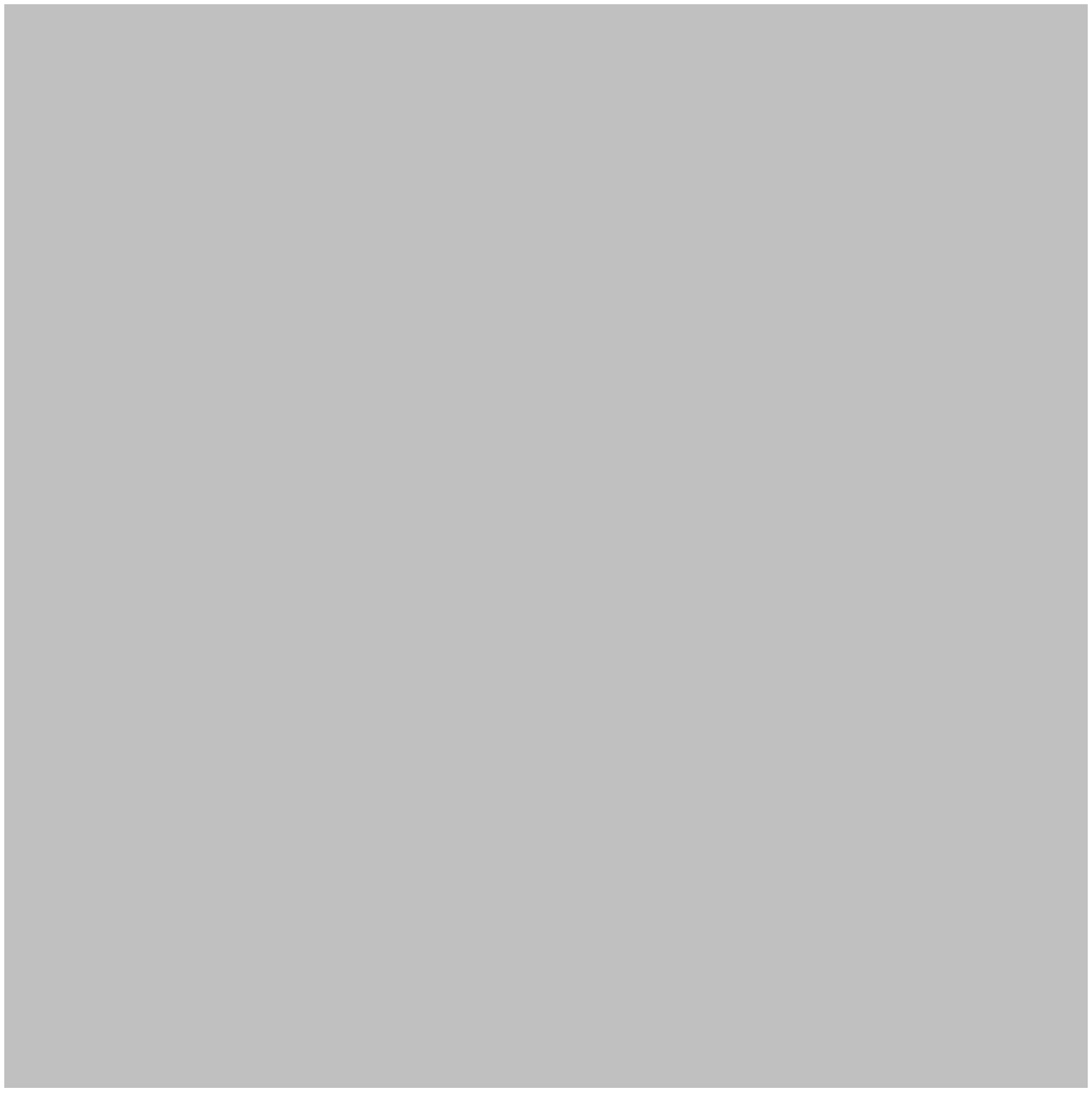


2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #1

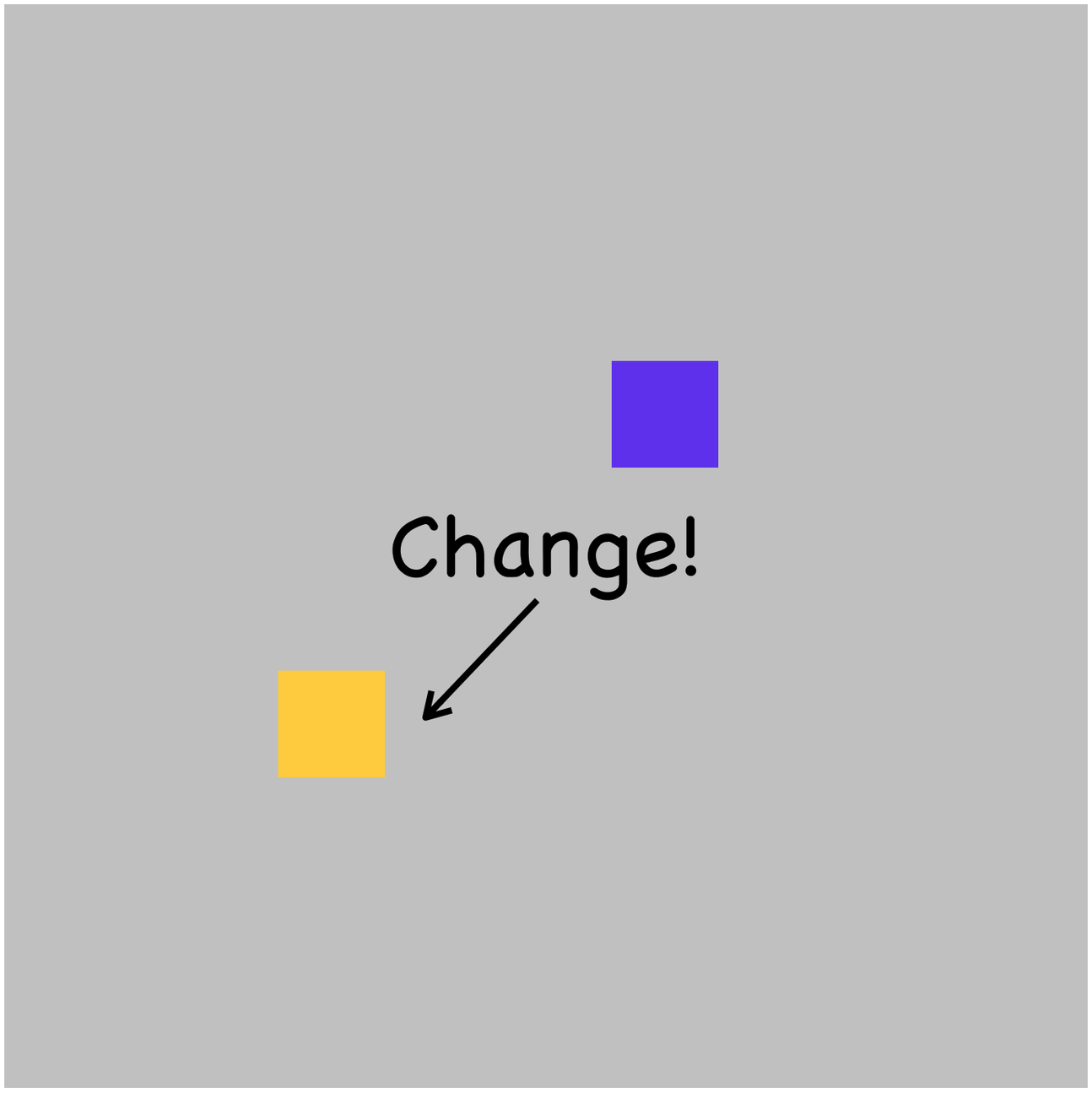


2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #1

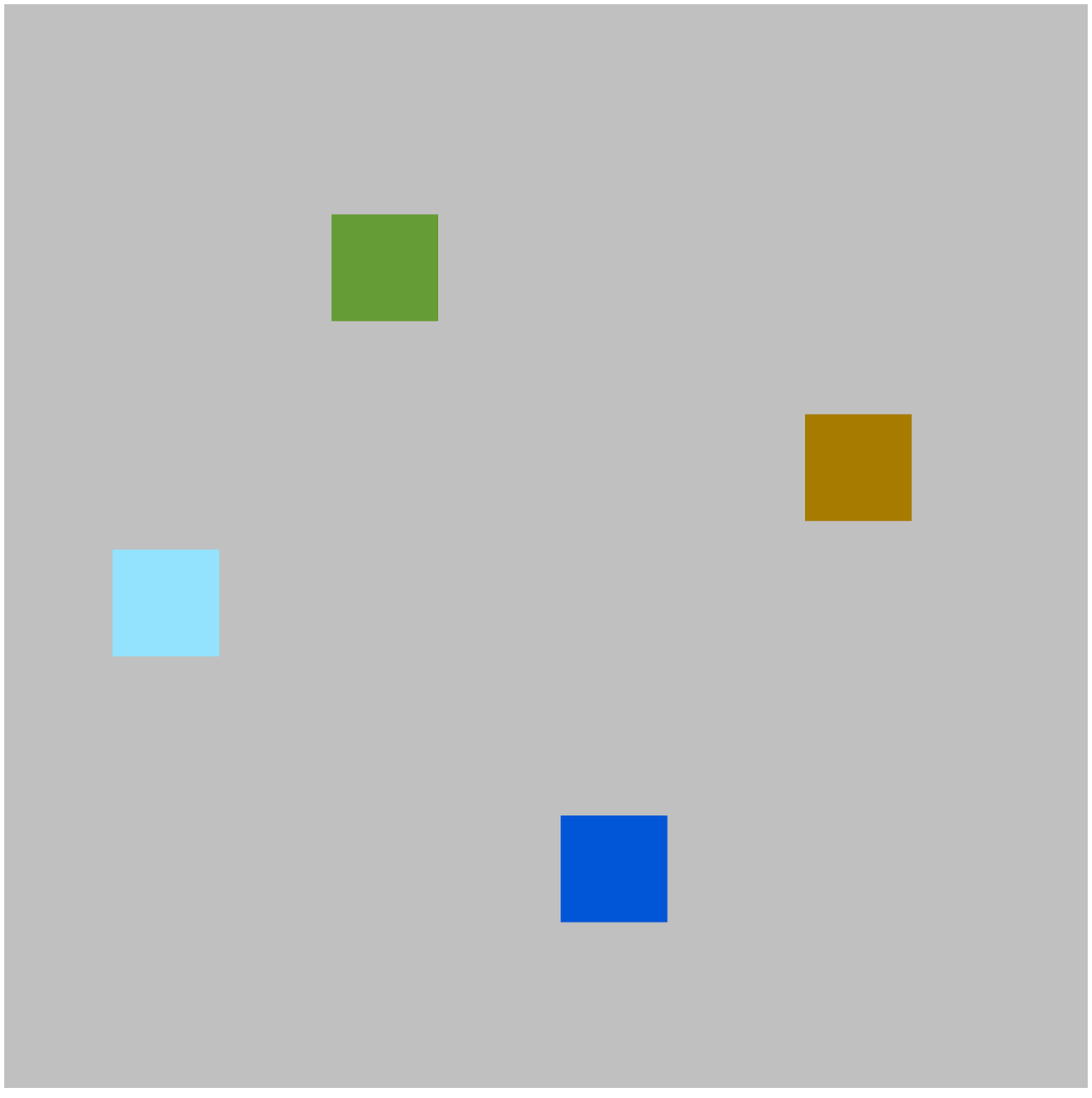


2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #2

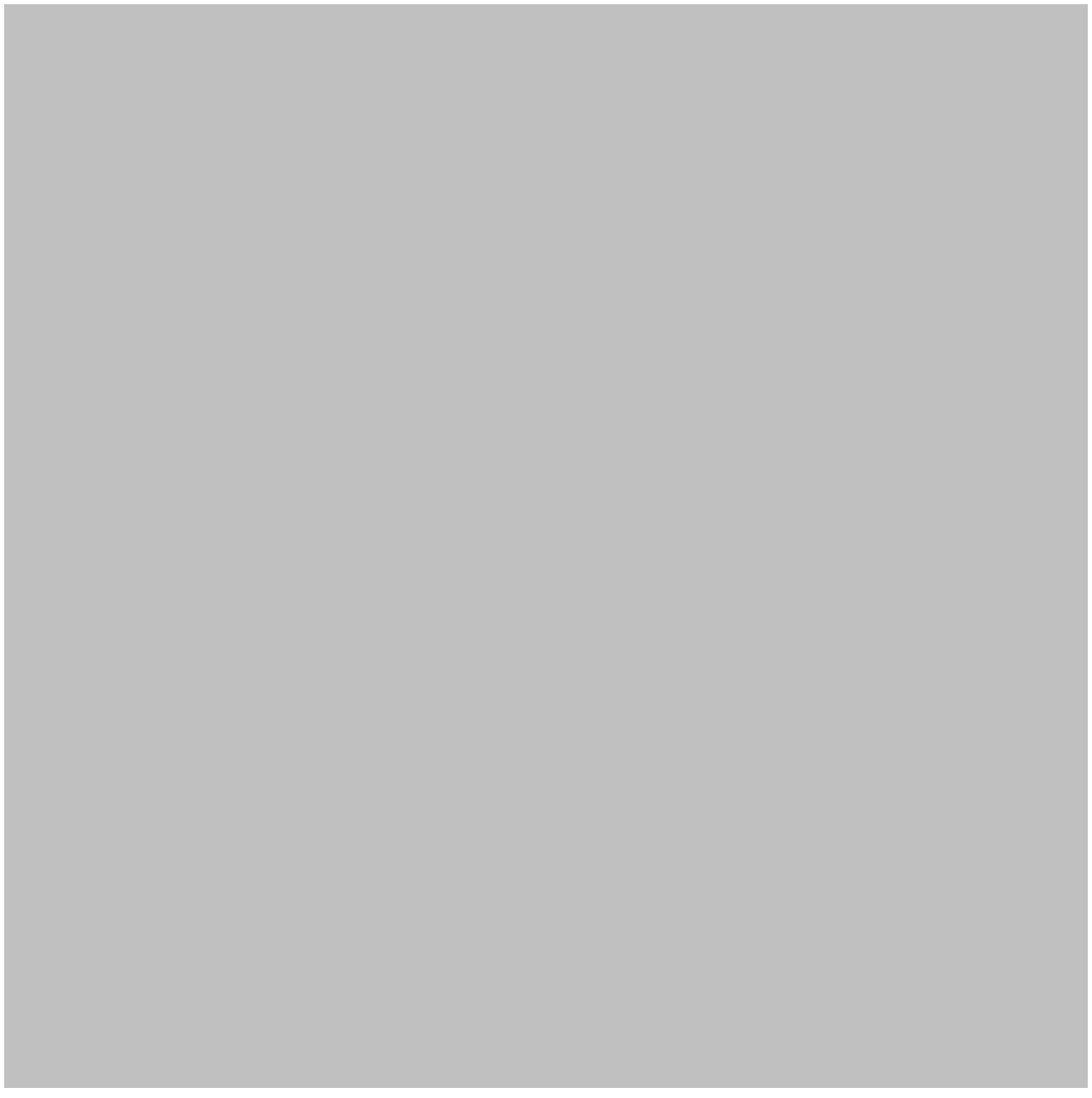


2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #2

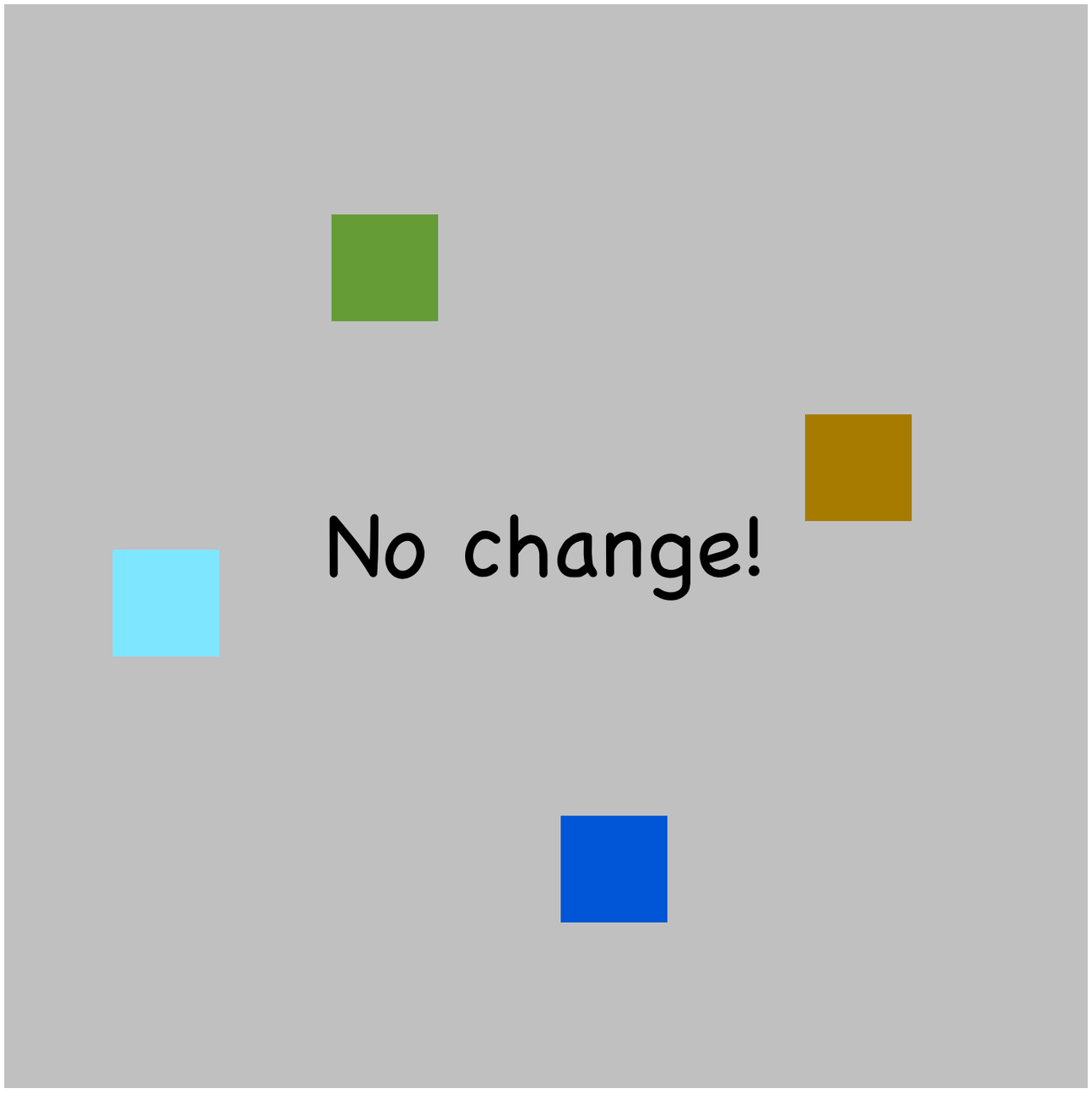


2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #2



2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

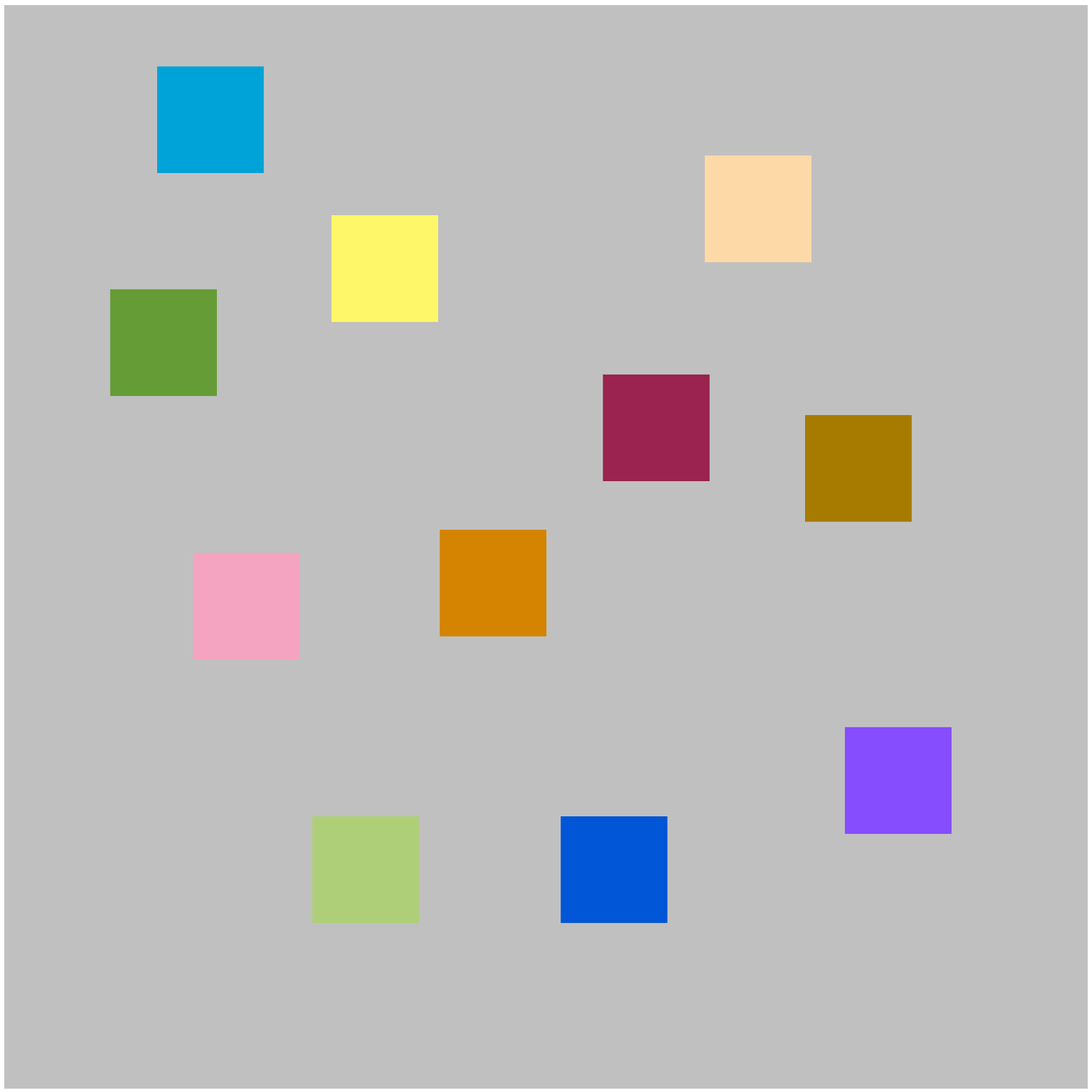
Trial #3

2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #3

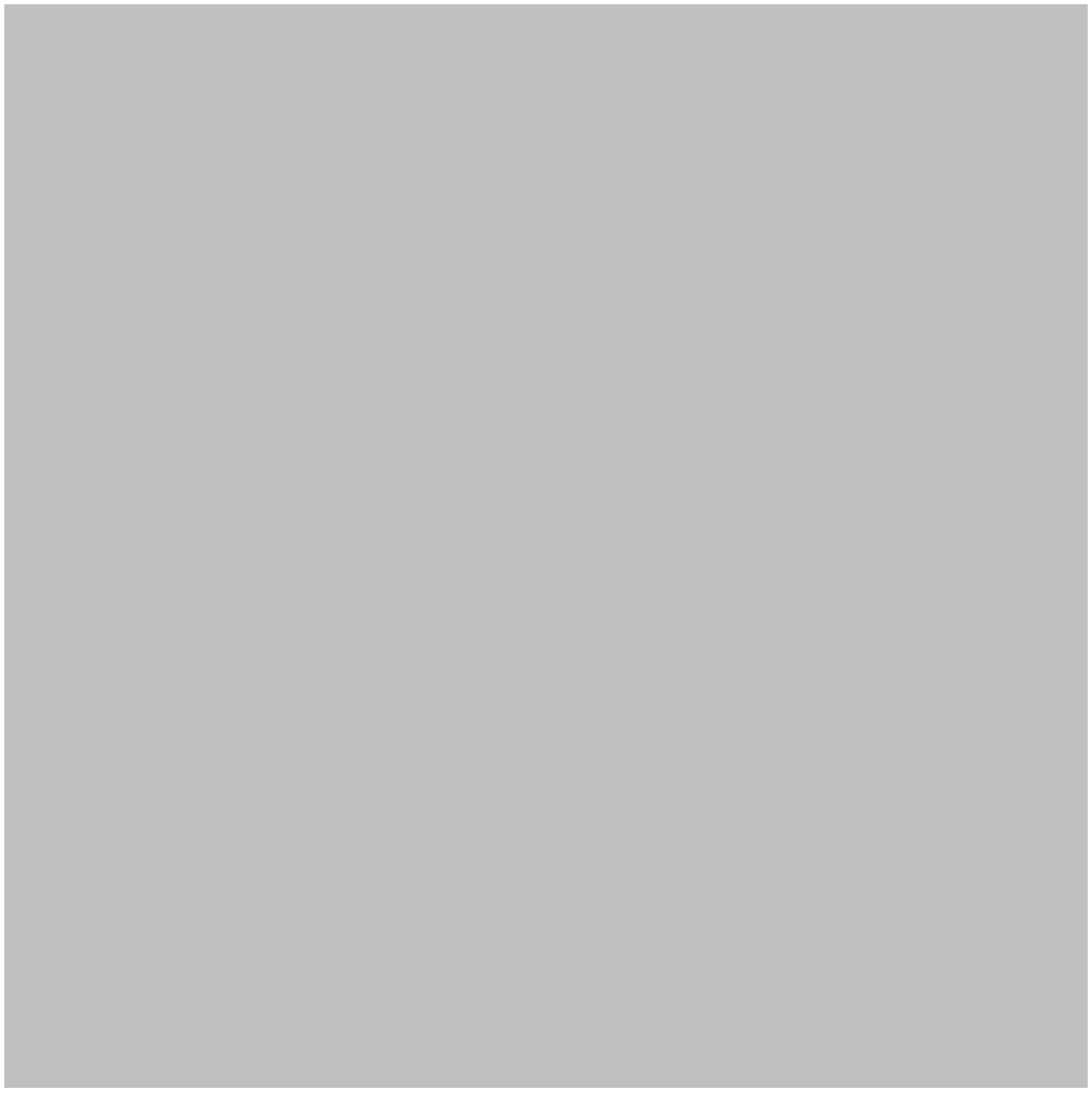


2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #3

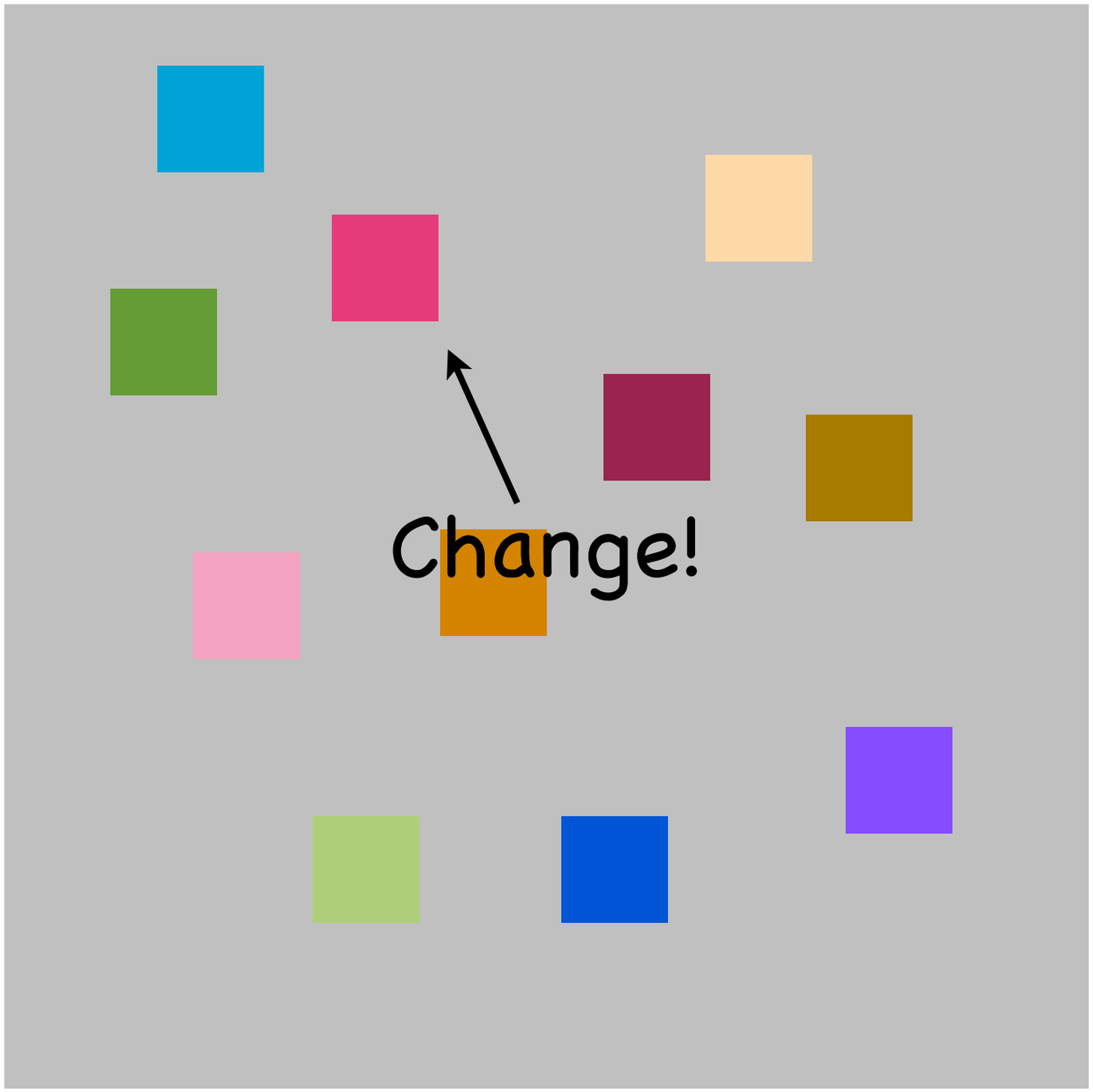


2. Limited capacity of visual short-term memory

Testing your memory capacity

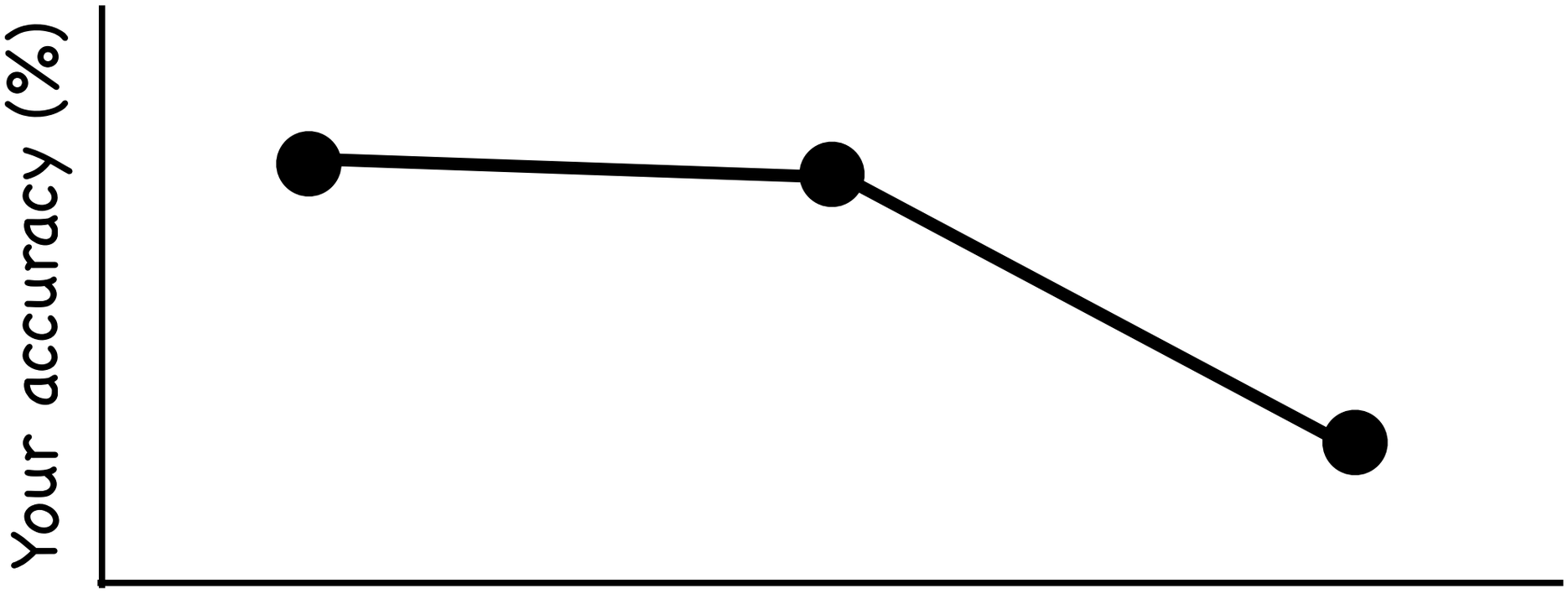
Change detection task: "Change? No change?"

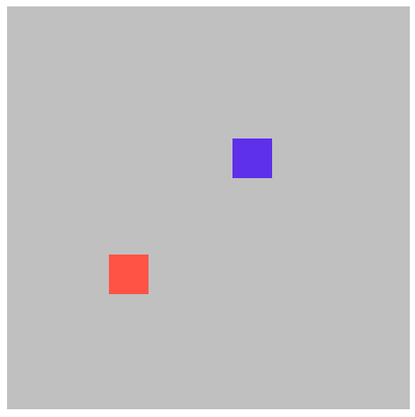
Trial #3

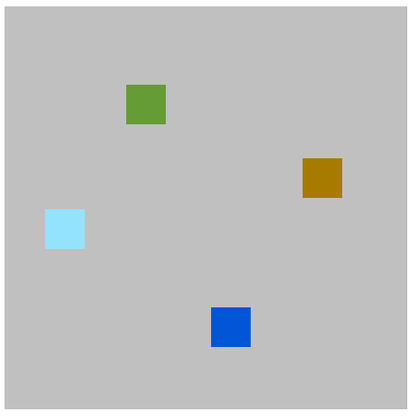


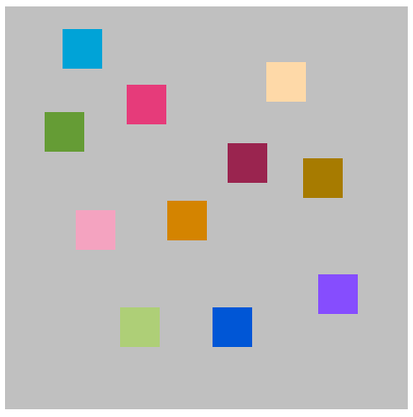
2. Limited capacity of visual short-term memory

You can remember only up to 4 items



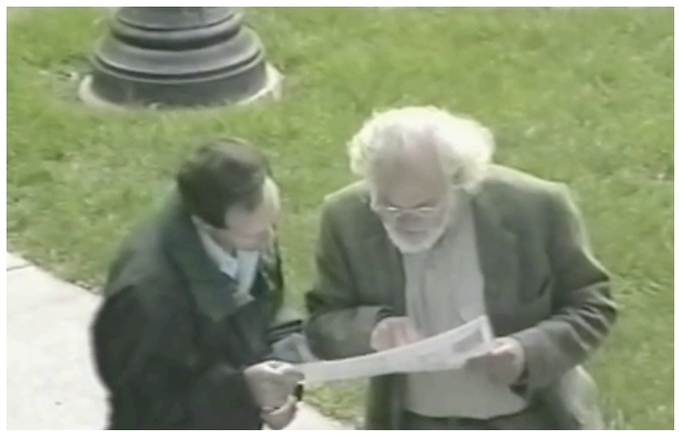


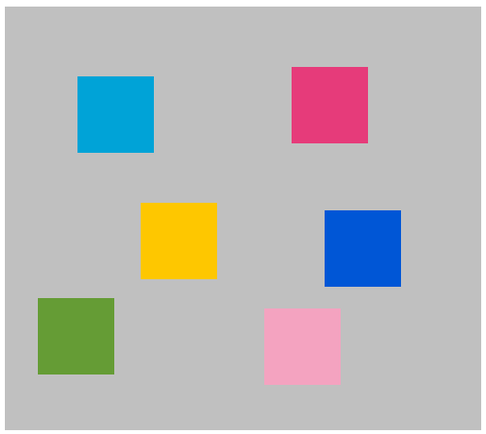




Conscious perception is limited

… because your visual attention and memory are limited!



All these results show that you are only aware of things that you select for your attention and short-term memory

Then, what about unattended things?

- Most of them will be decayed, forgotten, and discarded, so you cannot use them.

However…

3. The fate of unseen stimuli

Stimulus below an individual's threshold for conscious perception is registered and processed without our awareness

Subliminal perception

Example 1

Only appeared for a single frame (too short to consciously pick up)

18.1% increase in sales

57.8% increase in sales

Subliminal perception: Things we don't notice influences us, too

Stimulus below an individual's threshold for conscious perception is registered and processed without our awareness

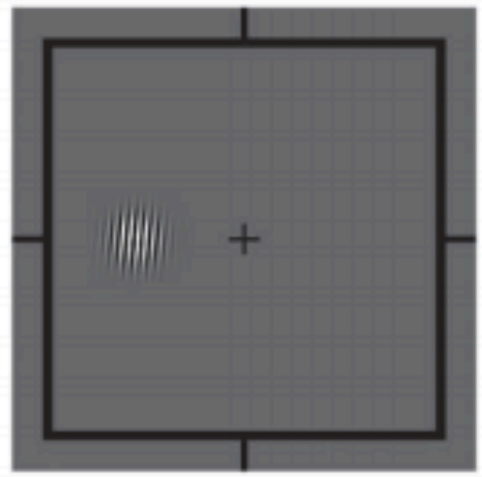
Example 2

Republican ad, 2000 Bush campaign, shows Al Gore then "RATS" appears for one frame (1/30 of a second, but slowed to 1/15th in clip here)

Invisible stimulus can attract attention

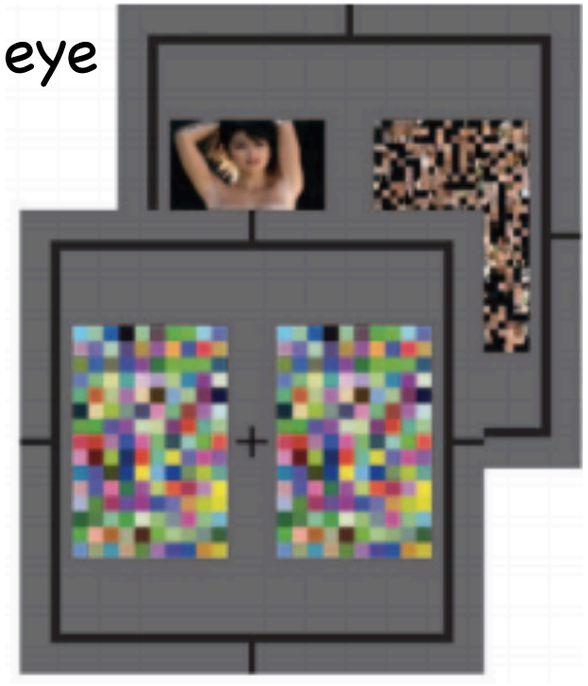
Interocular suppression: an image presented to one eye suppresses another image presented to the other eye

While un… pictures, subjects' … attracted to … (male) …



Right eye

Left eye



Jiang et al., (2006)

Despite your limited conscious perception...

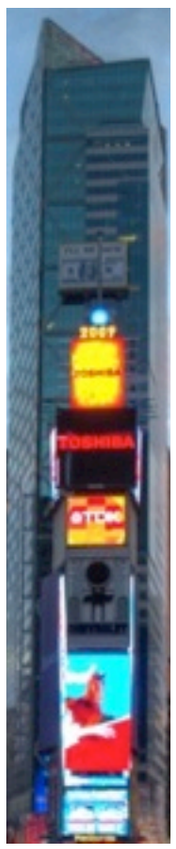
Despite your limited conscious perception...

Obviously, this is NOT something you see!

item 1

item 2

item 3



item 4 ...

Your visual experiences of scenes are much richer

4. Understanding visual scenes

1) Gist of a scene: fast visual scene understanding, even when the image is blurred

Oliva & Torralba, 2006

Understanding visual scenes

1) Gist of a scene: you can recognize a scene within 20 msec

Outdoor/Indoor?
Natural/Man-made?
Open/Closed?
Navigable/Non-navigable?

Potter (1975); Oliva & Torralba (2001)

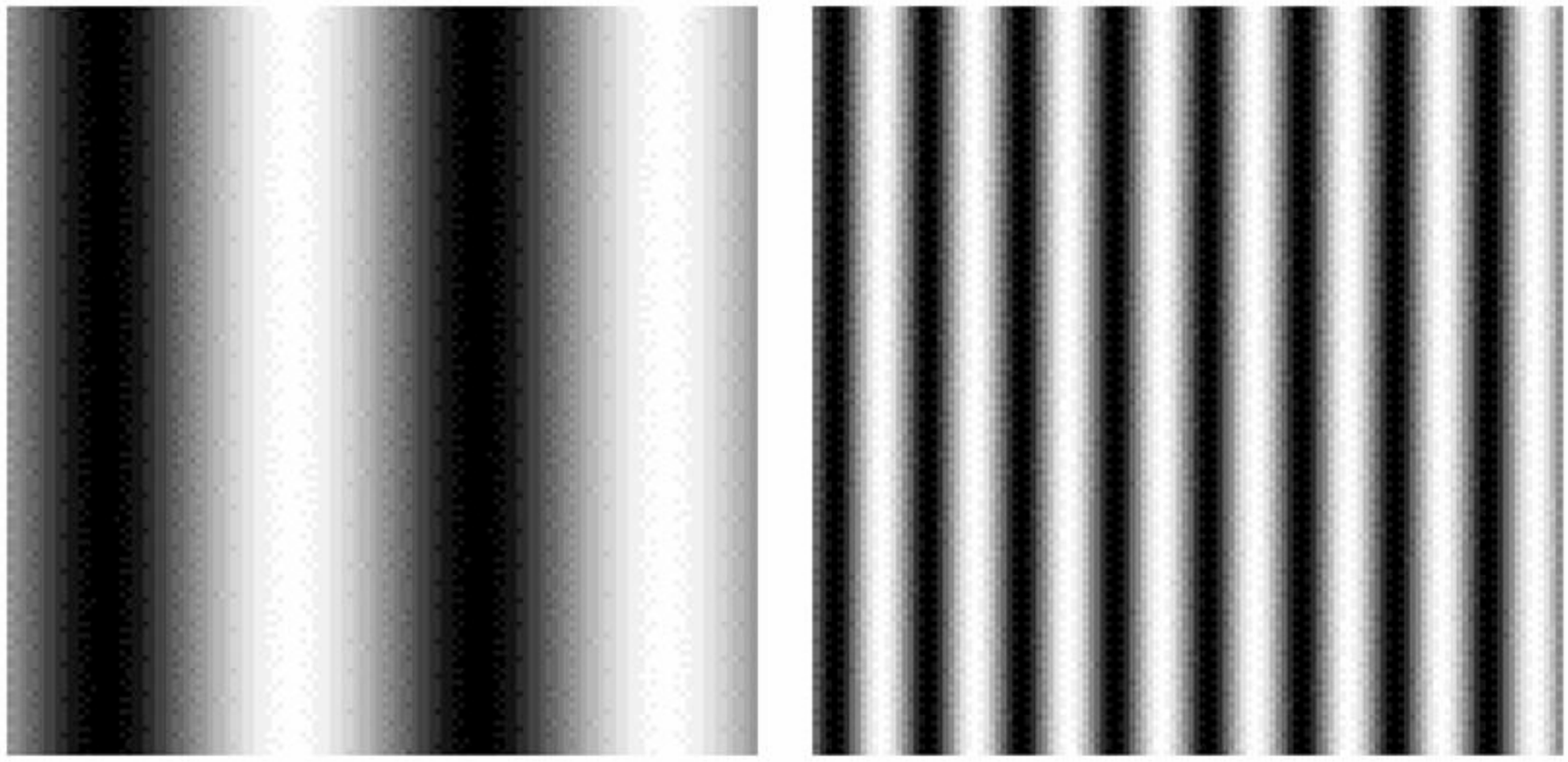
Understanding visual scenes

2) Spatial layout of a scene (for global structure of the scene)

How can this be achieved so fast?

How can perceiving scenes be so fast?

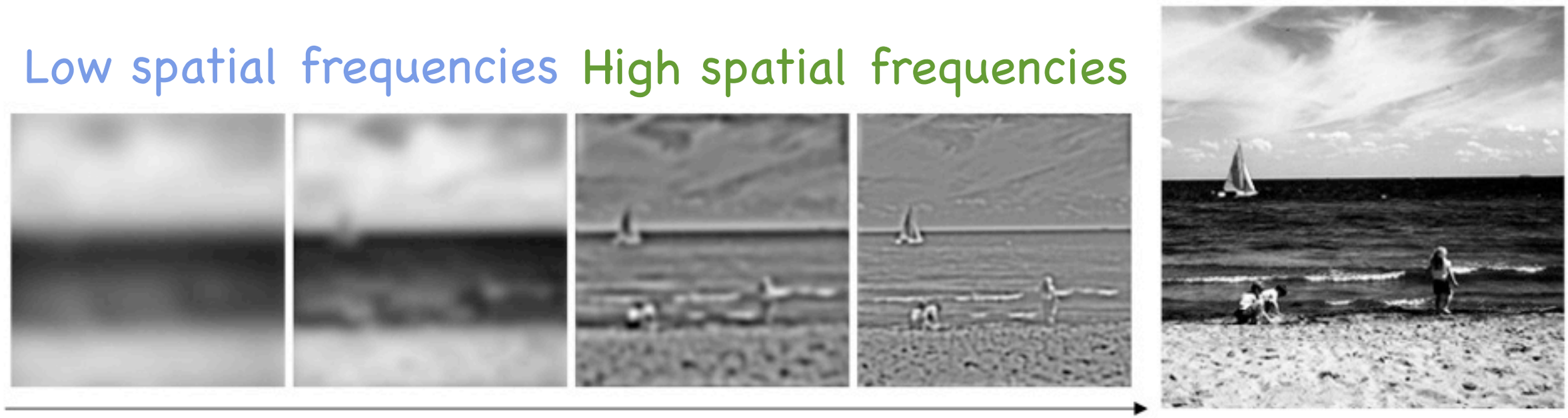
Two different components of a visual scene



Low spatial frequency

High spatial frequency

How can perceiving scenes be so fast?



Global information about a whole scene relies on the low-spatial frequency component. Visual system can quickly analyze this information while we are not aware of it at all.

Guided search by global information of a scene

Gist of a scene (e.g., kitchen)
Spatial layout of a scene

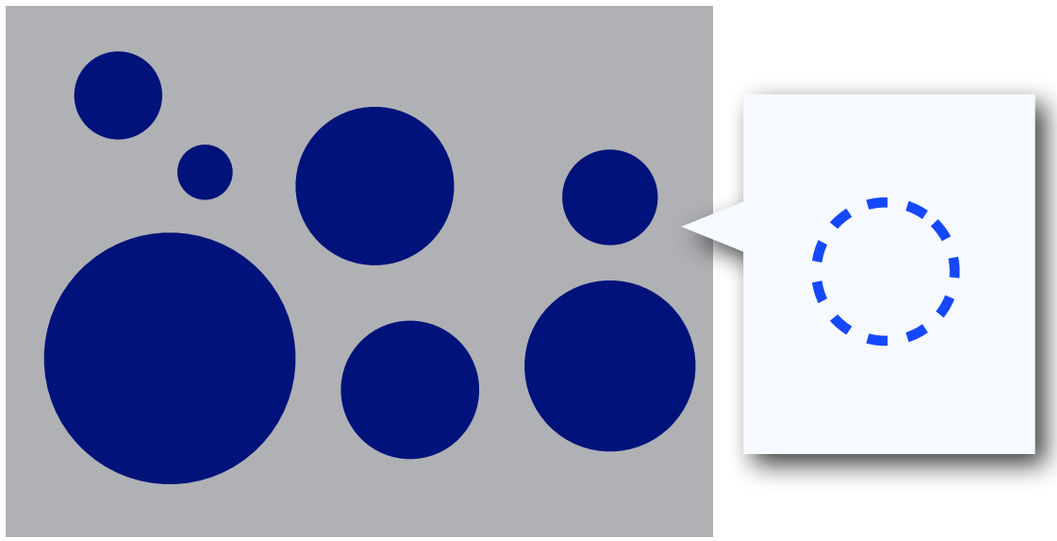
Your eye movement

Wolfe (2011)

Ensemble representations

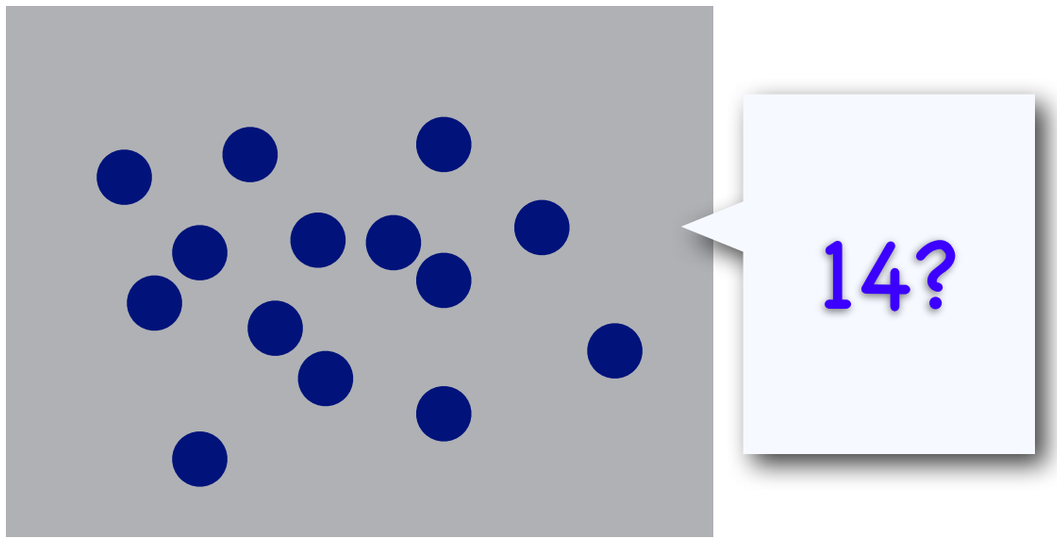
Knowledge about the properties of a group of objects

Mean size



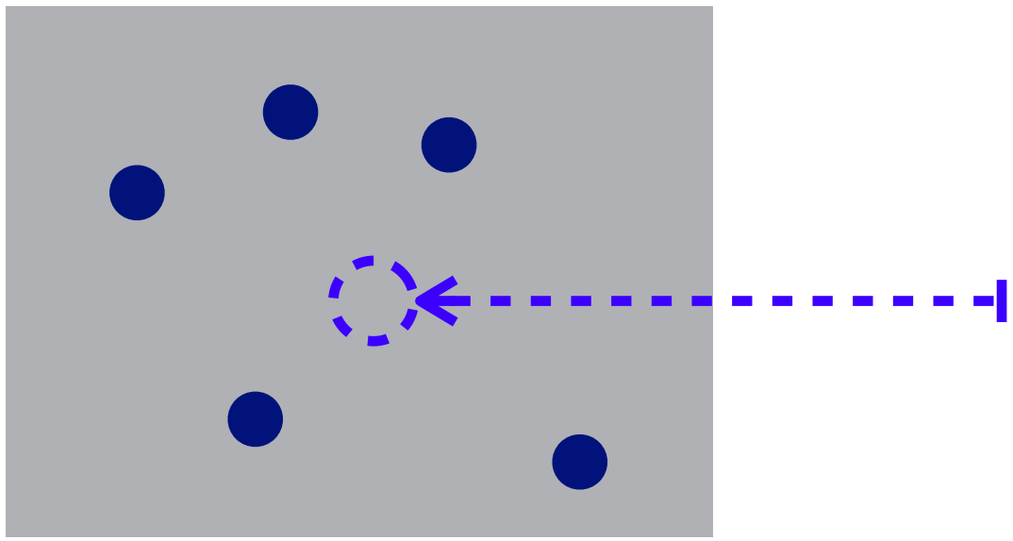
Ariely, 2001; Chong & Treisman, 2003

Approximate number



Halberda, Sires, & Feigenson, 2006

Centroid



Alvarez & Oliva, 2008

Mean emotion

Haberman & Whitney, 2007

Ensemble representations

They are about "groups" of similar objects

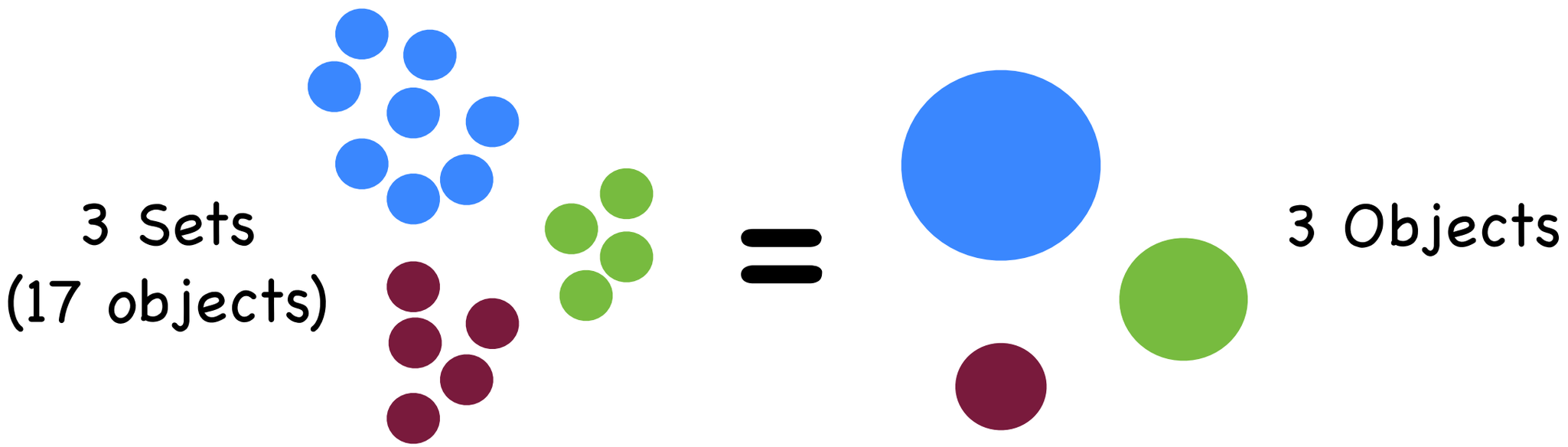
They are useful because the natural scenes often contain many similar objects

Redundancy and regularity

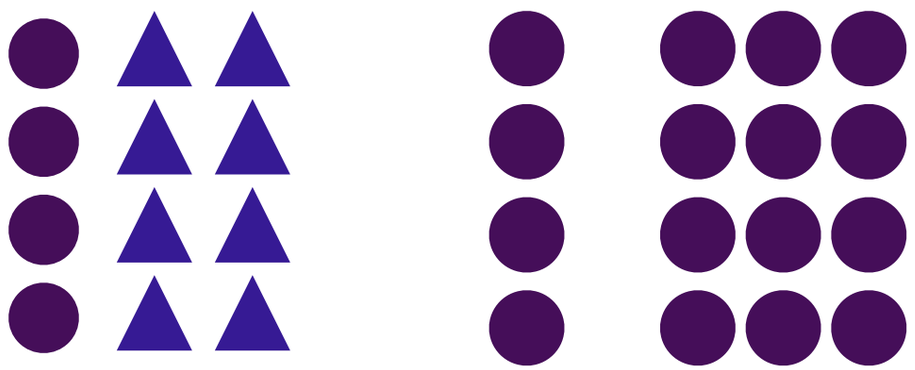


Ensemble representations are efficient and economical

1) Given the limited capacity of attention and memory
(EX. Chunking: F-B-I-C-I-A-N-S-A vs. :)

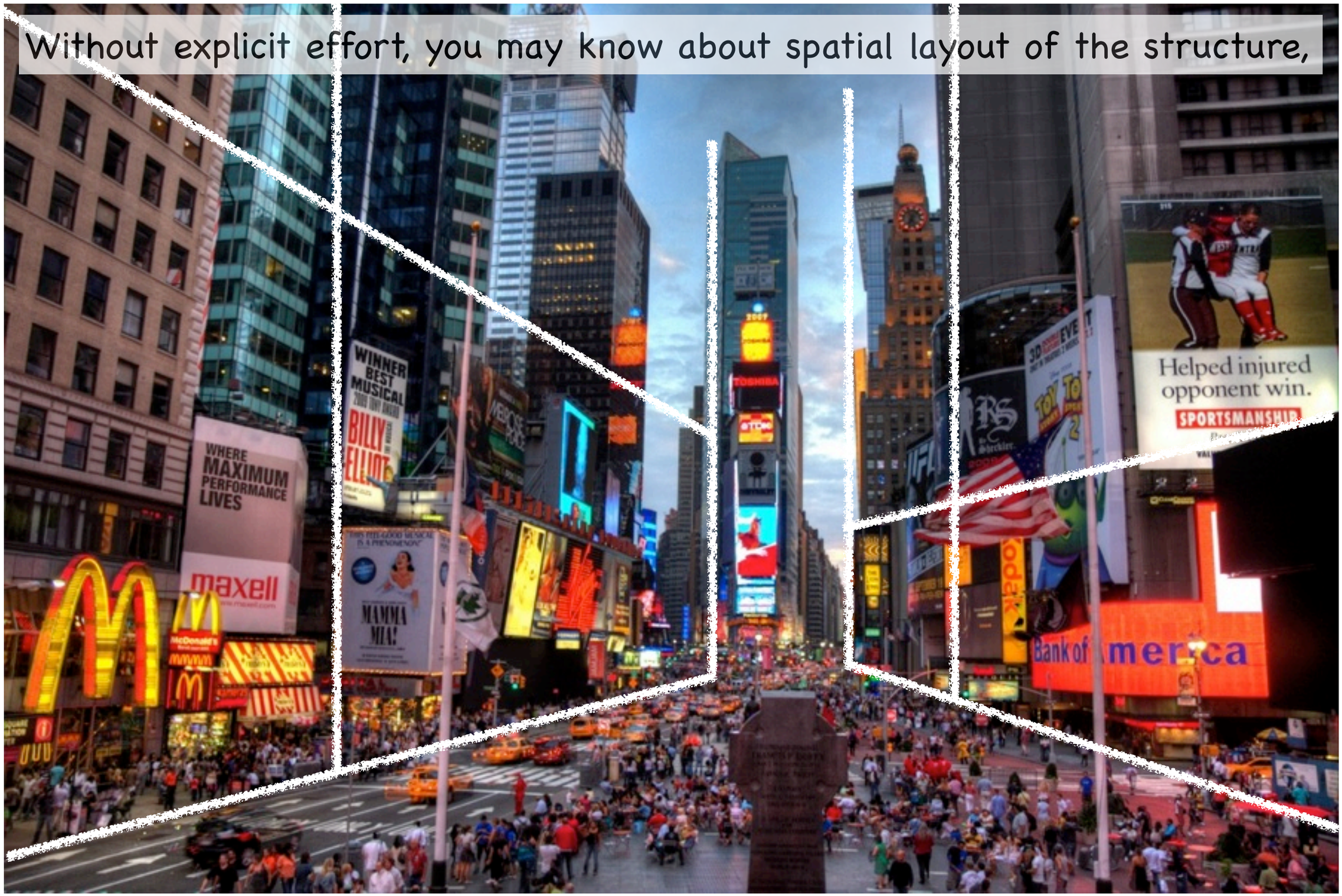


2) Given the remarkable ability to group things together



You use ensemble representations everyday

Global information makes your visual experiences of a scene rich and vivid



Global information makes your visual experiences of a scene rich and vivid

Without explicit effort, you may know about spatial layout of the structure,

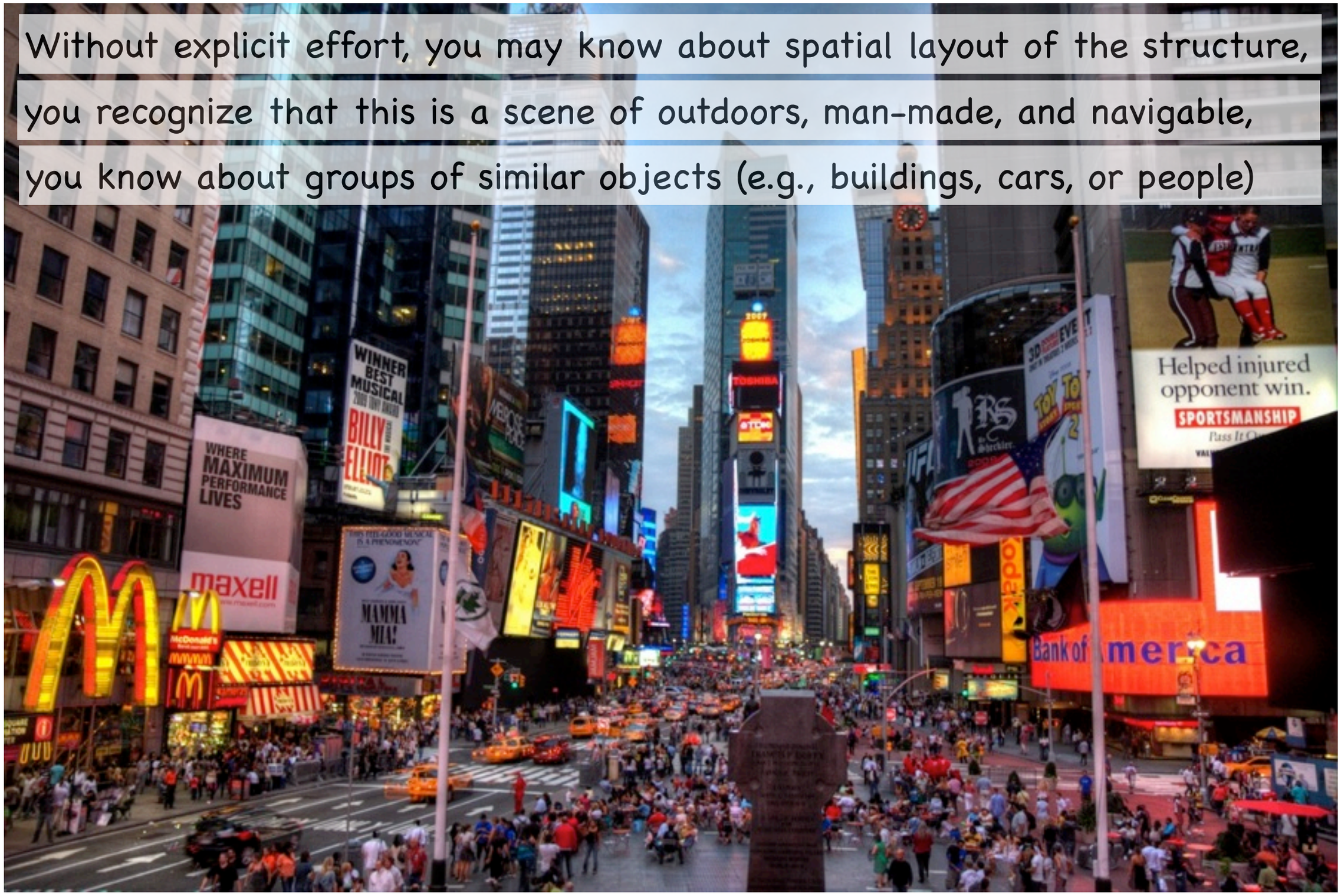
you recognize that this is a scene of outdoors, man-made, and navigable,

Global information makes your visual experiences of a scene rich and vivid

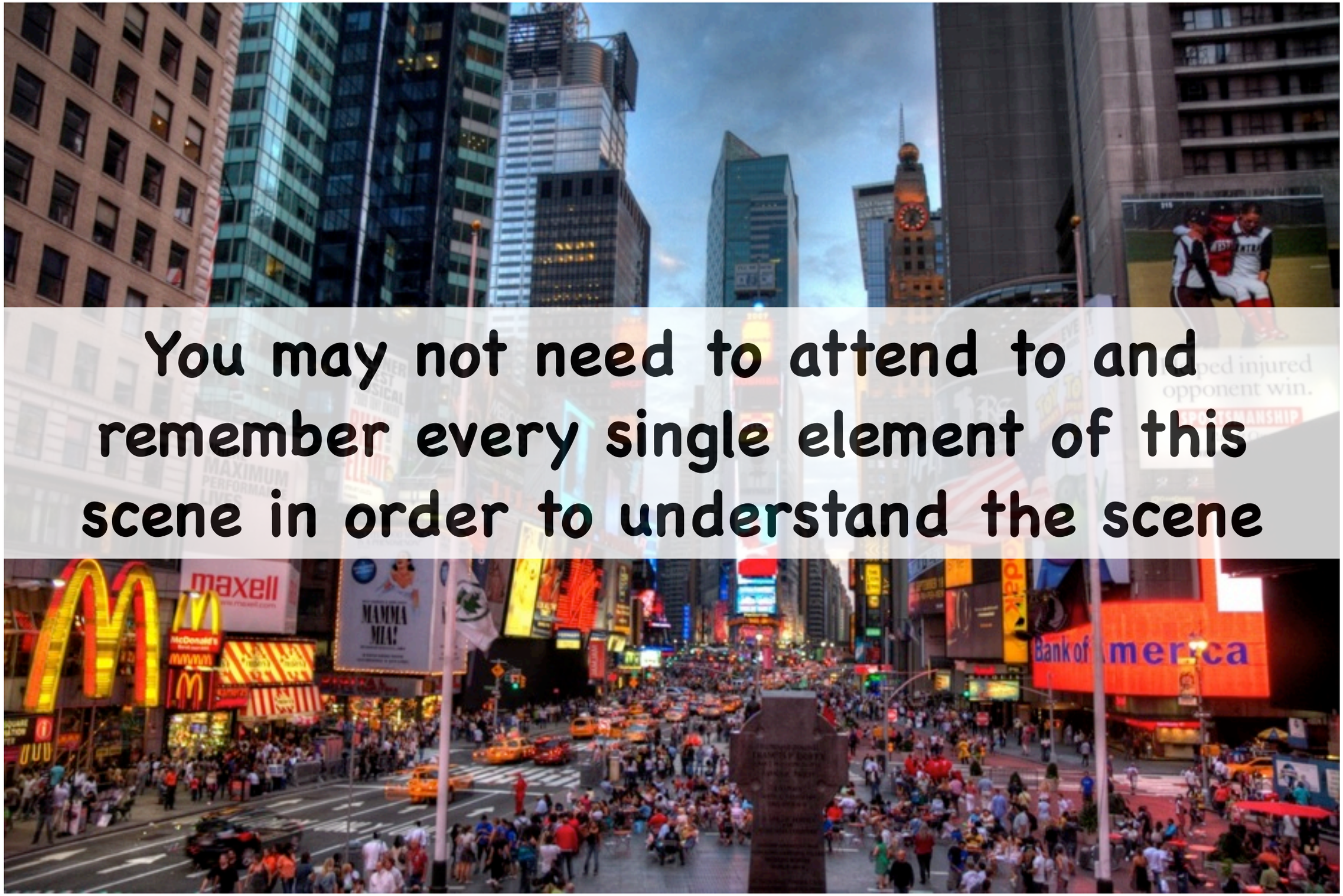
Without explicit effort, you may know about spatial layout of the structure,

you recognize that this is a scene of outdoors, man-made, and navigable,

you know about groups of similar objects (e.g., buildings, cars, or people)

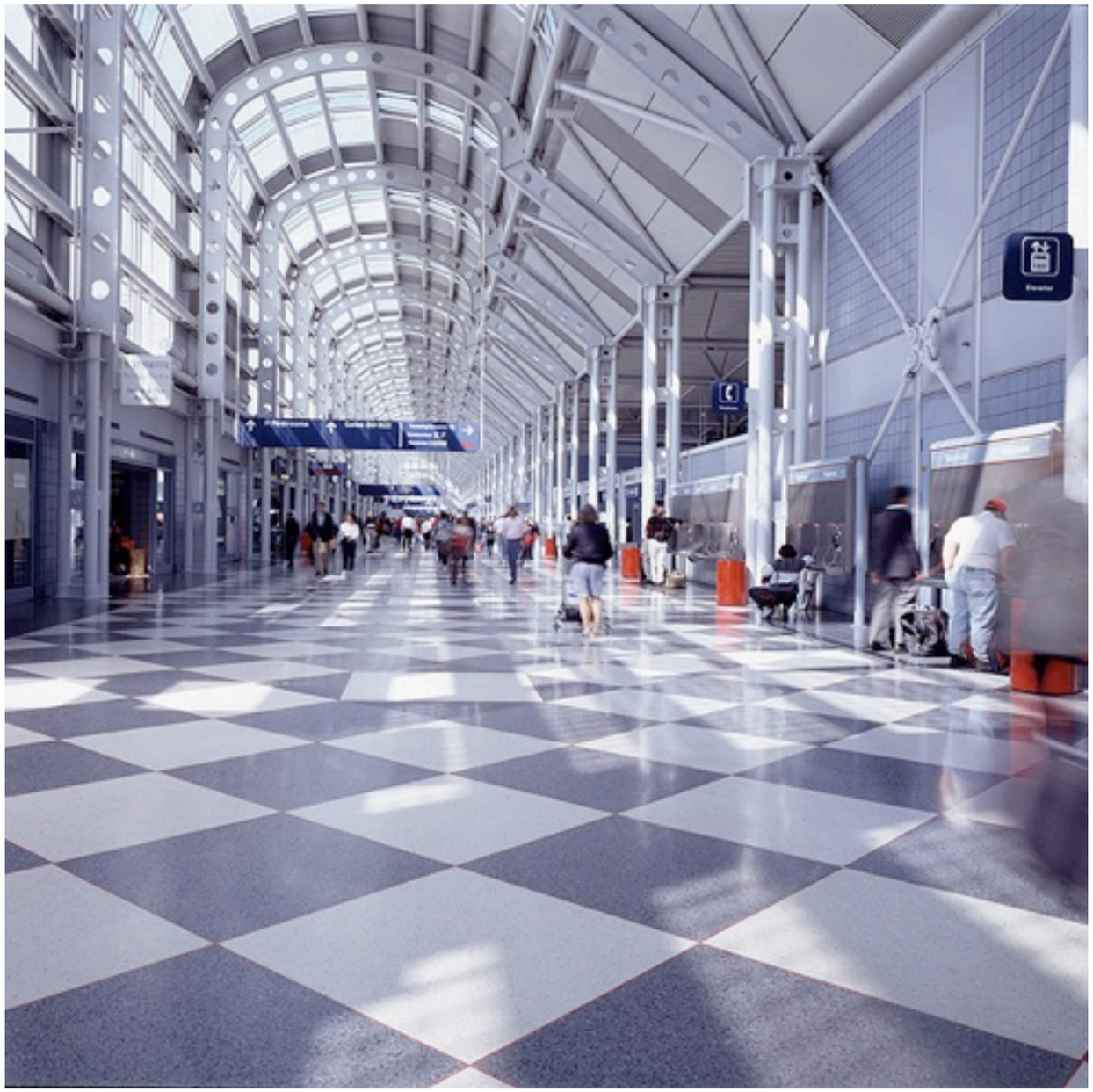


Global information help you to deal with complex visual scenes efficiently



Memory for scenes

The last demo for today!
Simply look at pictures for 2 sec each



Memory for scenes is amazingly good

Participants were shown 10000(!?!!) images for 5 seconds each.

They were about 90% correct about the images when quizzed 2 days later!!

Can you spot one new picture?

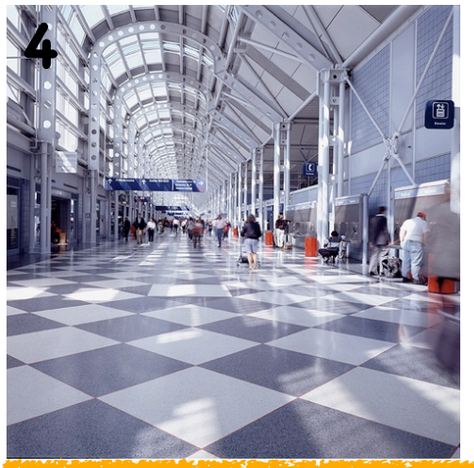
Standing (1973)

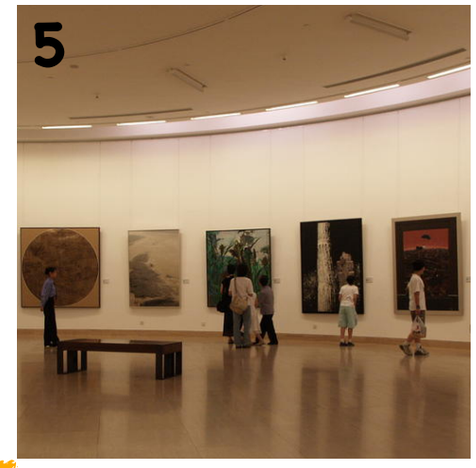
Memory for scenes is amazingly good

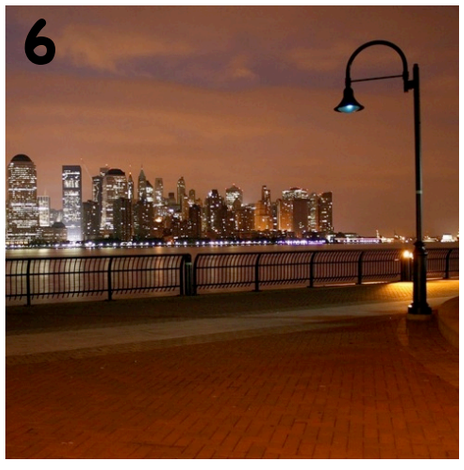
-Because you can understand visual scenes fast and efficiently

-Because you already have so much knowledge about scenes in your long-term memory

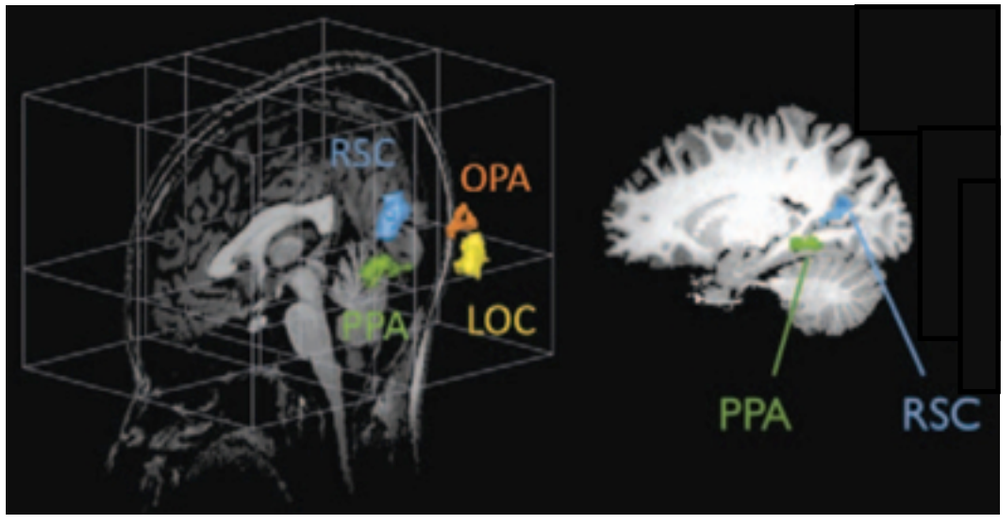
Can you spot one new picture?







Neural basis for scene perception



Parahippocampal place area (PPA)

Retrosplenial complex (RSC)

Complimentary functions of the PPA and RSC

- PPA treats each view of panoramic scene as different images (Viewpoint-specific representation)
- RSC treats different views of panorama as the same stimulus

Together they enable both specific and integrative representations of scenes across several viewpoints

Summary

1] Conscious perception limited by attention and memory

- Motion-induced blindness
- Inattentional blindness & Change blindness
- Limited memory capacity (up to 4 items)

2] Effect by unseen stimulus

- Subliminal perception
- Attention attracted by a suppressed image

3] Global processing for scene perception

- Fast, non-selective
- Gist, Spatial layout, Ensemble representations
- Remarkable memory for scenes
- Neural basis for scene perception: PPA & RSC (complementary & integrative)

One-minute quiz

Next week...
Nov 6 Lecture 18: Attention and awareness (SP 7: 187-206)