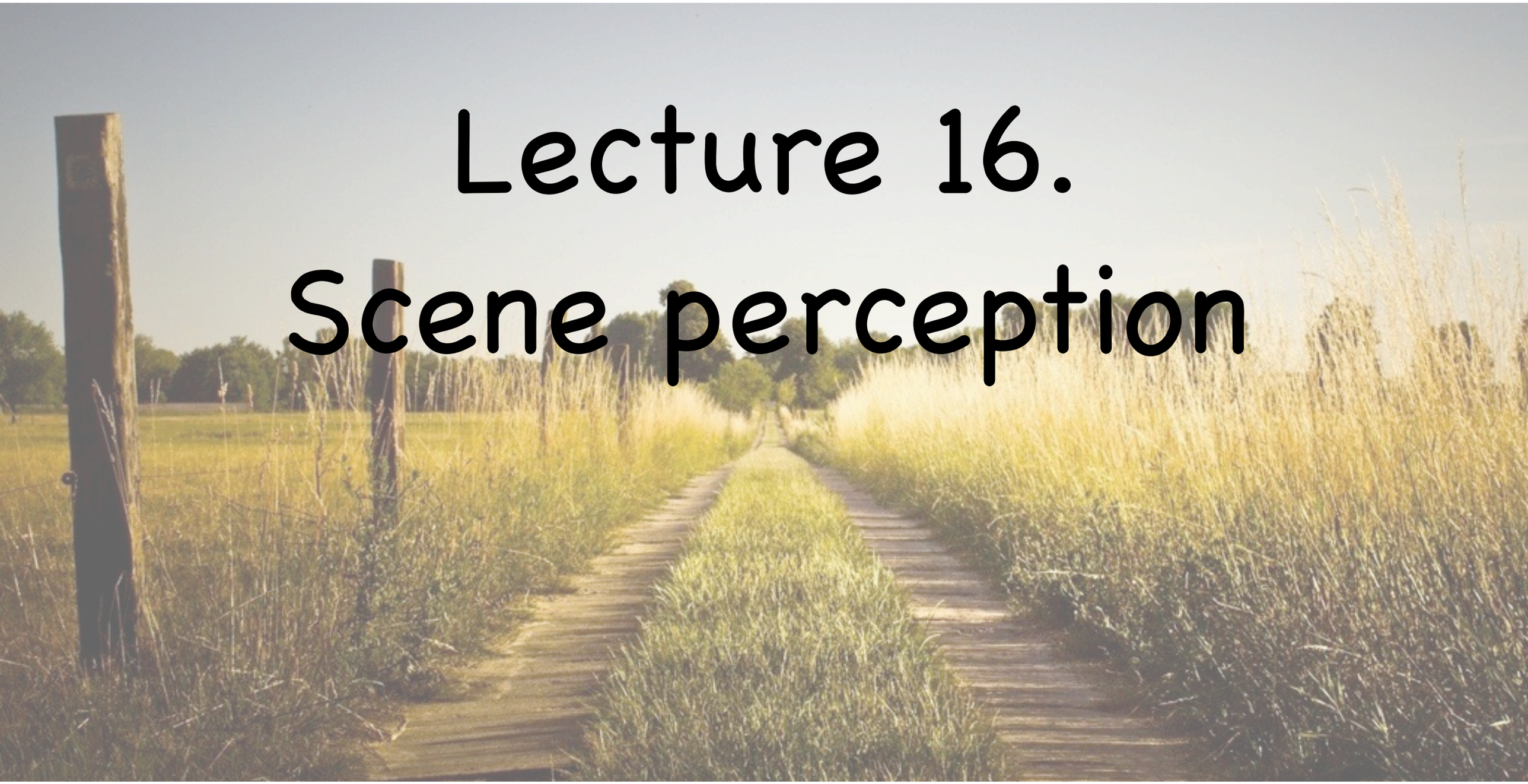

Lecture 16.

Scene perception

Outline

Outline

1] Conscious perception limited by attention and memory

- Motion-induced blindness
- Change blindness

Outline

1] Conscious perception limited by attention and memory

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2] Limited capacity of visual working memory

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- Influence by subliminal perception
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- Gist
- Spatial layout
- How can perceiving scenes be so fast?
- Guided search by global information of a scene
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- Gist
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- Boundary extension
- Neural basis for scene perception

1. Conscious perception limited by attention and memory

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Did he guess right? Or is it an illusion?

1. Conscious perception limited by attention and memory

Did he guess right? Or is it an illusion?

Before

After

1. Conscious perception limited by attention and memory

Did he guess right? Or is it an illusion?

"We only see things we attend to"

Before

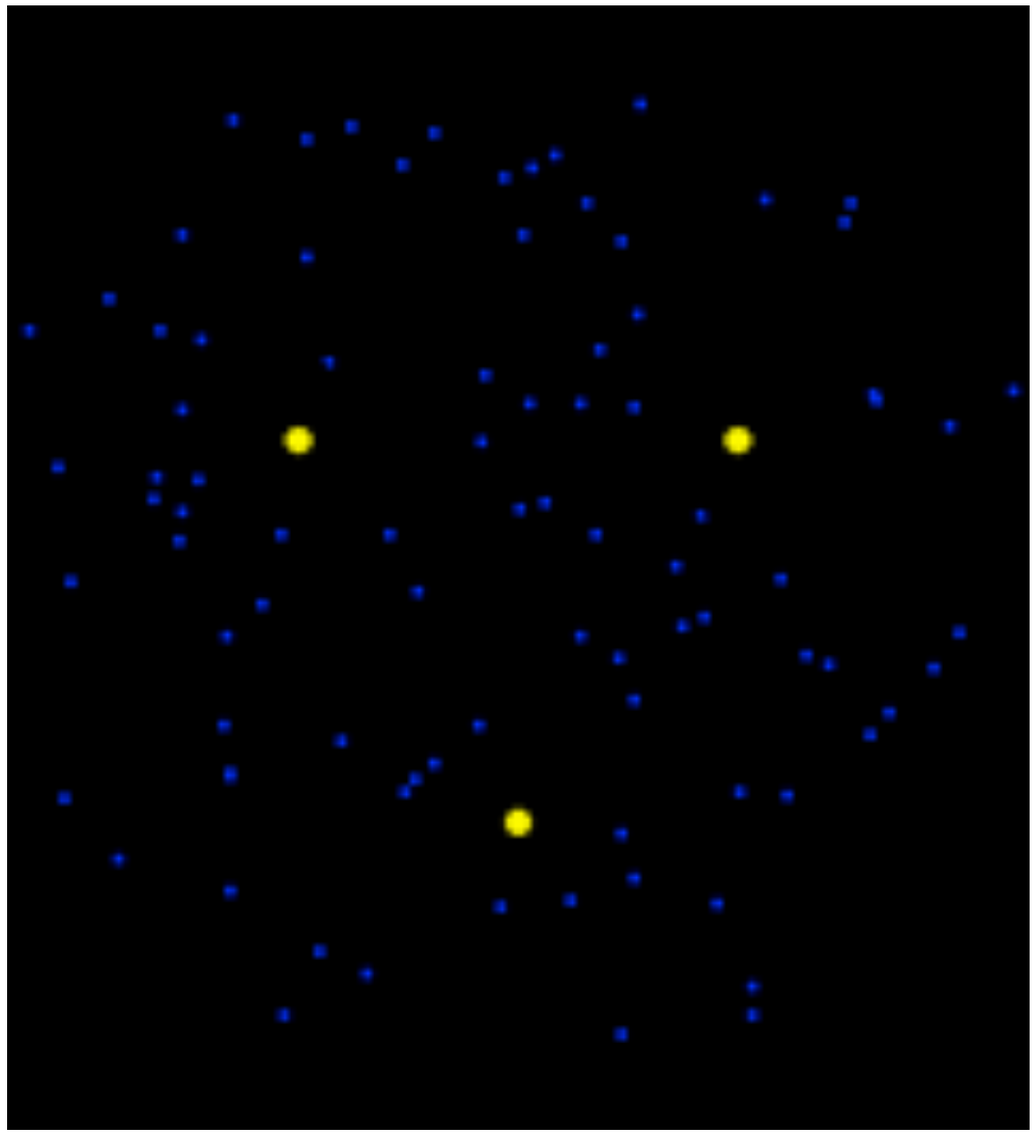
After

Motion-induced blindness

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

Motion-induced blindness

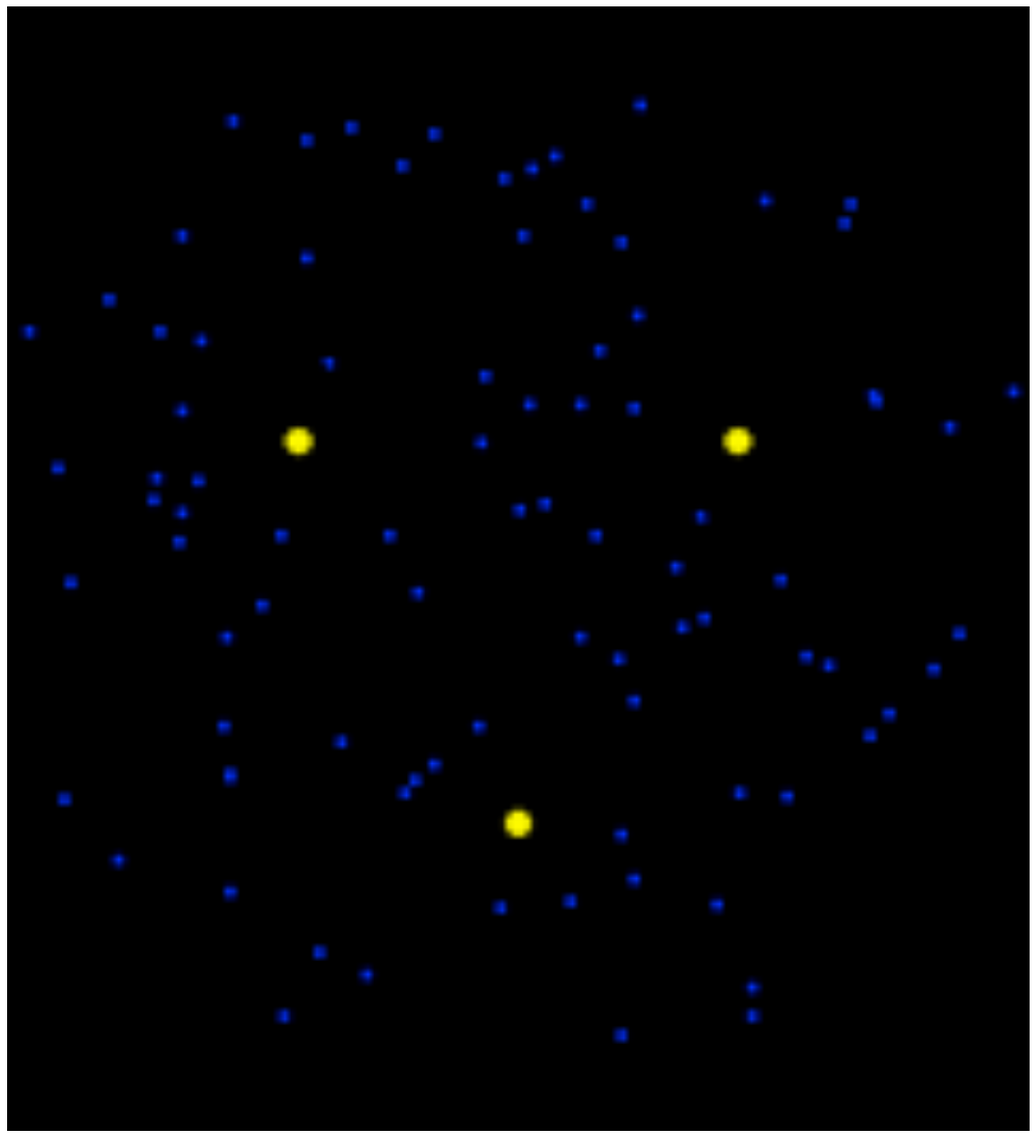
Stare in the middle of the display. After several seconds, yellow dots will begin to disappear



Motion-induced blindness

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)



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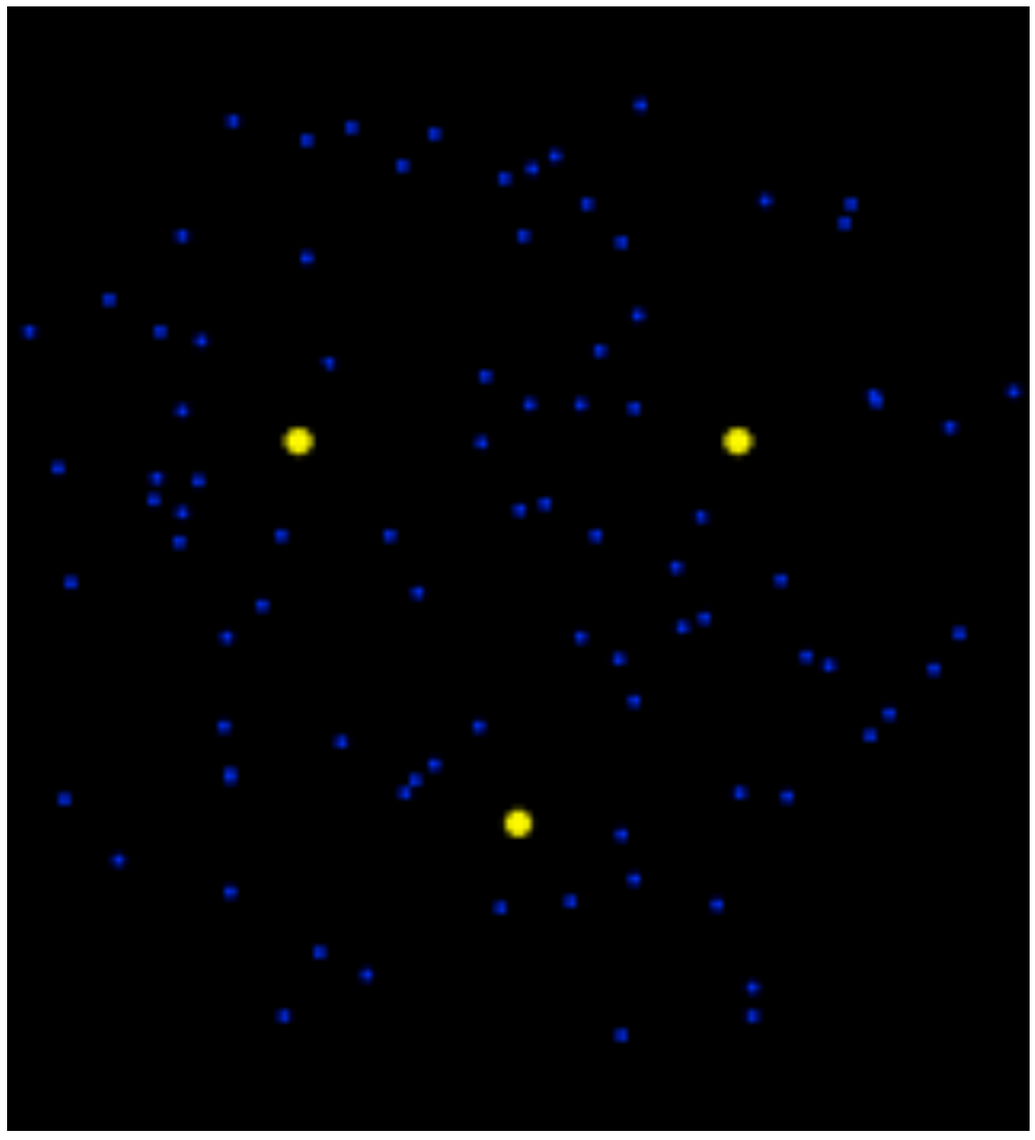
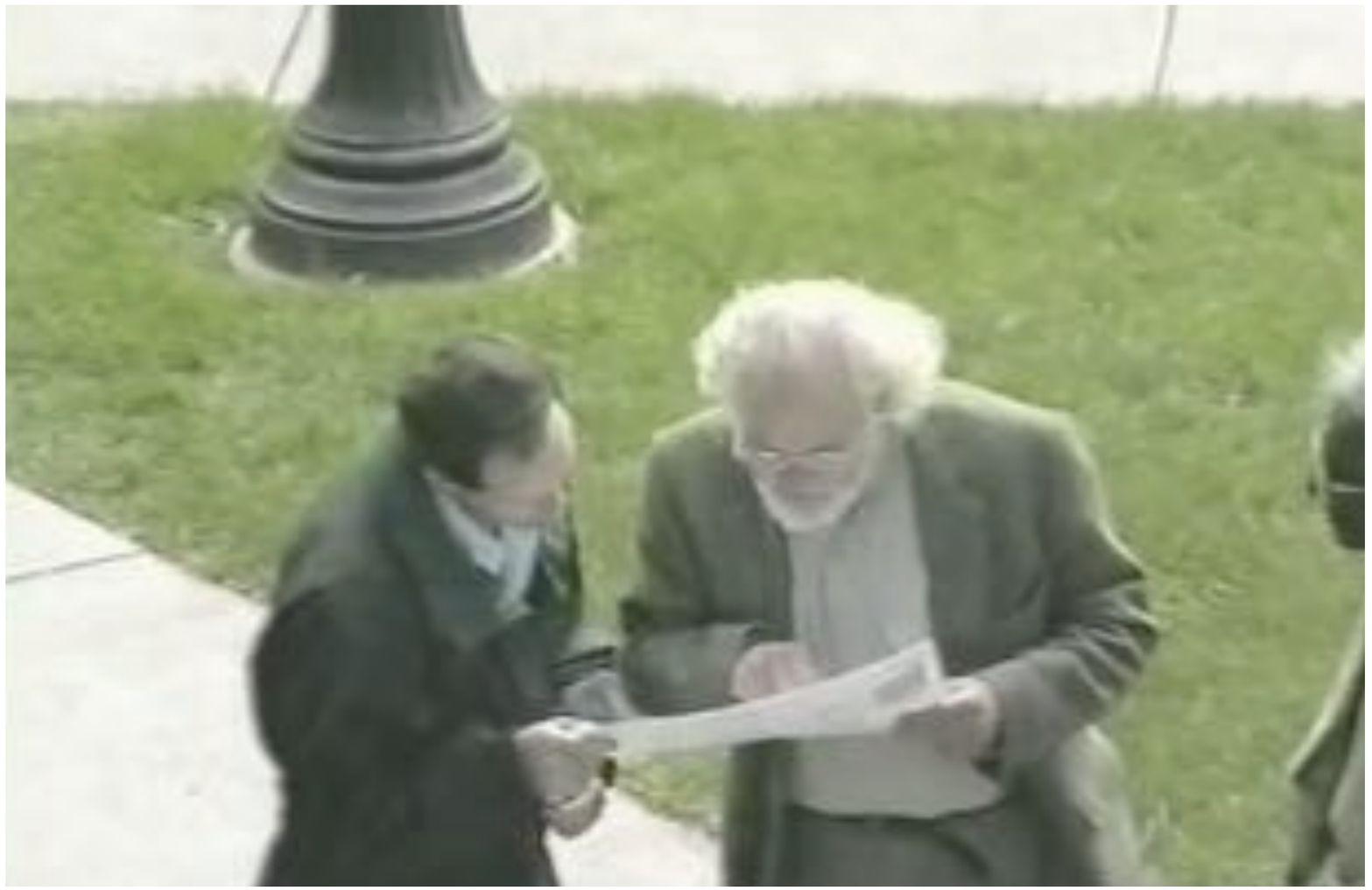


Change blindness

Change blindness

He did not realize even when the person you were talking to switched (Simons & Ambinder, 2005)



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

Change blindness demo- Spot the difference!

Change blindness demo- Spot the difference!

Change blindness demo- Spot the difference!

Change blindness demo- Spot the difference!

Changes go unnoticed when your attention is elsewhere
(Simons & Levin, 1997)

Only attended items enter visual short-term memory

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Sensory memory (Iconic memory)

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

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Attention

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Attention

Short-term memory (working memory)

- Lasts over many seconds
- Very limited capacity

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Rehearsal

Only attended items enter visual short-term memory

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- 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

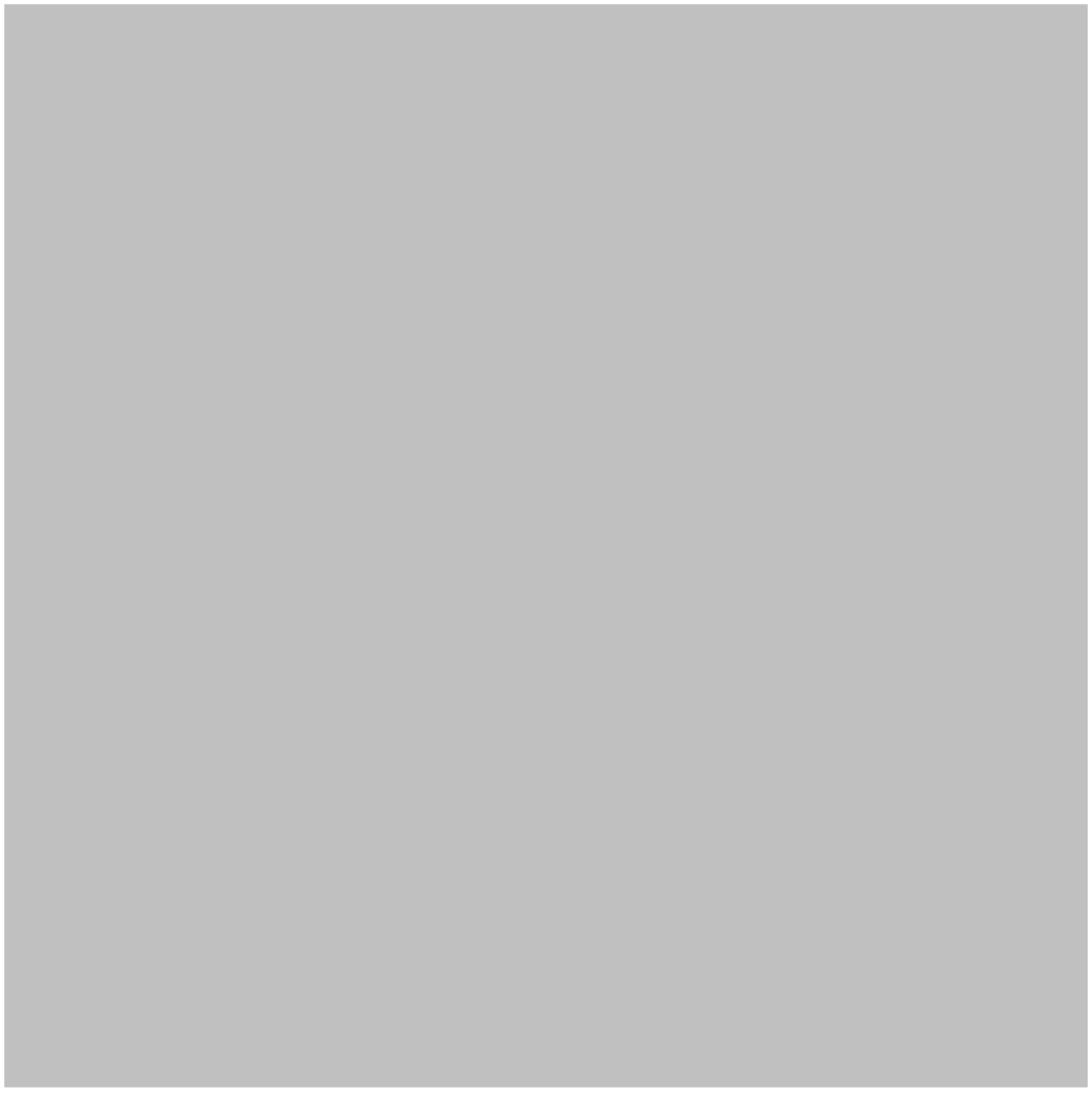
- Capacity and duration unlimited

2. Limited capacity of visual short-term memory

Testing your memory capacity

Change detection task: "Change? No change?"

Trial #1



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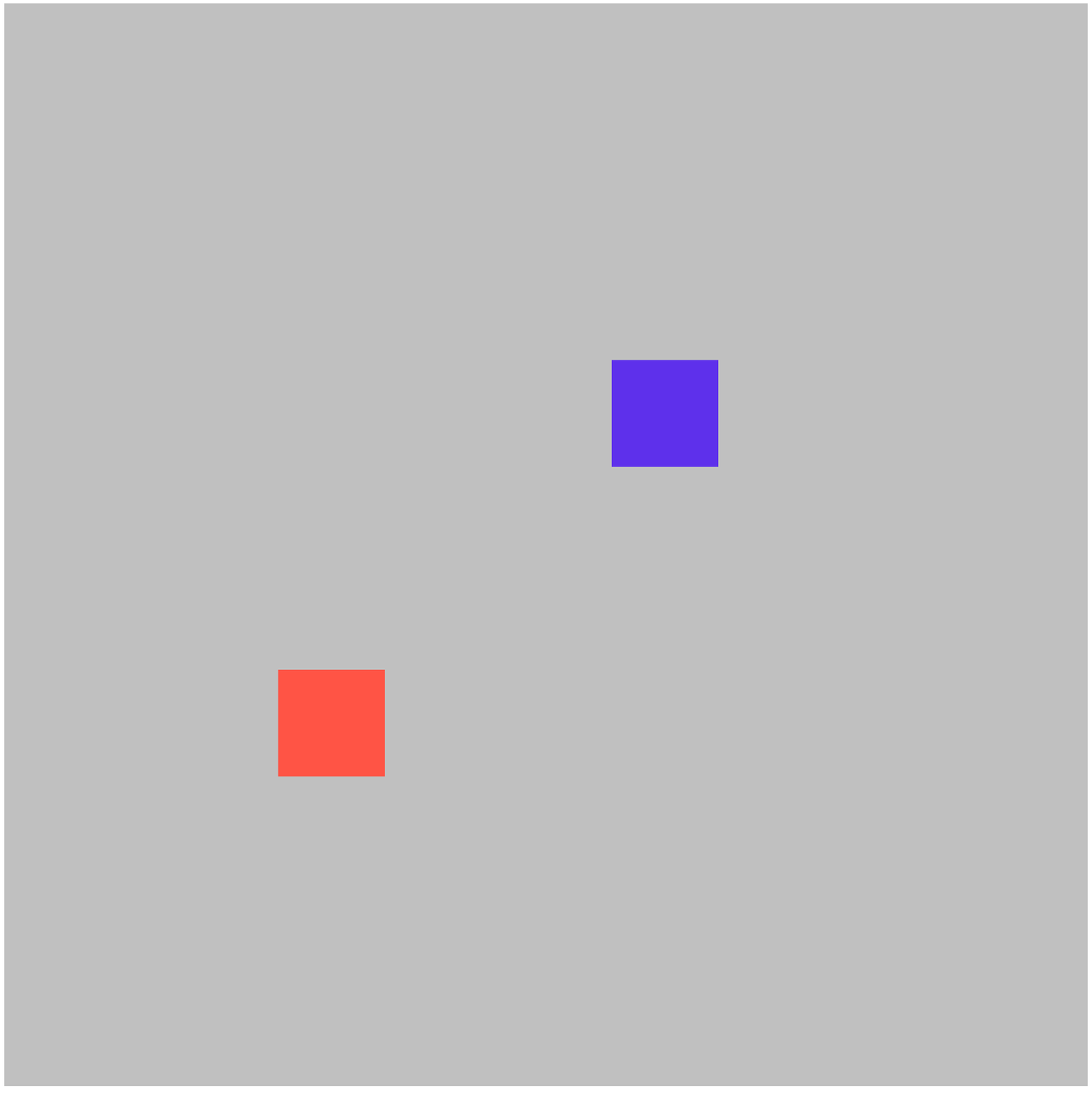

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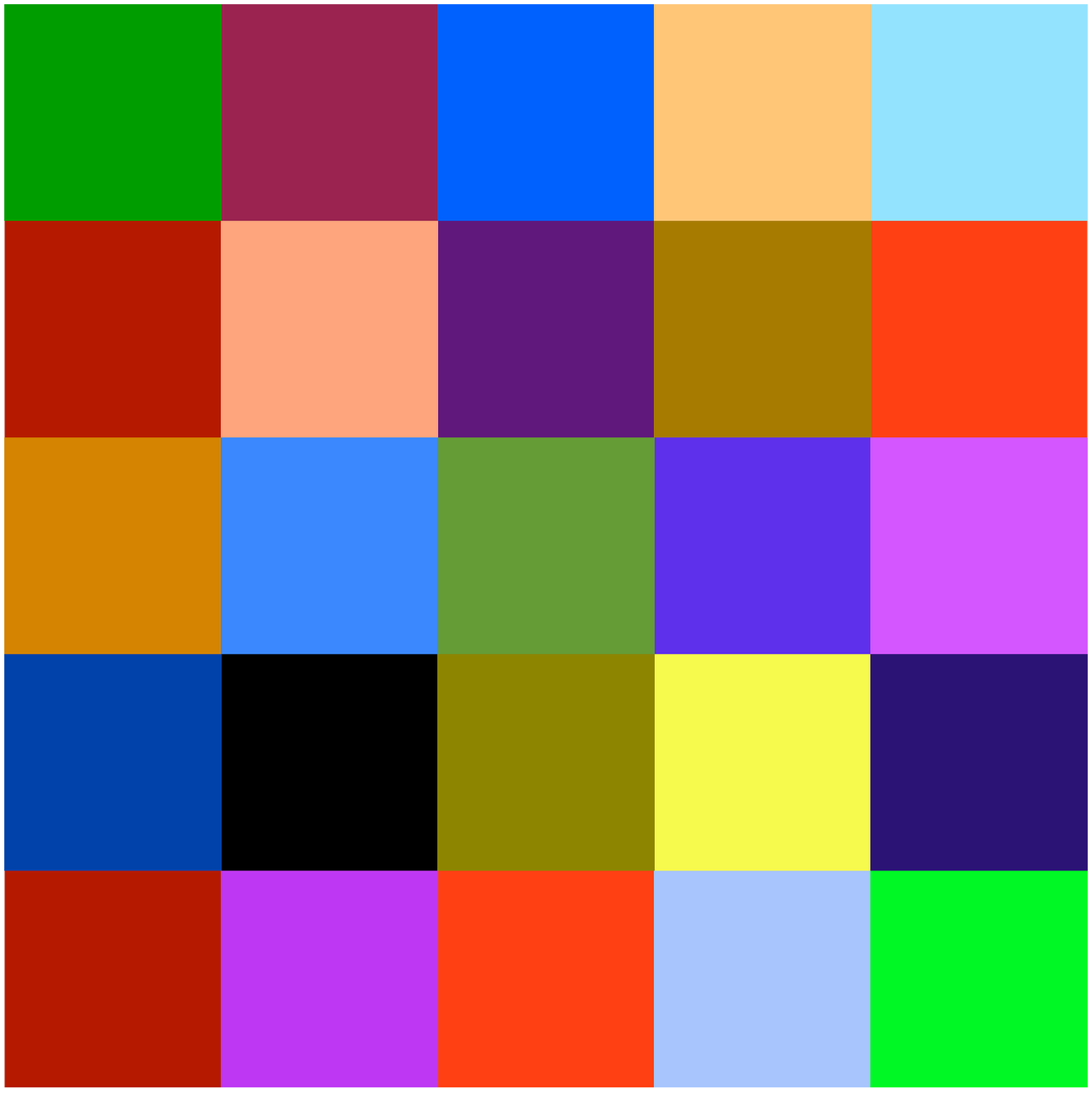

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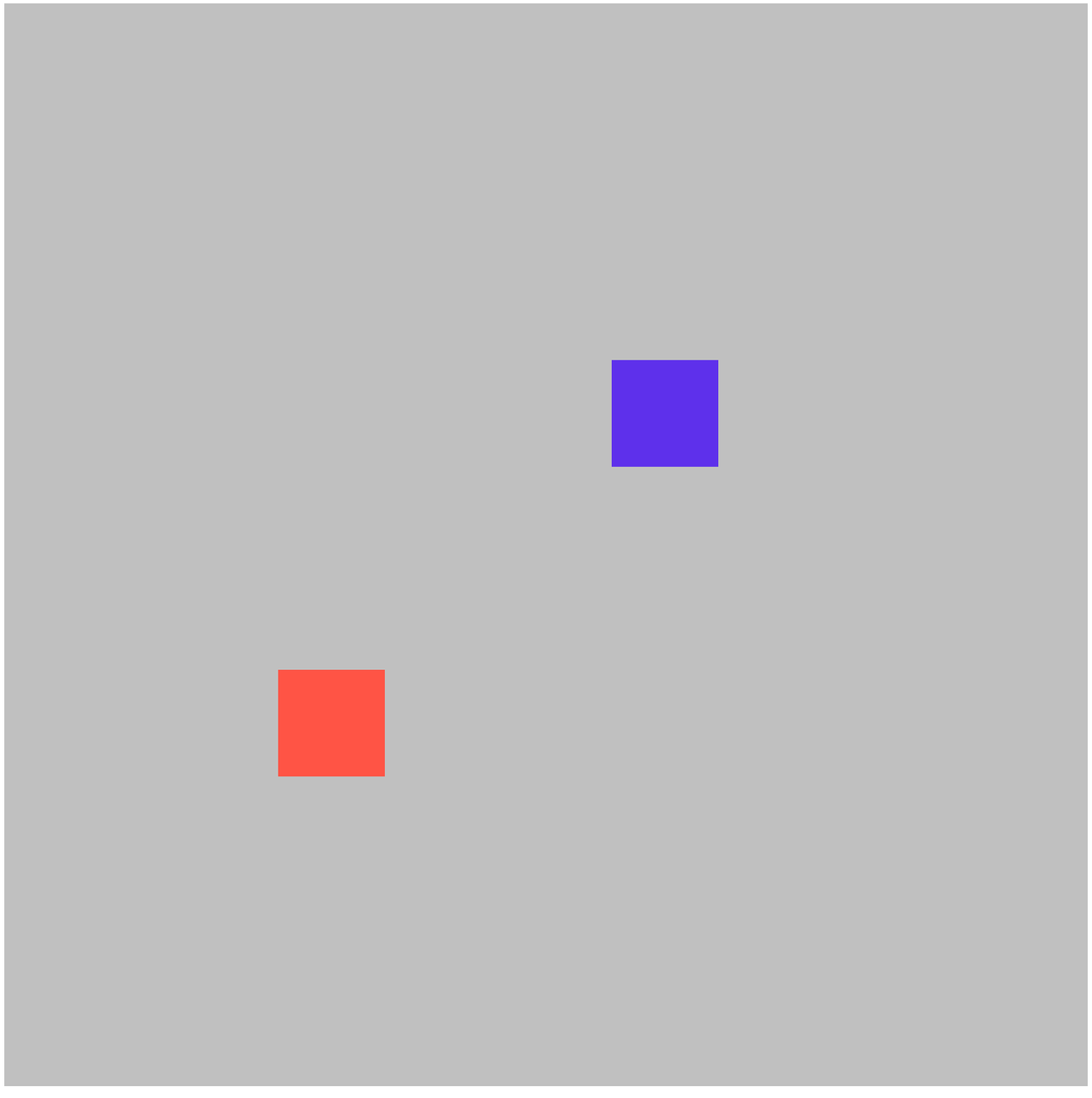

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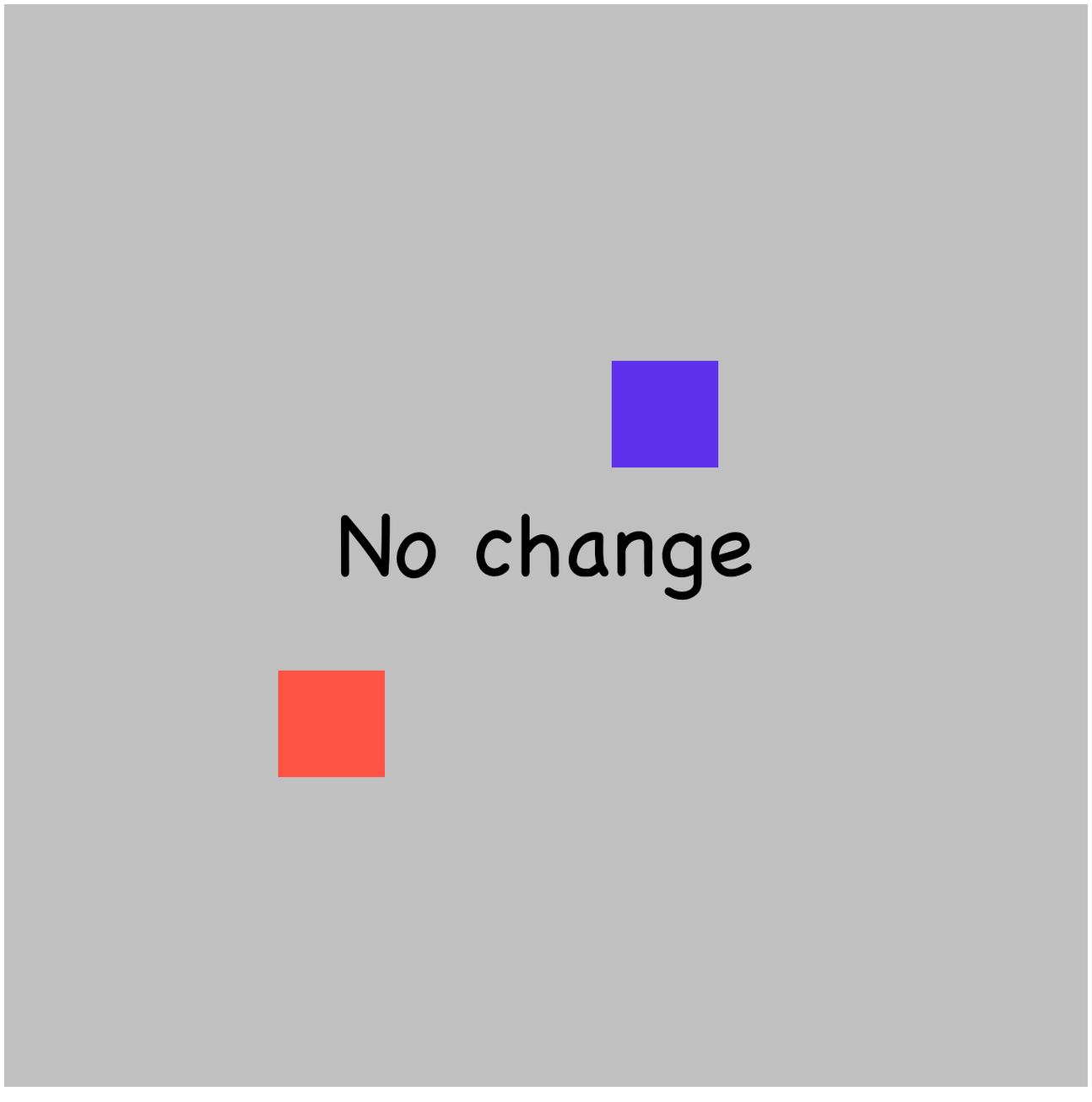

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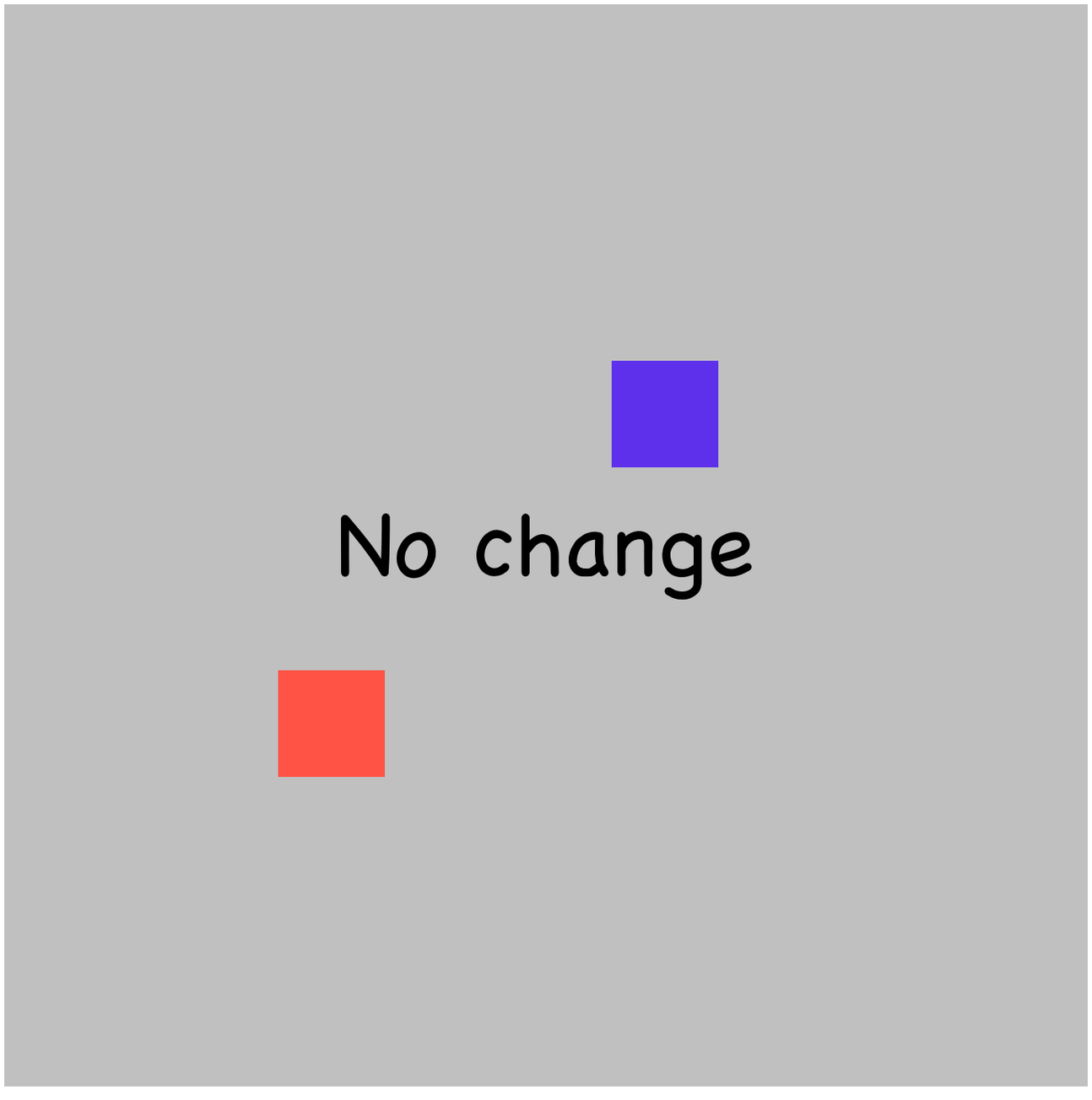
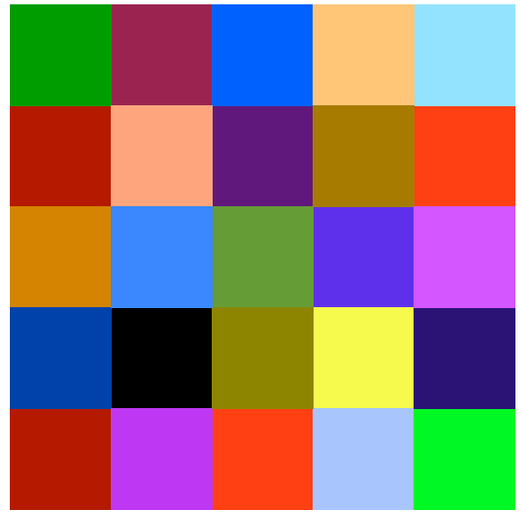


Mask



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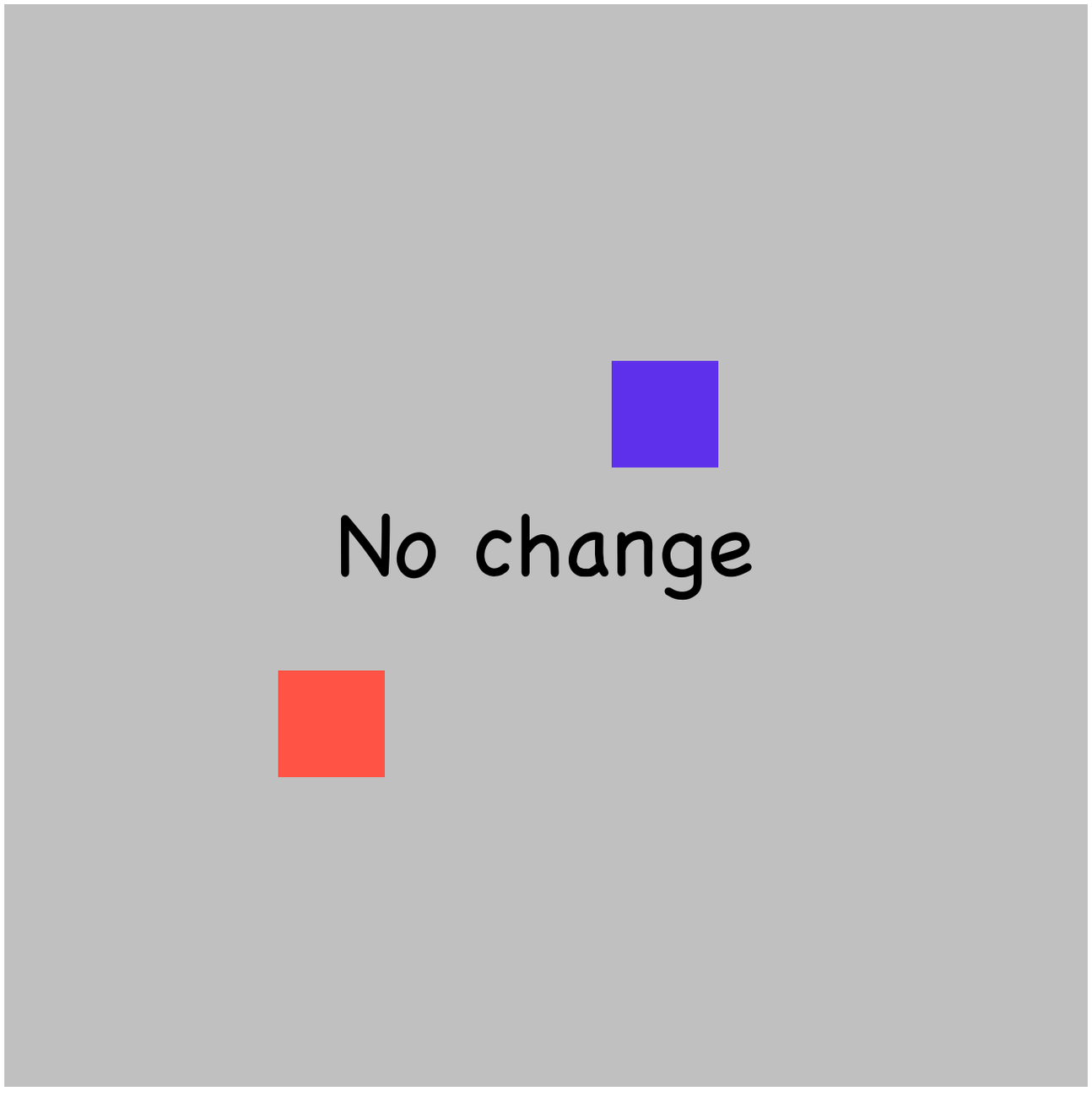

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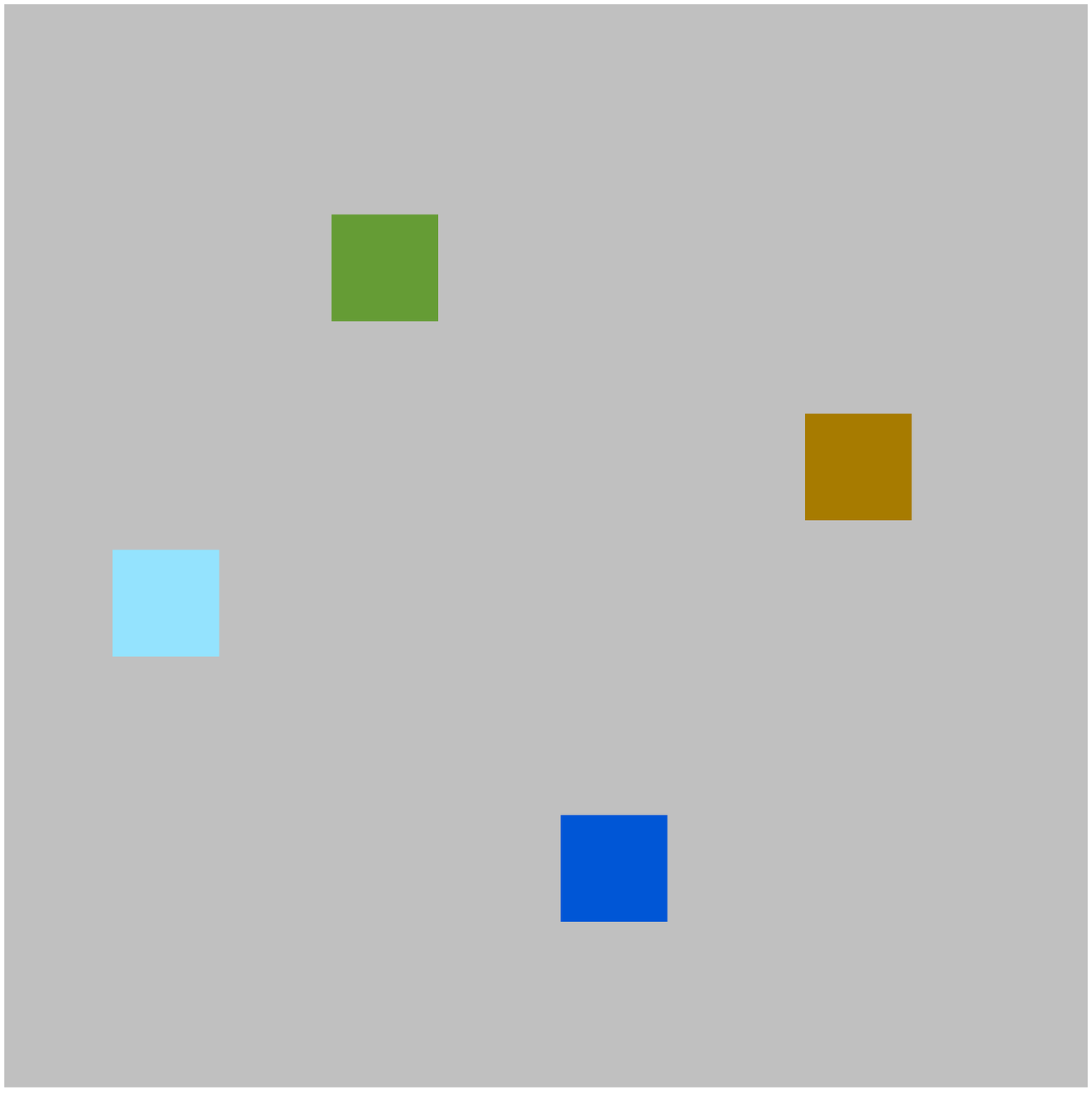

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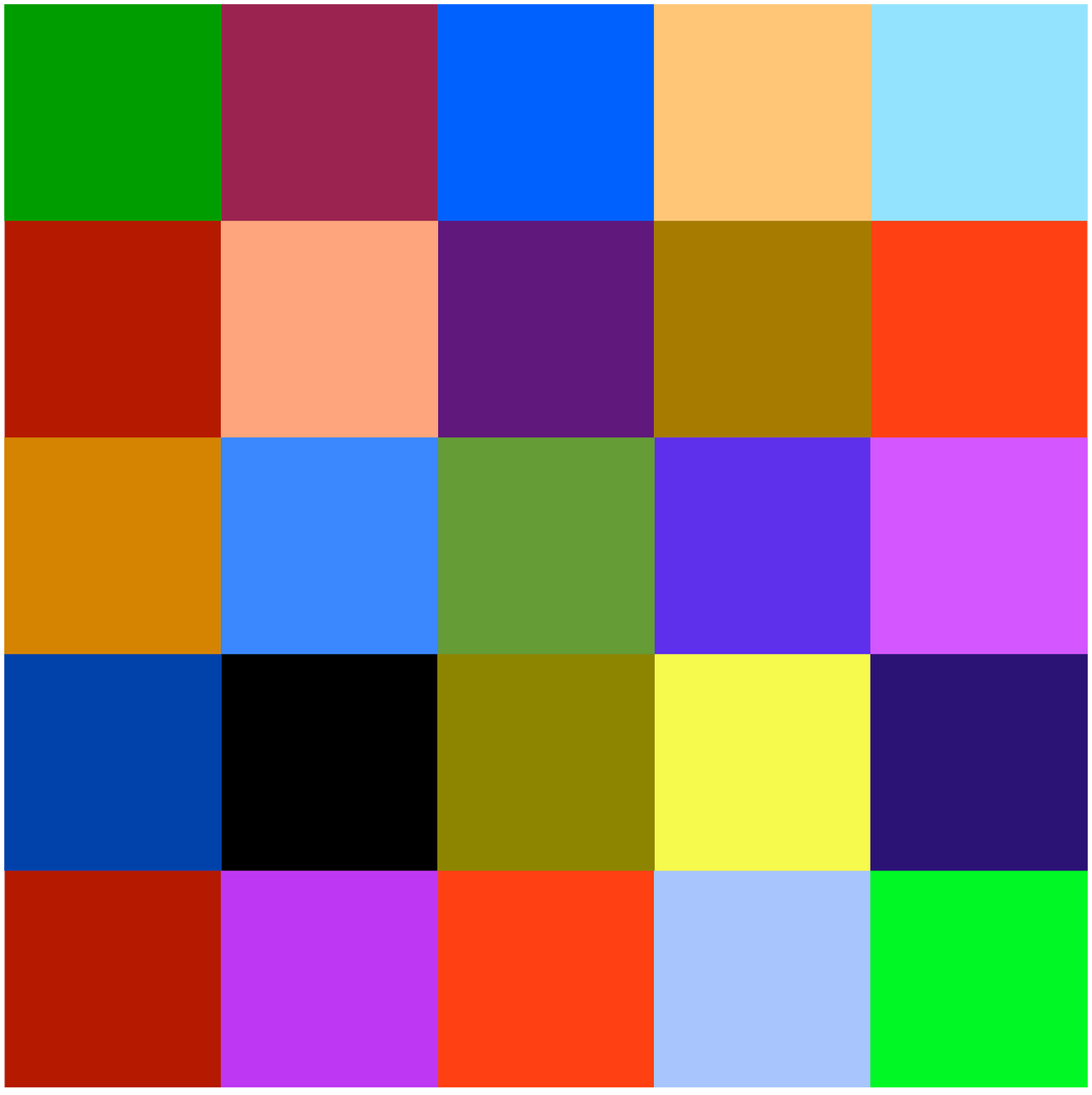

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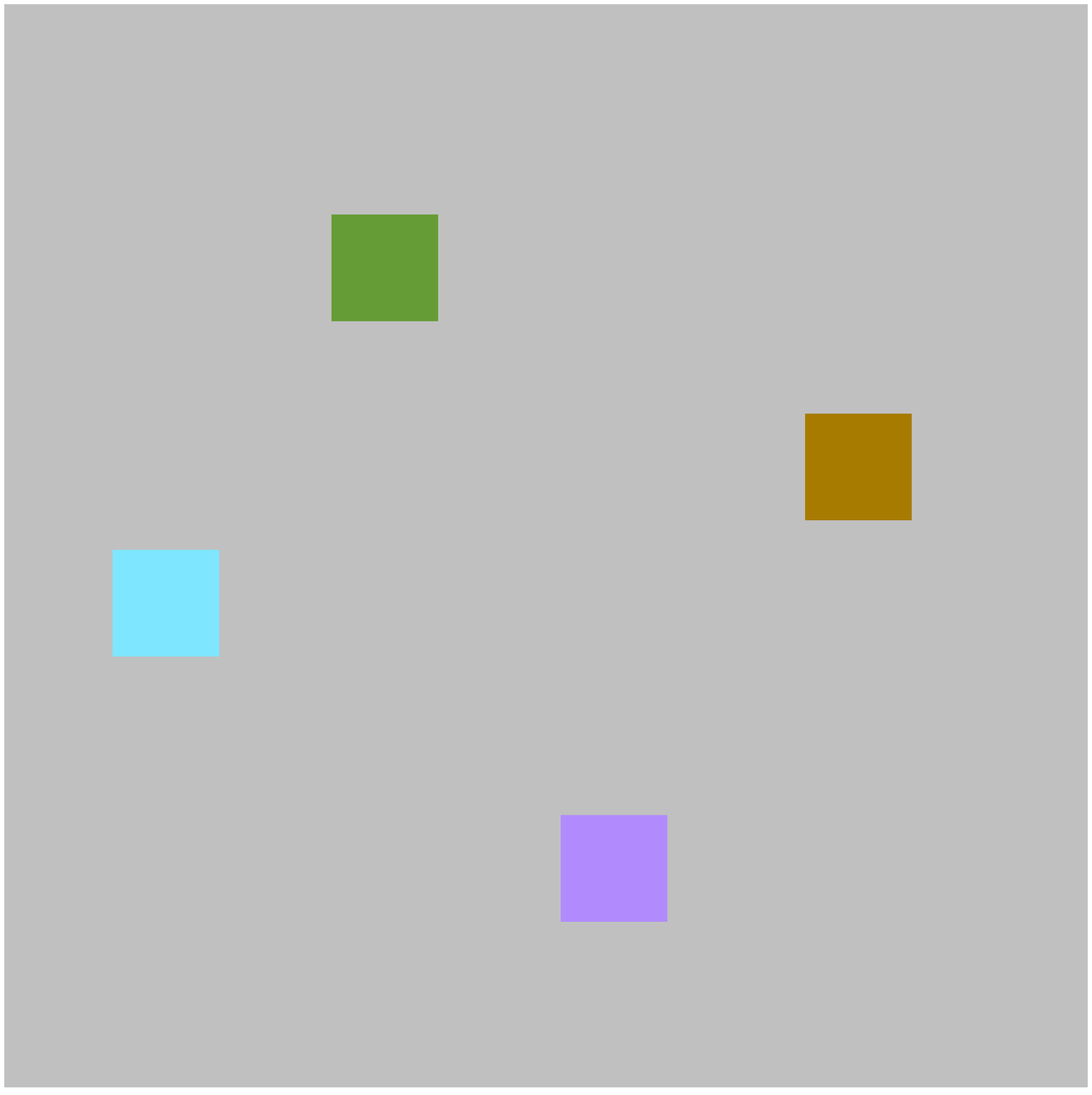

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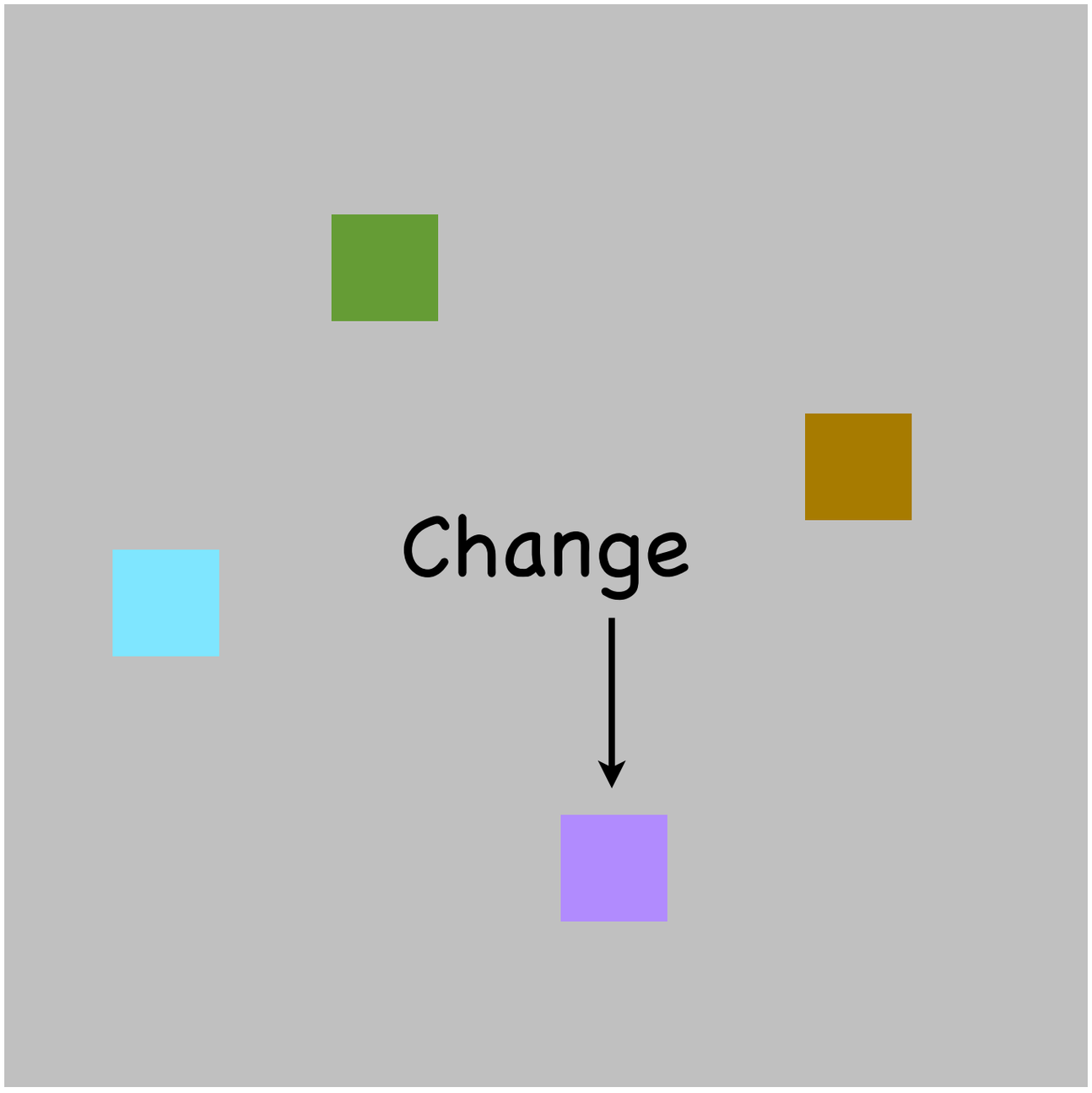

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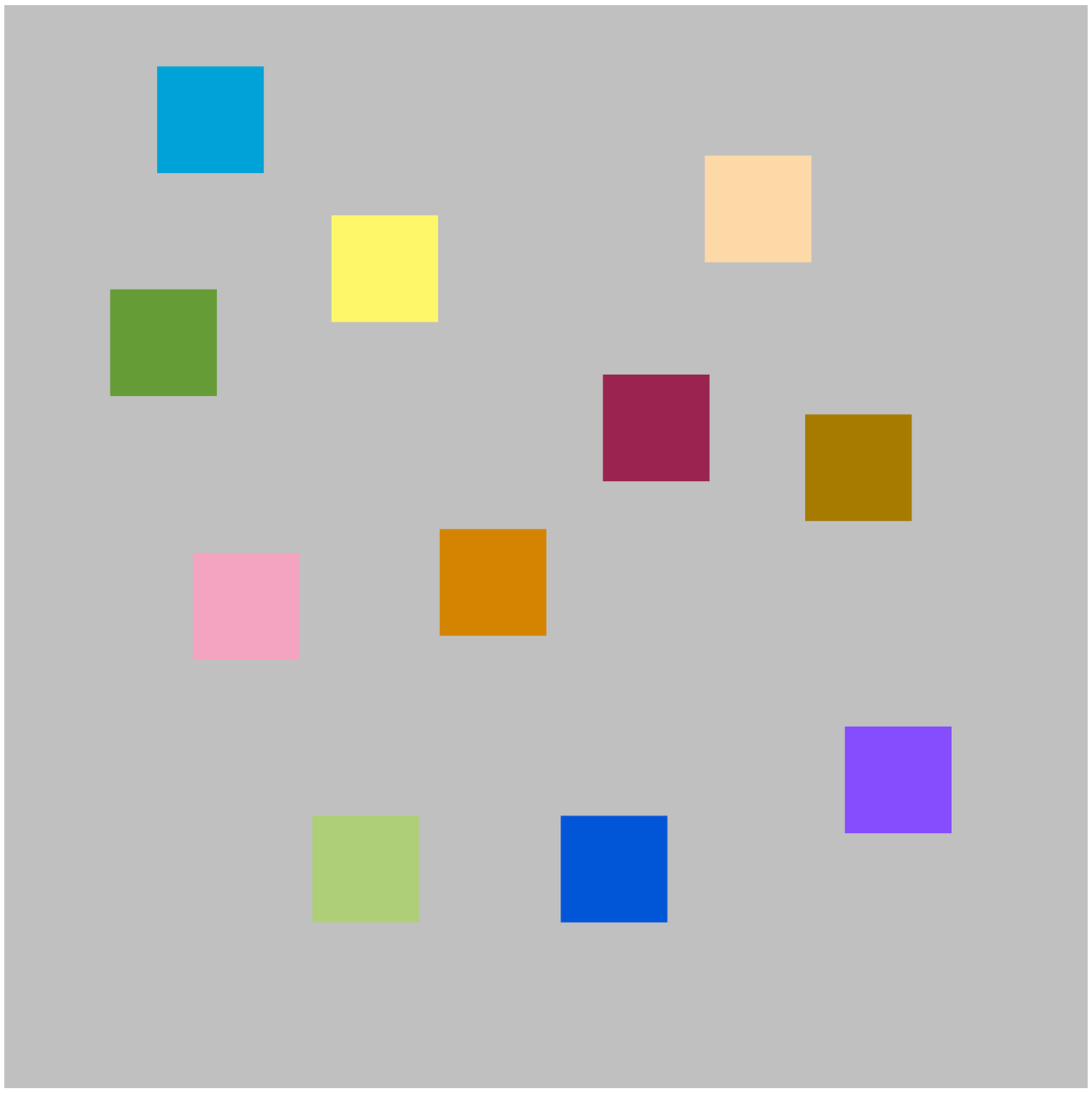

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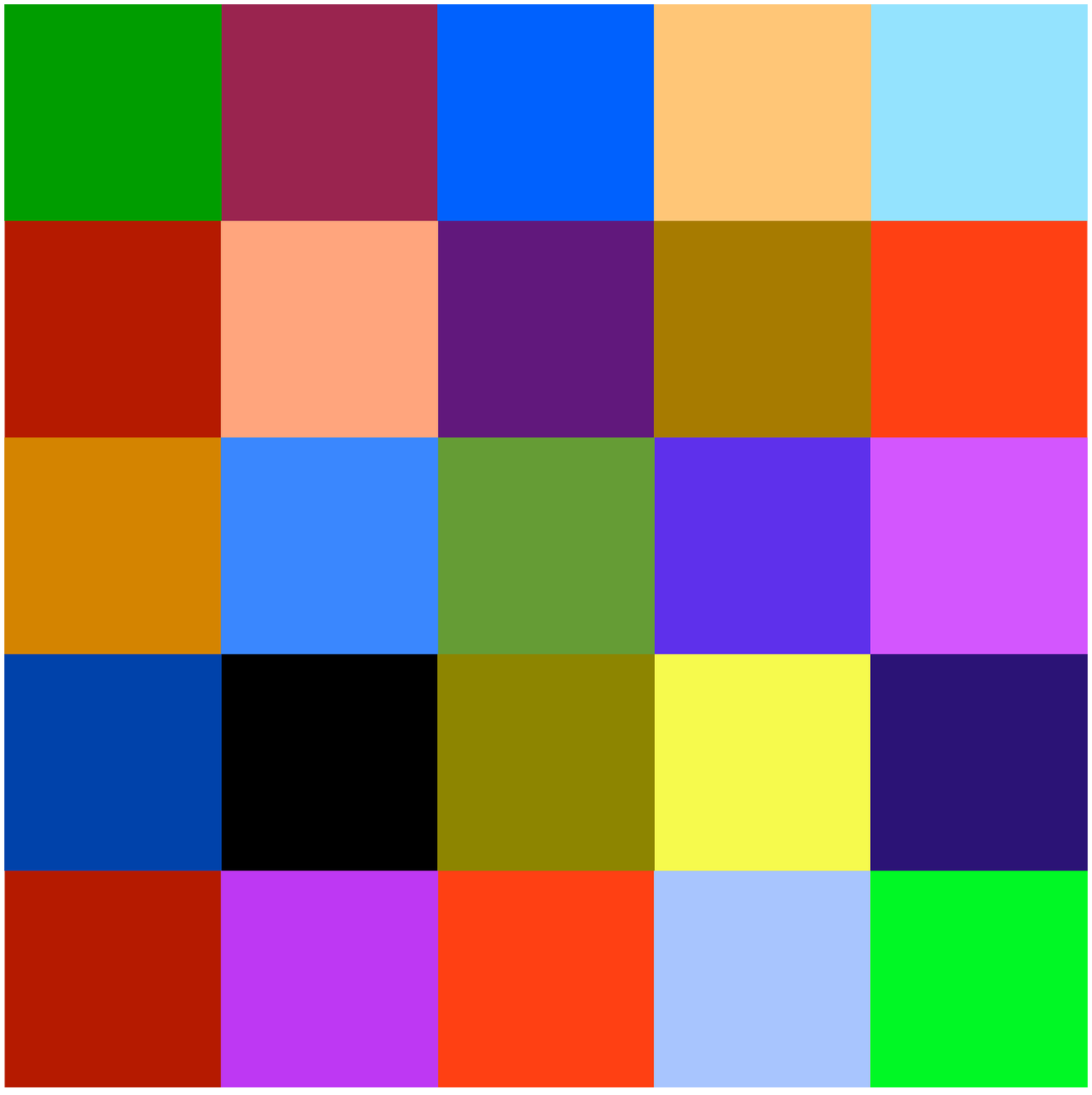

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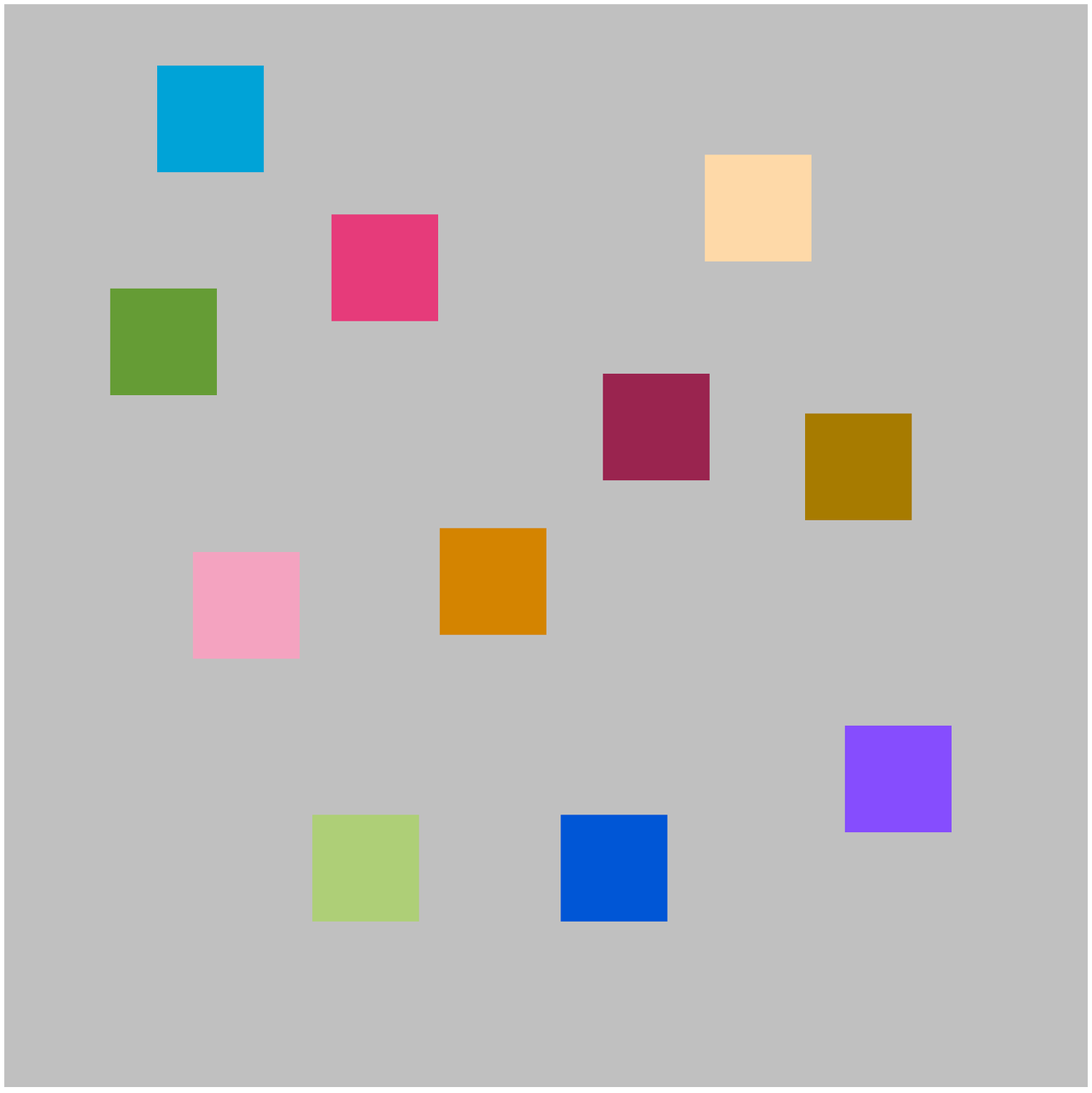

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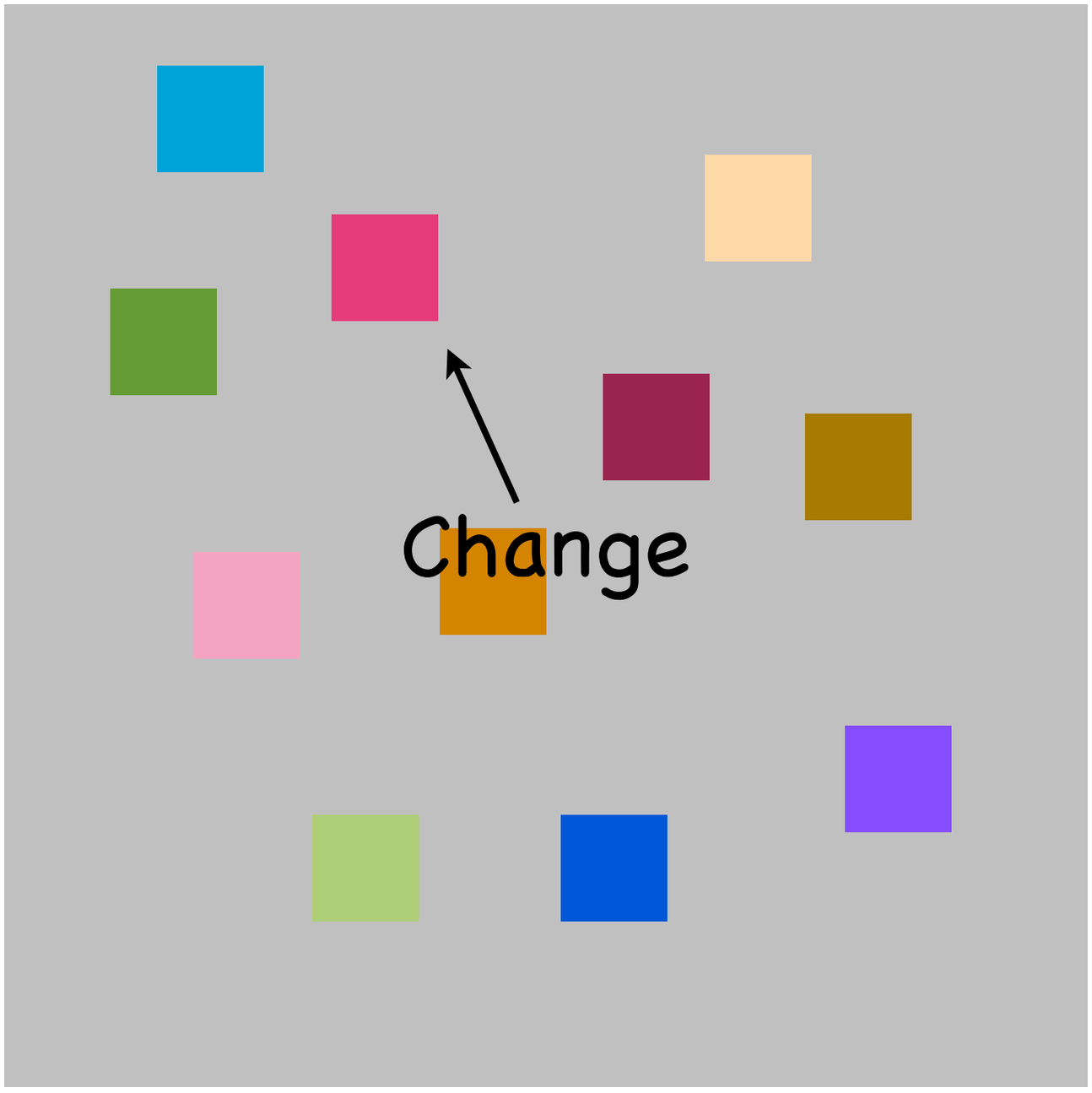

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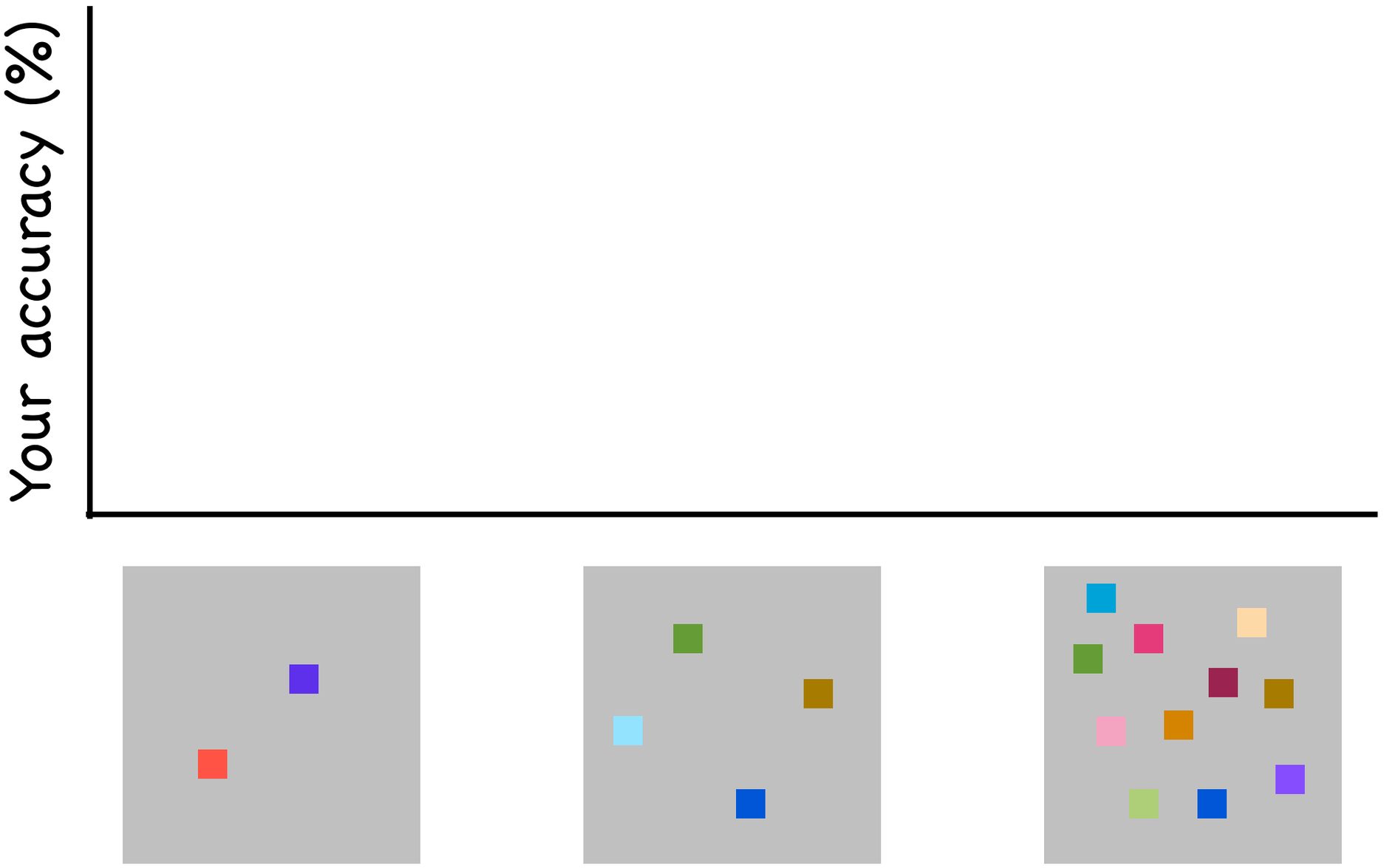

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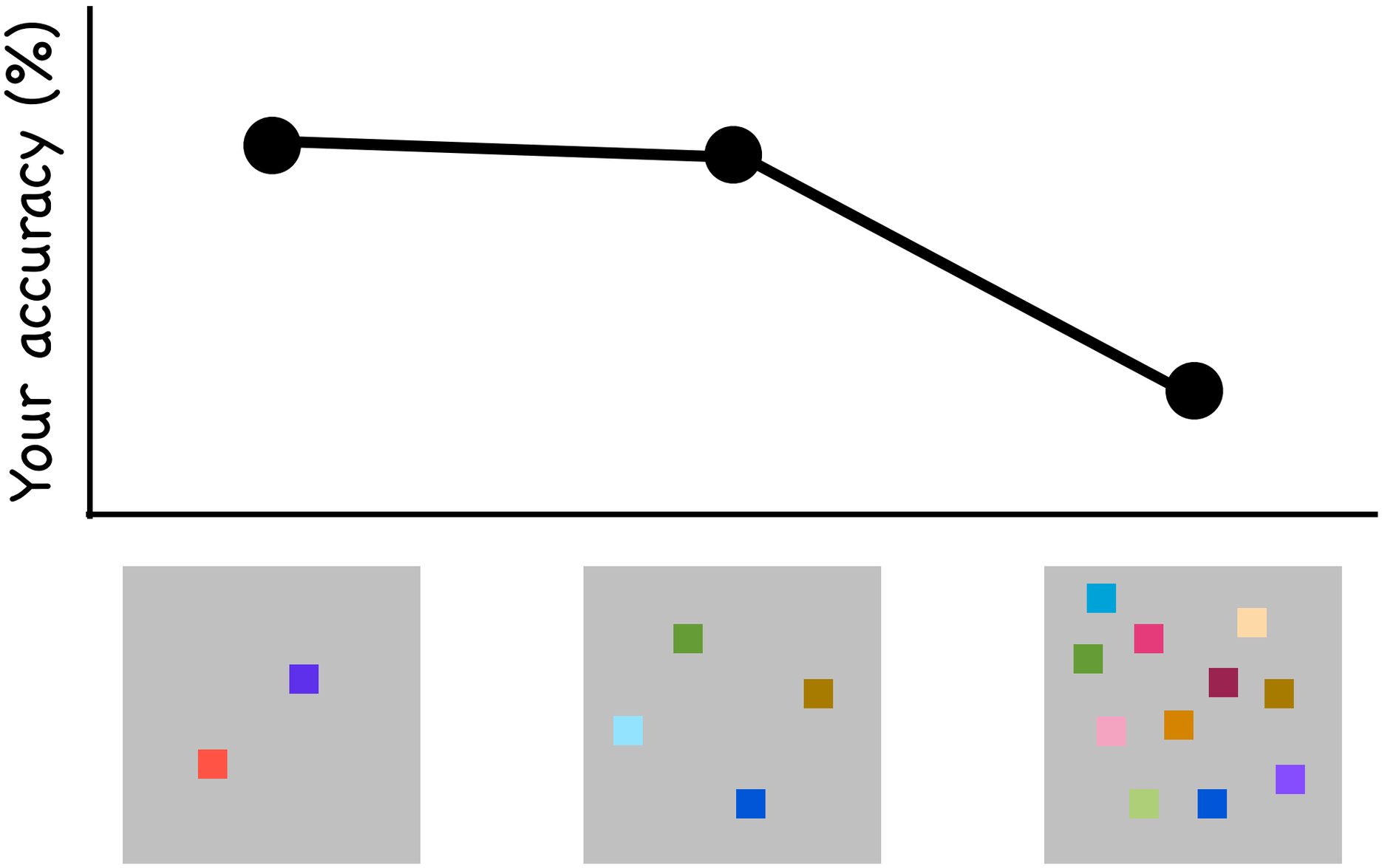
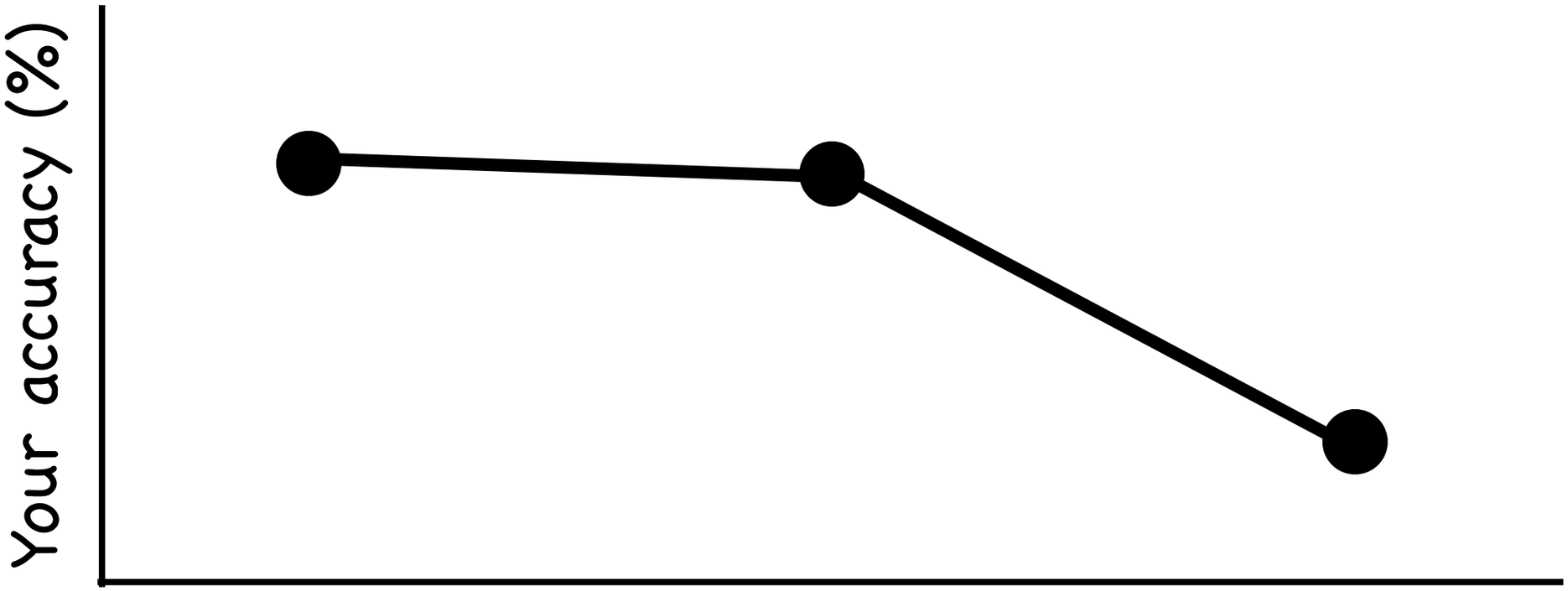
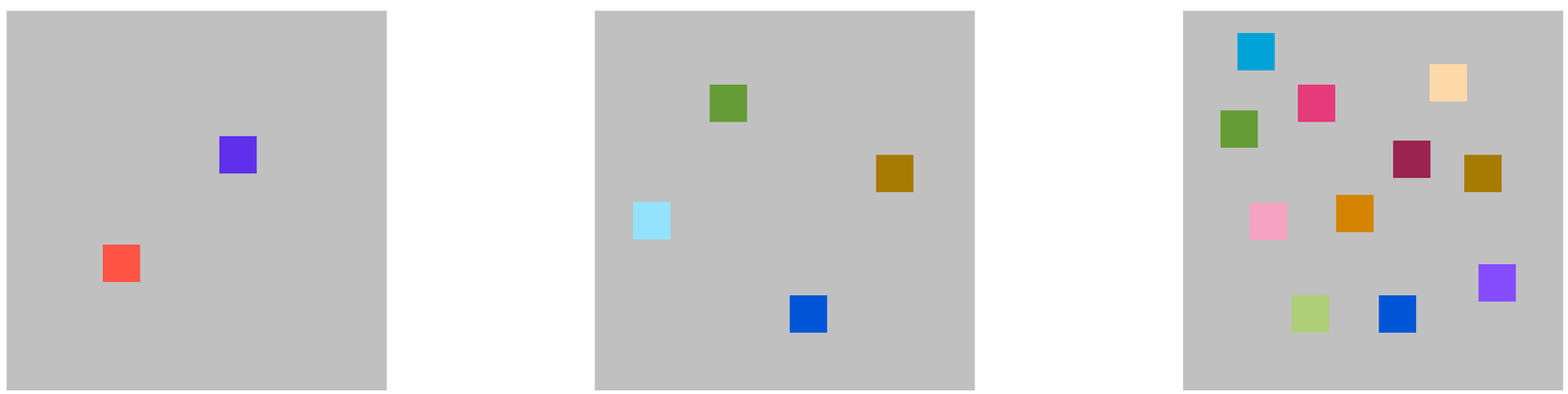


2. Limited capacity of visual short-term memory

You can remember only up to 4 items





Conscious perception is limited

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... because your visual attention and memory are limited!

Conscious perception is limited

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

Conscious perception is limited

… because your visual attention and memory are limited!

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Then, what about unattended things?

Conscious perception is limited

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All these results show that you 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.

Conscious perception is limited

… because your visual attention and memory are limited!

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

Then, what about unattended things?

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However…

3. The fate of unseen stimuli

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

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Subliminal perception

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Subliminal perception

Example 1

3. The fate of unseen stimuli

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Subliminal perception

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Subliminal perception

Example 1

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

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

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

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

Jiang et al., (2006)

Invisible stimulus can attract attention

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

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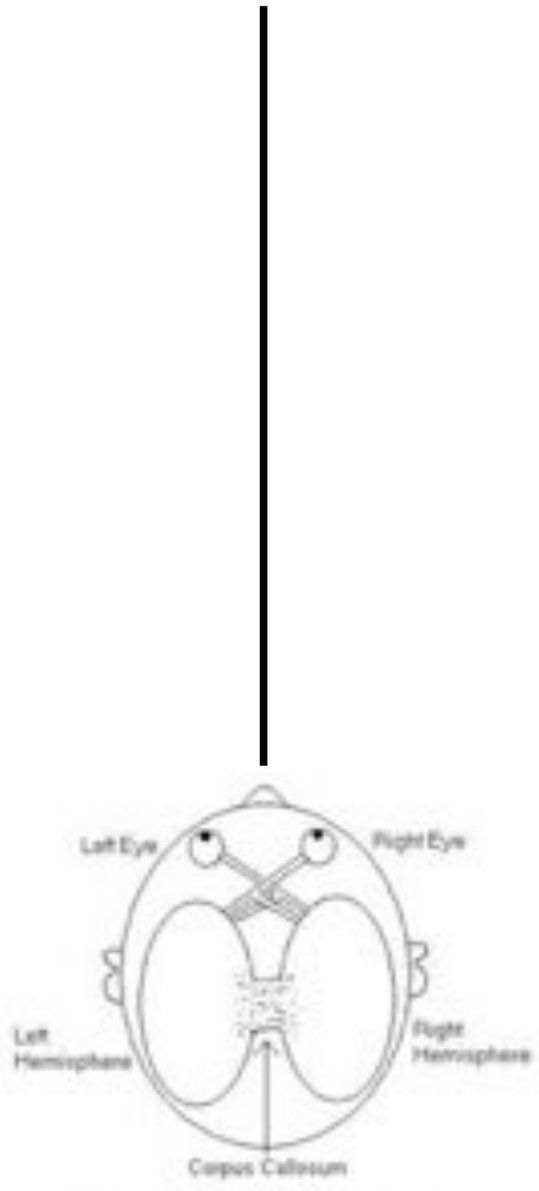

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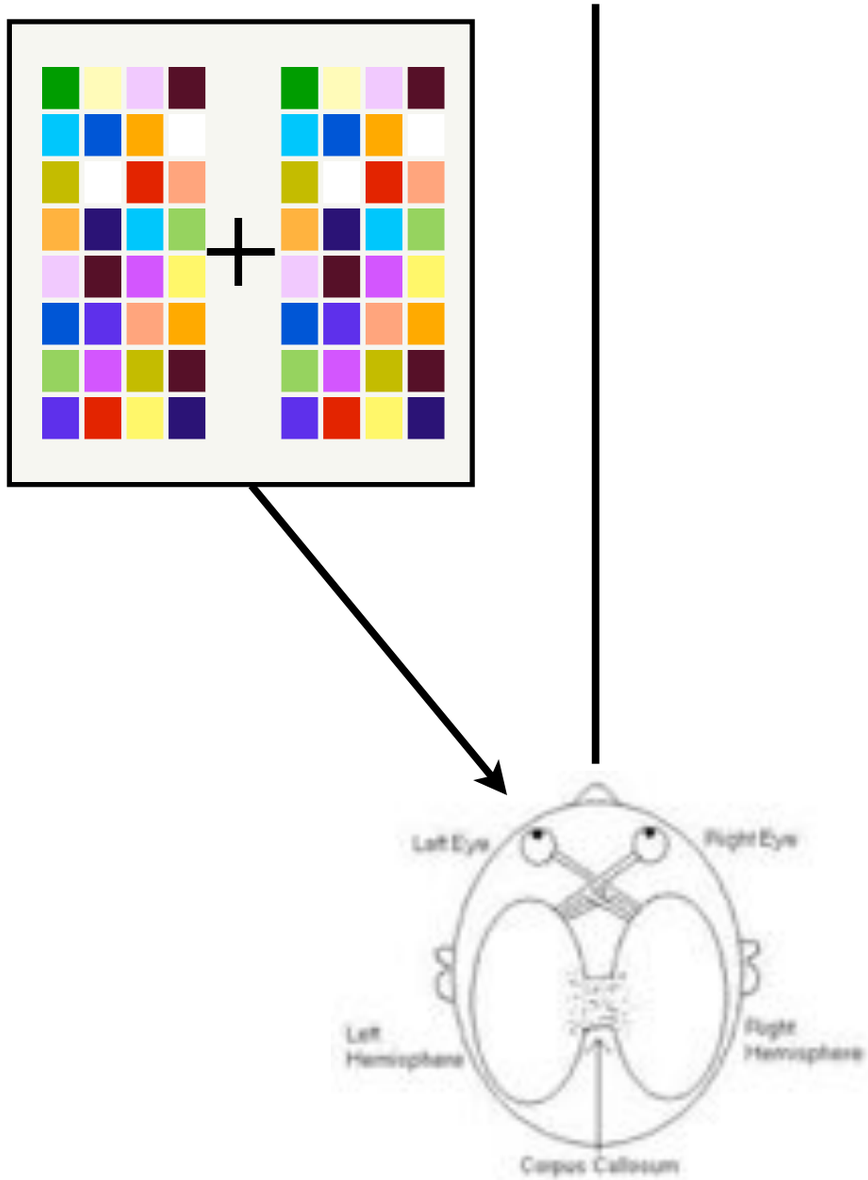

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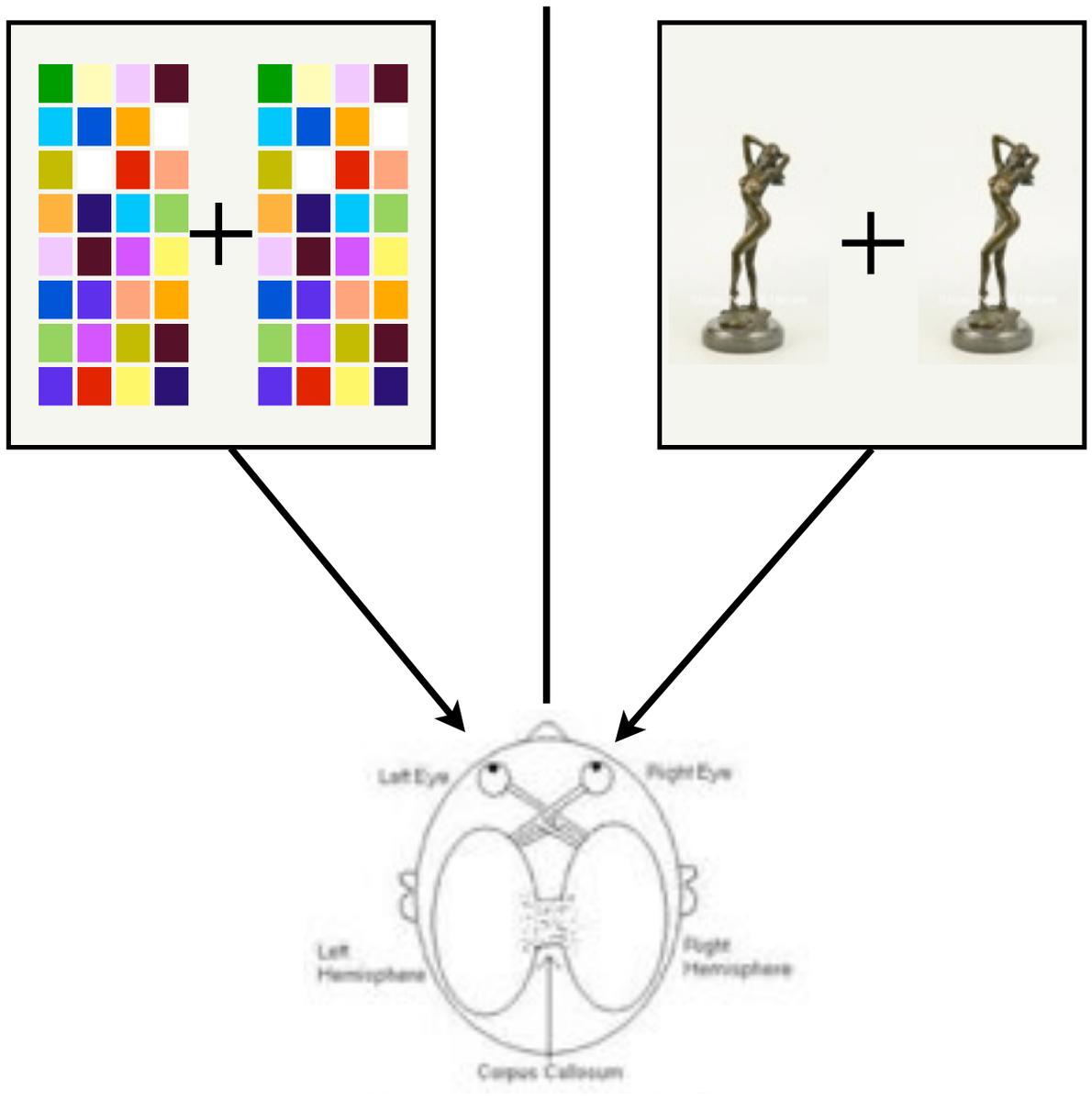

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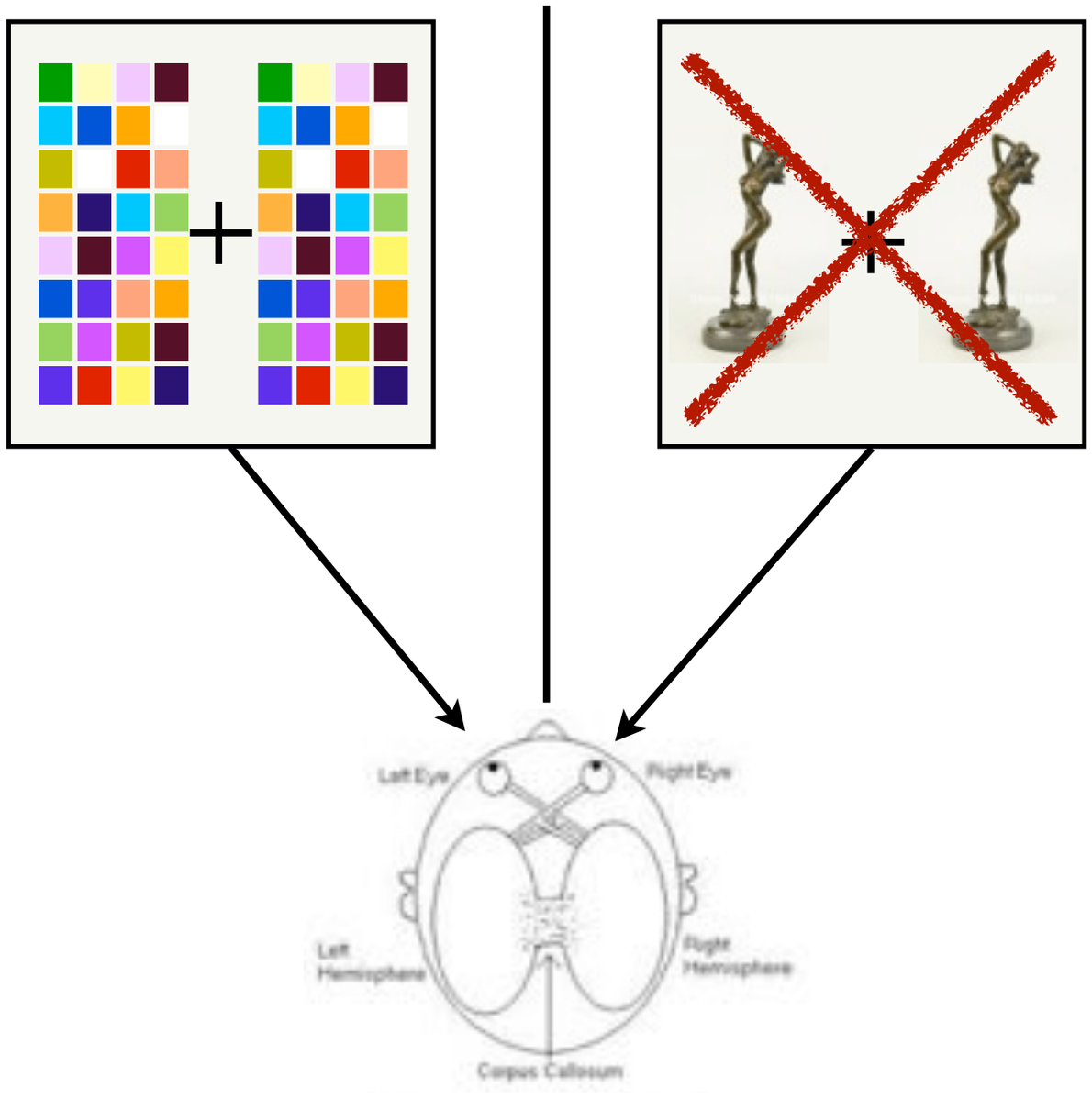

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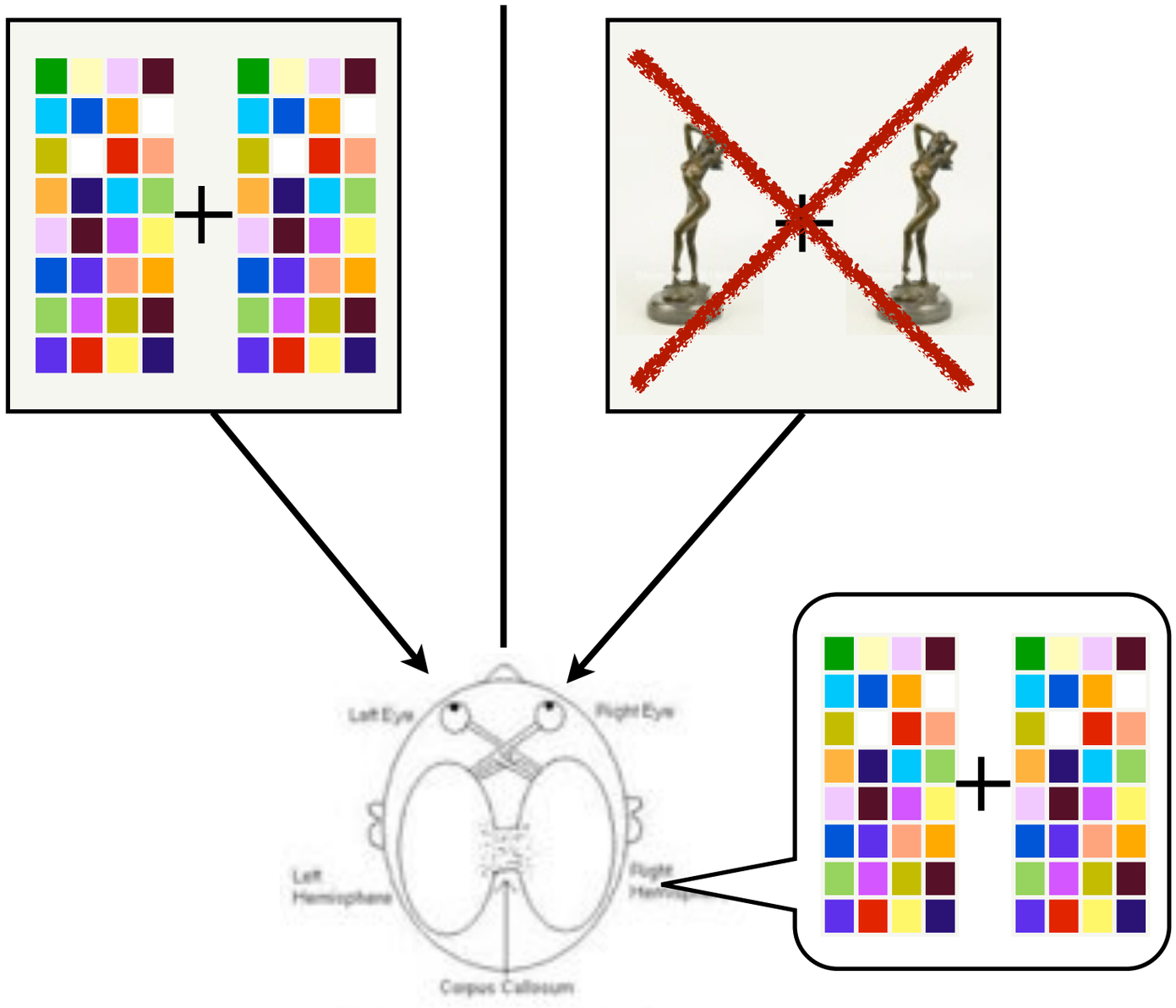

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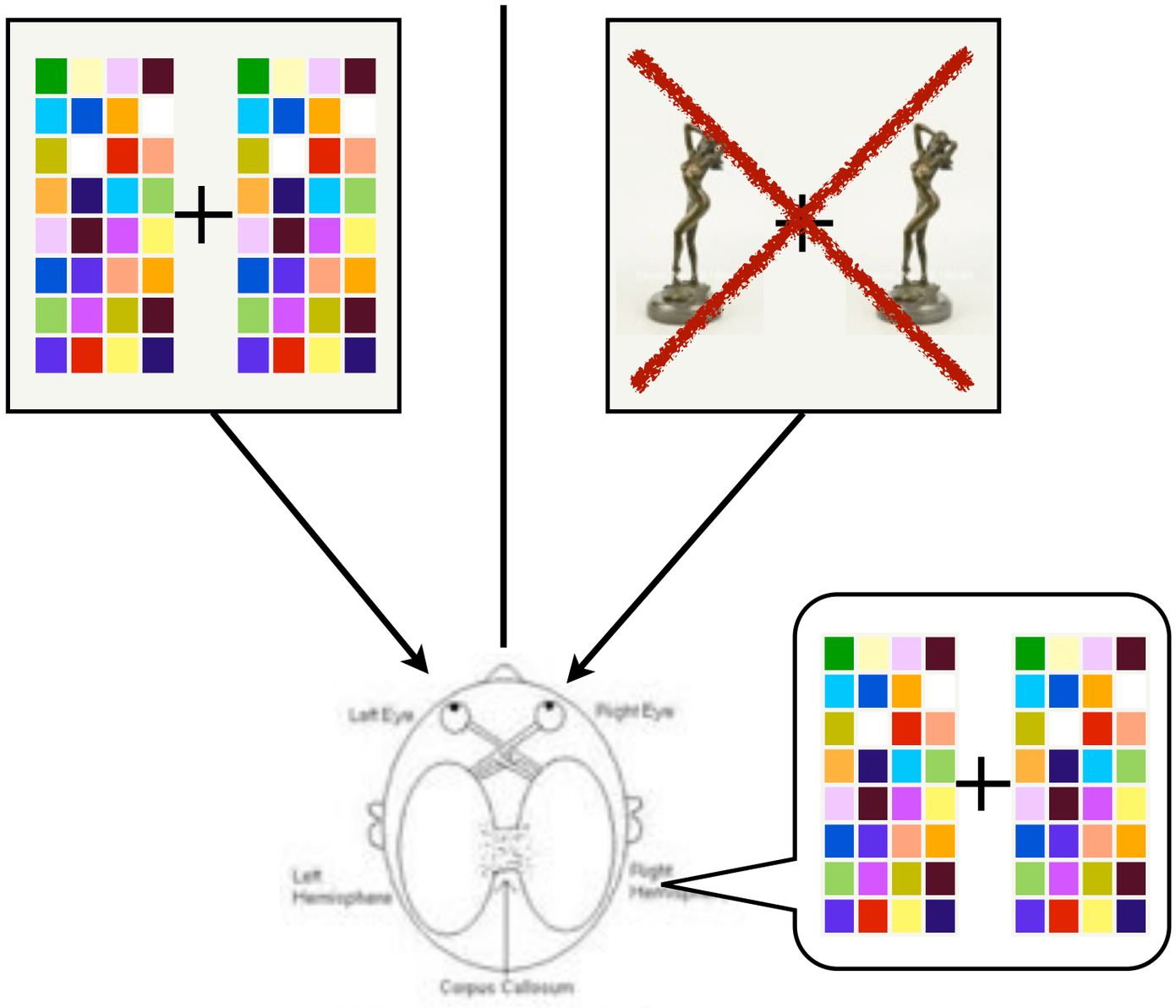

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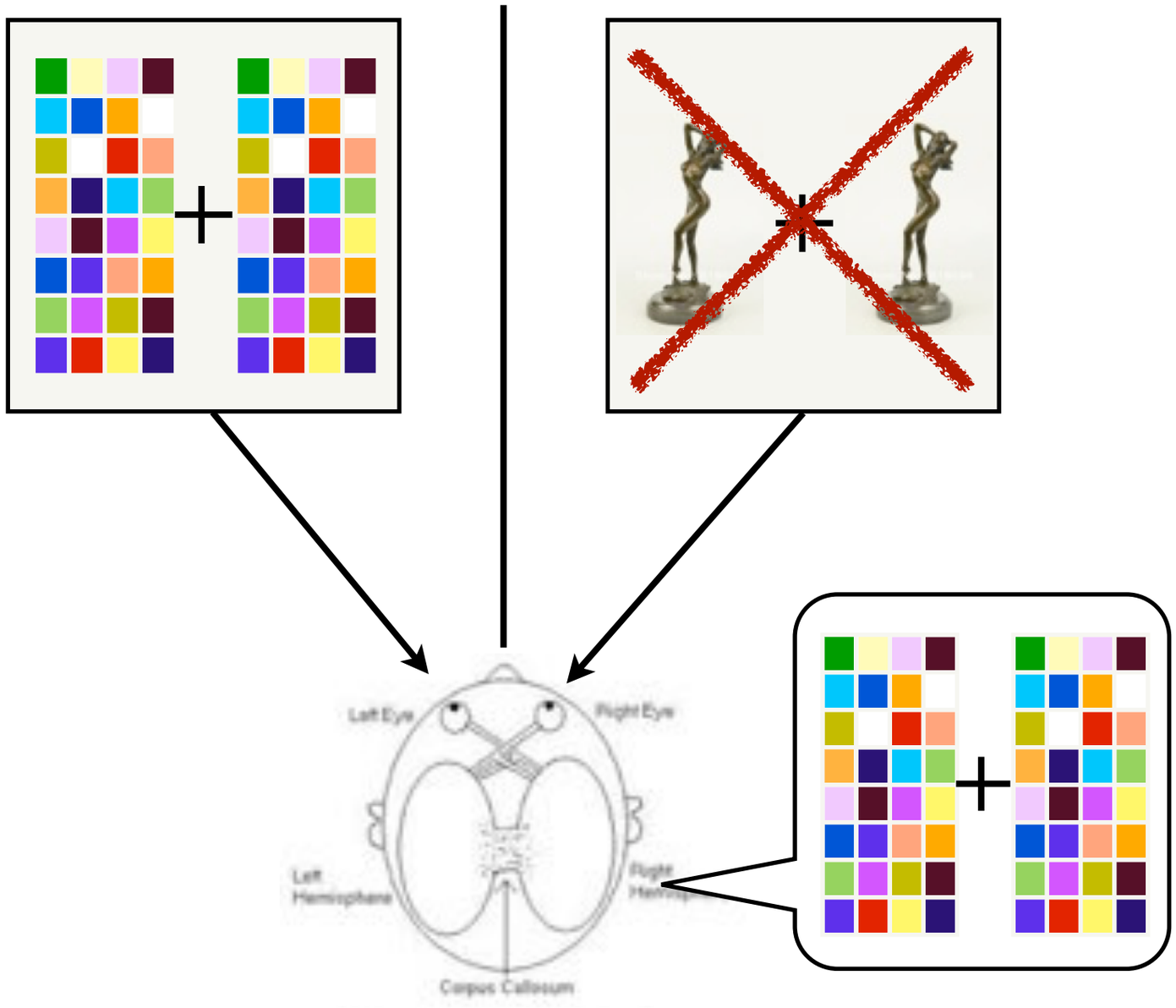

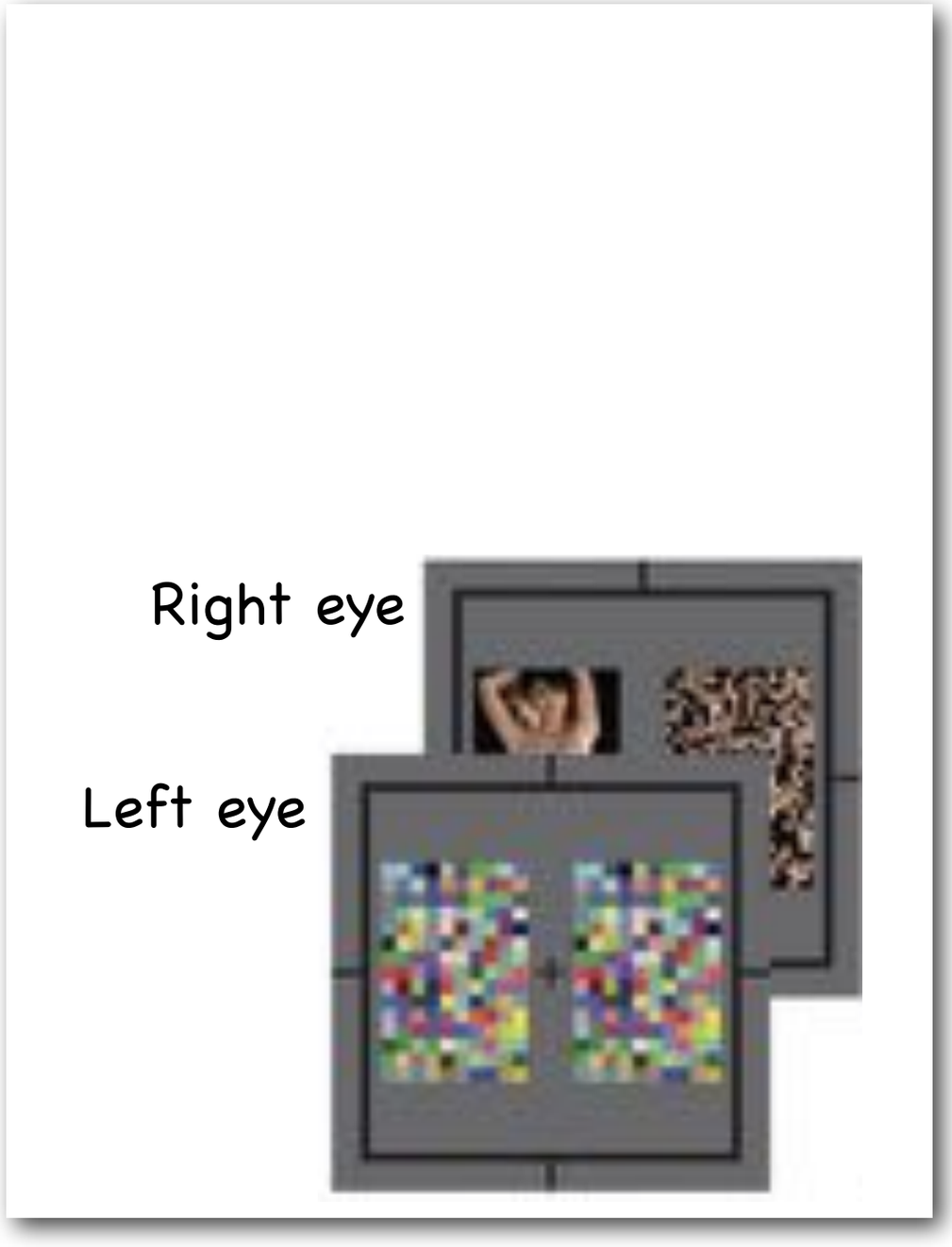

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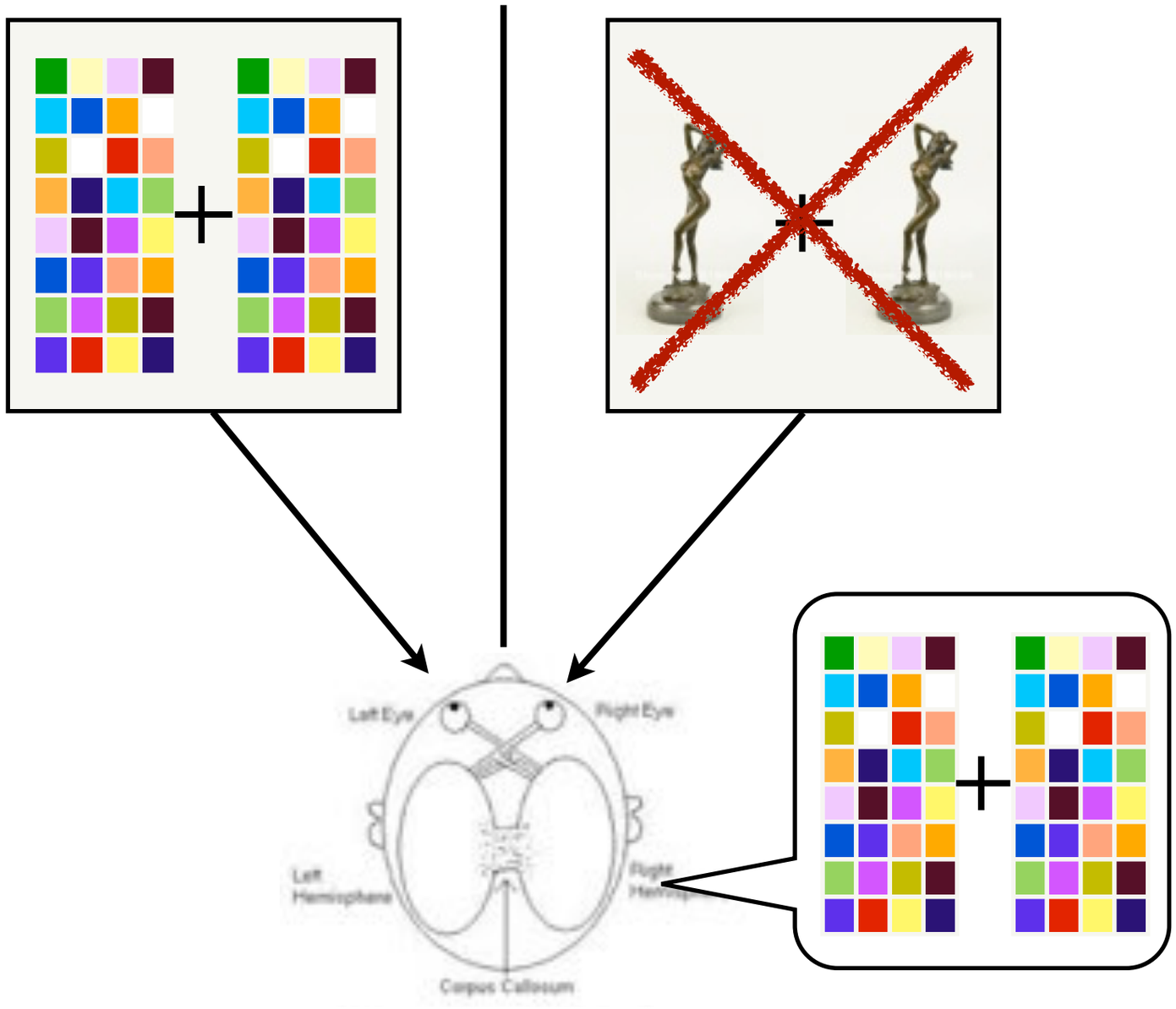

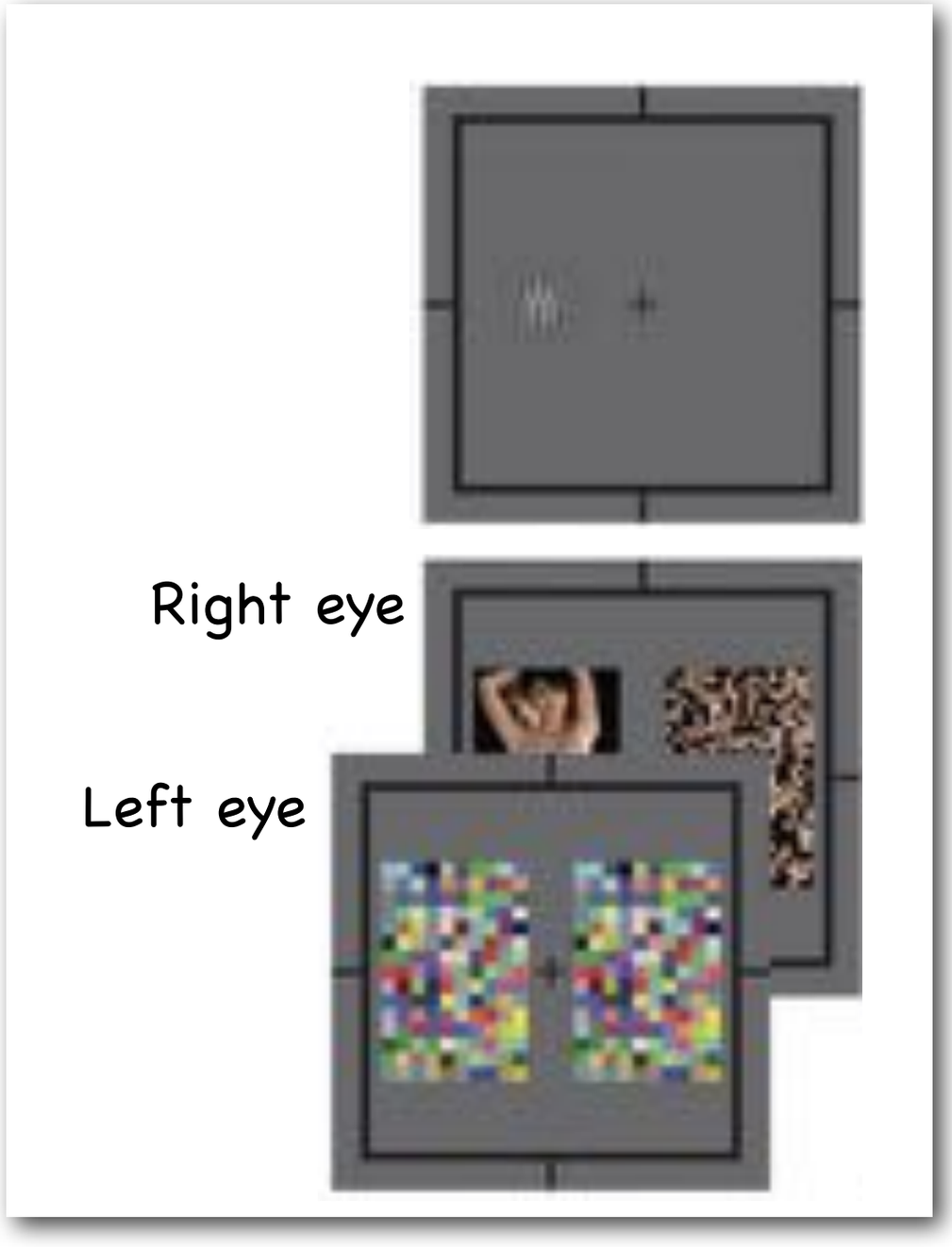

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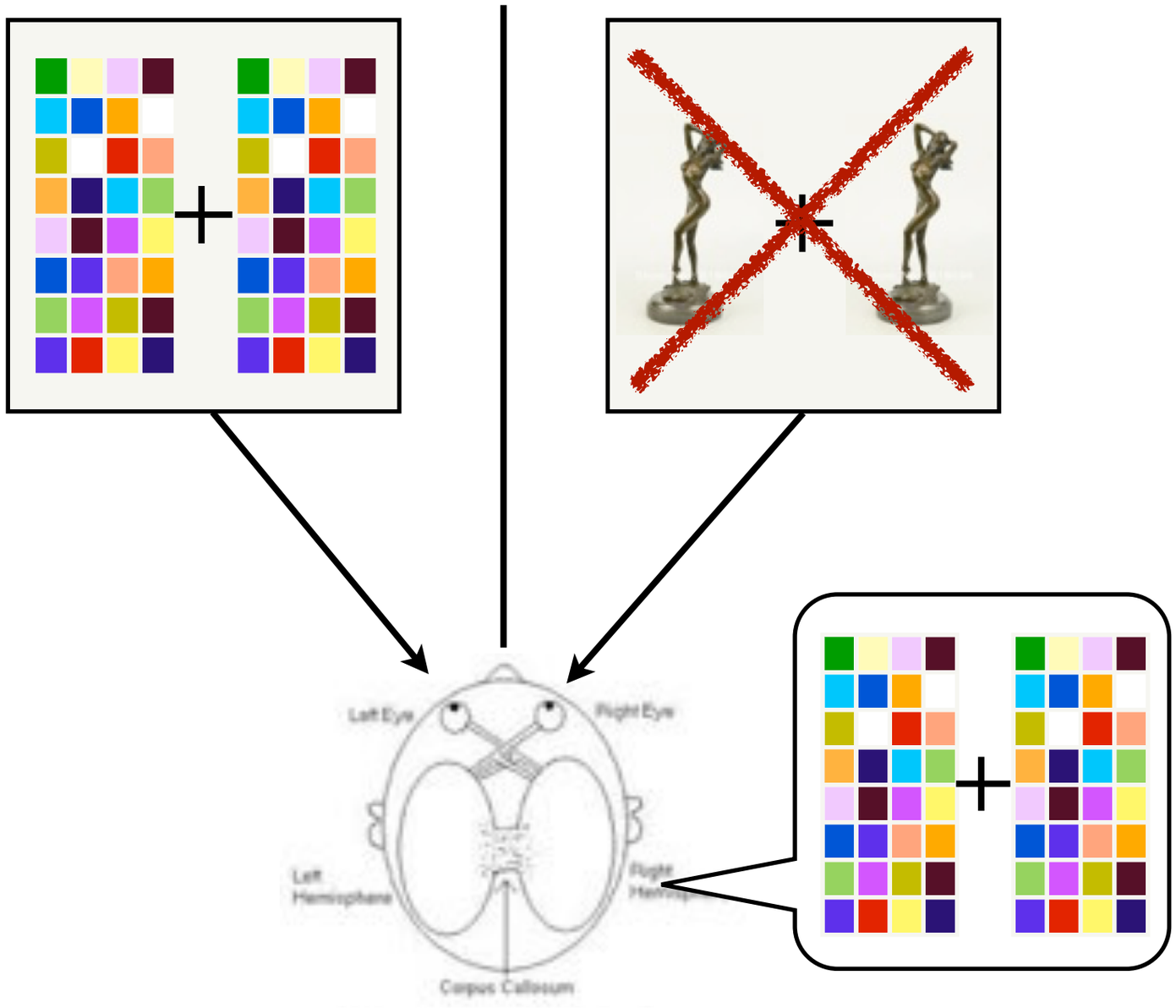
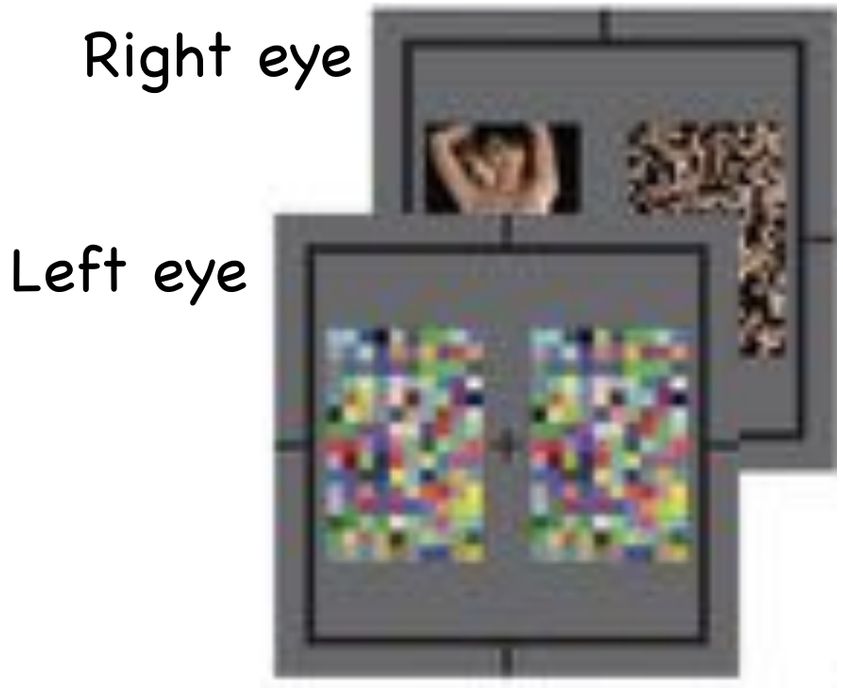


While unaware of the pictures, male (female) subjects' attention was attracted to invisible female (male) nude's side!



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

Understanding visual scenes

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: 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

Potter (1975); Oliva & Torralba (2001)

Understanding visual scenes

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Understanding visual scenes

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

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Outdoor/Indoor?

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Outdoor/Indoor?
Natural/Man-made?

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

Potter (1975); Oliva & Torralba (2001)

Understanding visual scenes

Understanding visual scenes

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

Understanding visual scenes

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Understanding visual scenes

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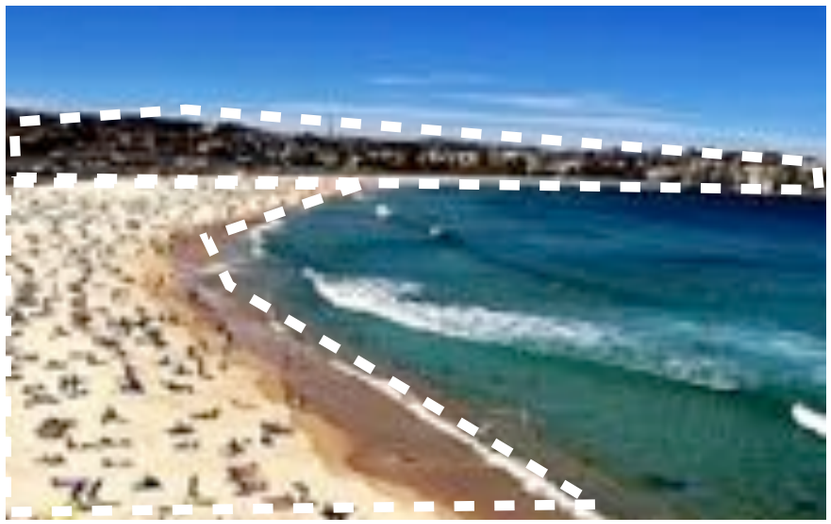

Understanding visual scenes

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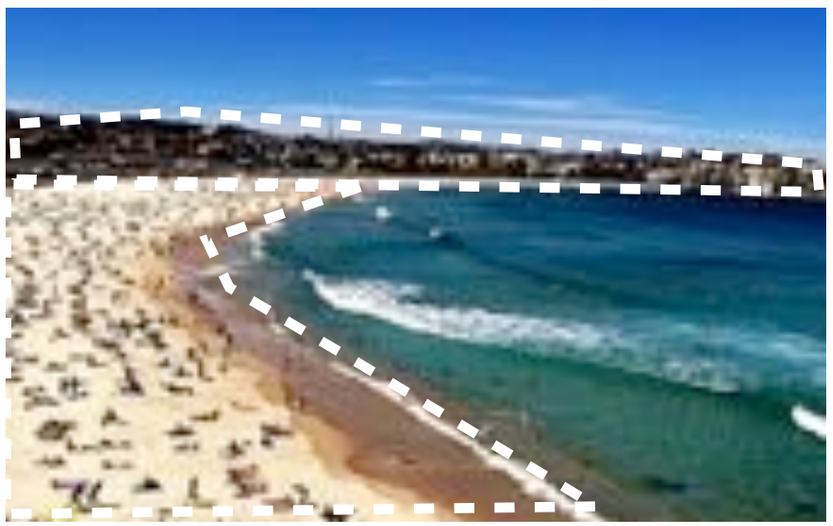
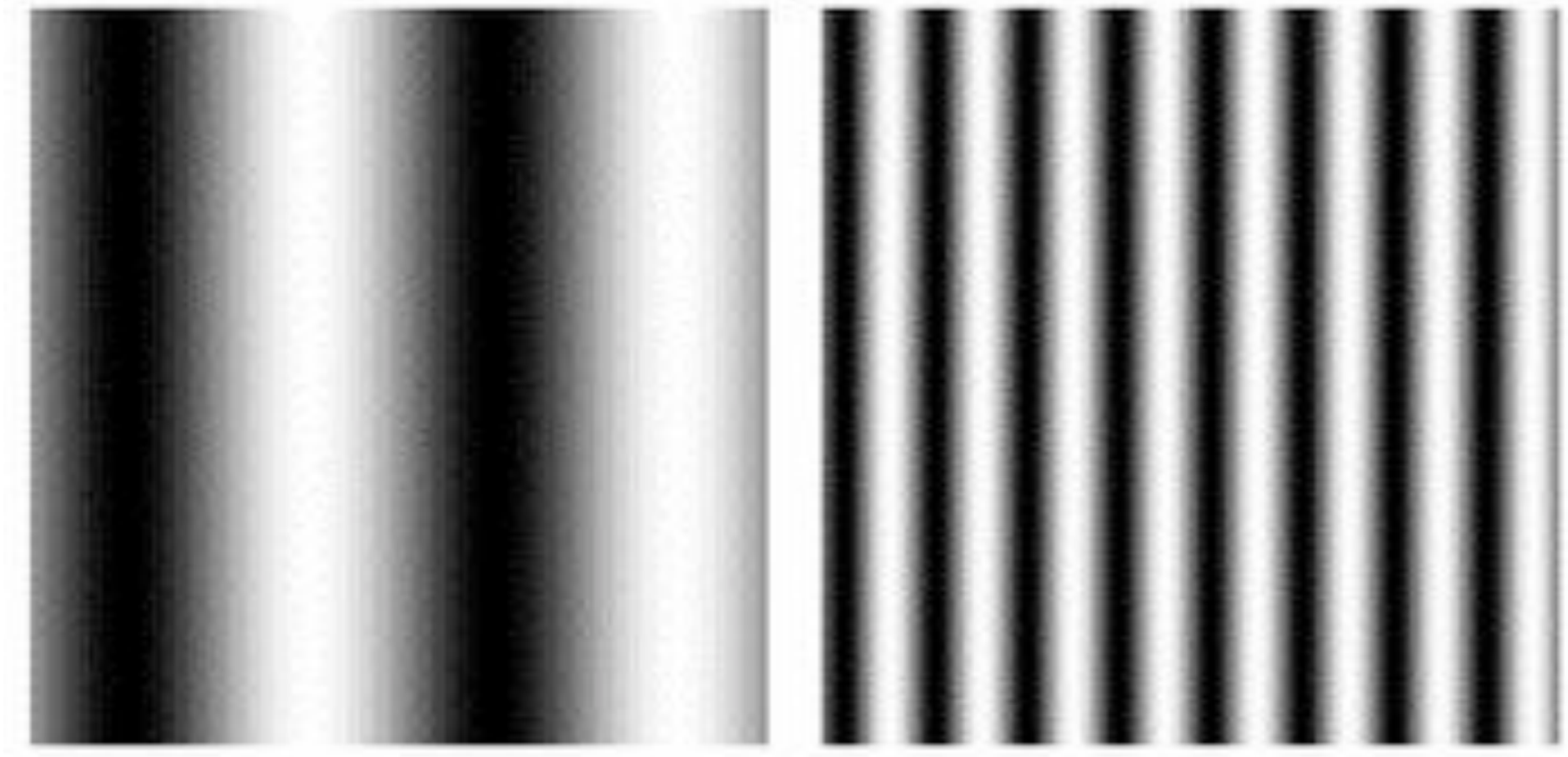


How can this be achieved so fast?

How can perceiving scenes be so fast?

Two different components of a visual scene

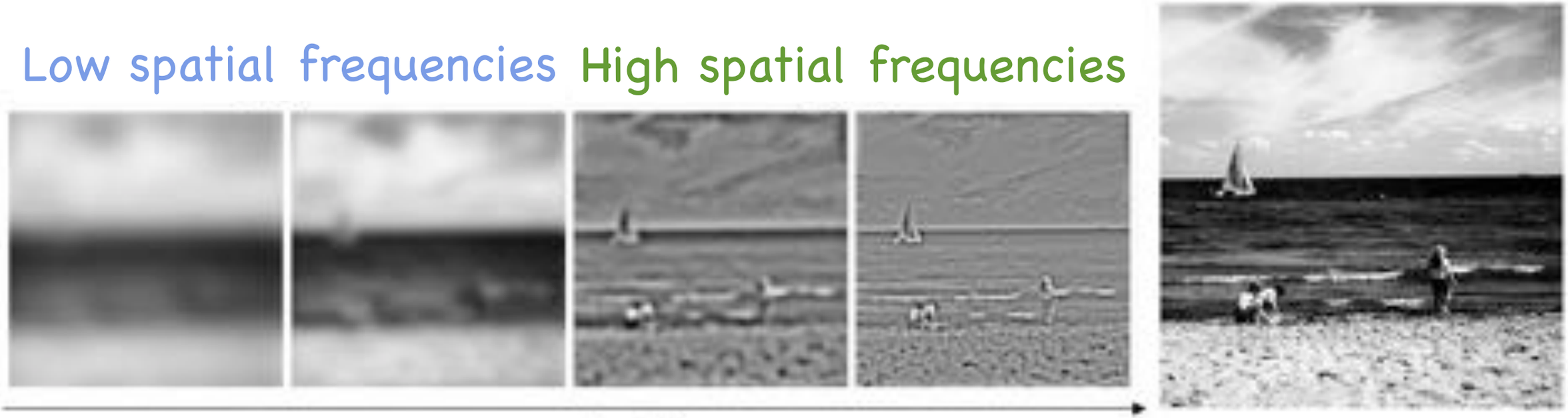


Low spatial frequency

High spatial frequency

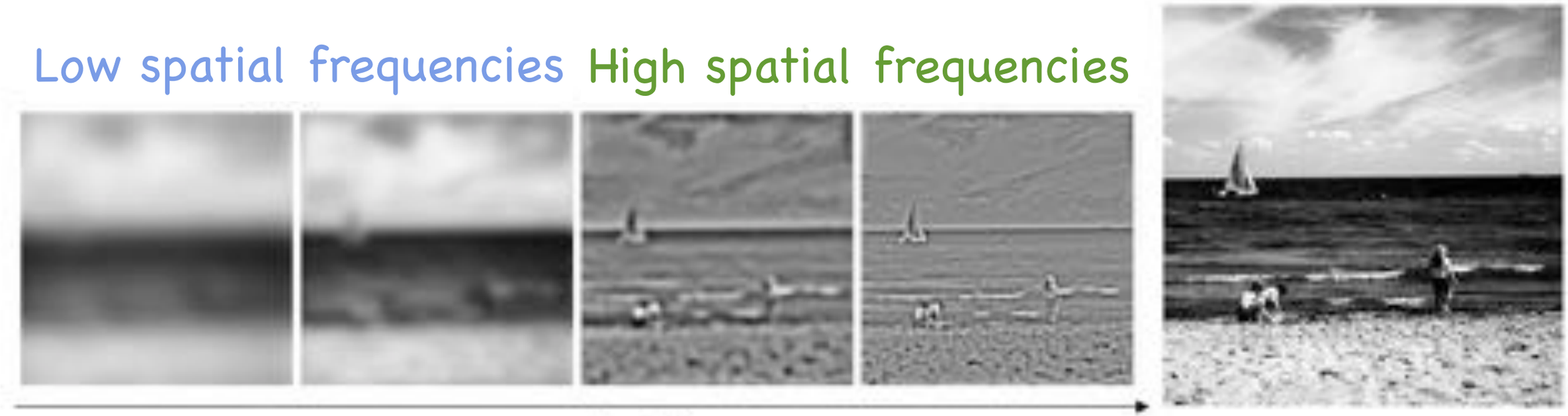
How can perceiving scenes be so fast?

Low spatial frequencies High spatial frequencies



Coarse to fine

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

Wolfe (2011)

Guided search by global information of a scene

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Guided search by global information of a scene

- Your eye movement

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Guided search by global information of a scene

Your eye movement

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

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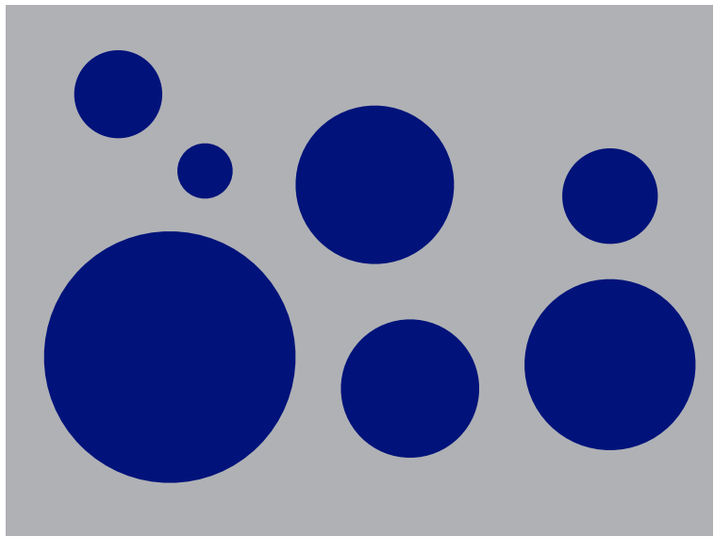
Ensemble representations

Knowledge about the properties of a group of objects

Ensemble representations

Knowledge about the properties of a group of objects

Mean size



Ariely, 2001; Chong & Treisman, 2003

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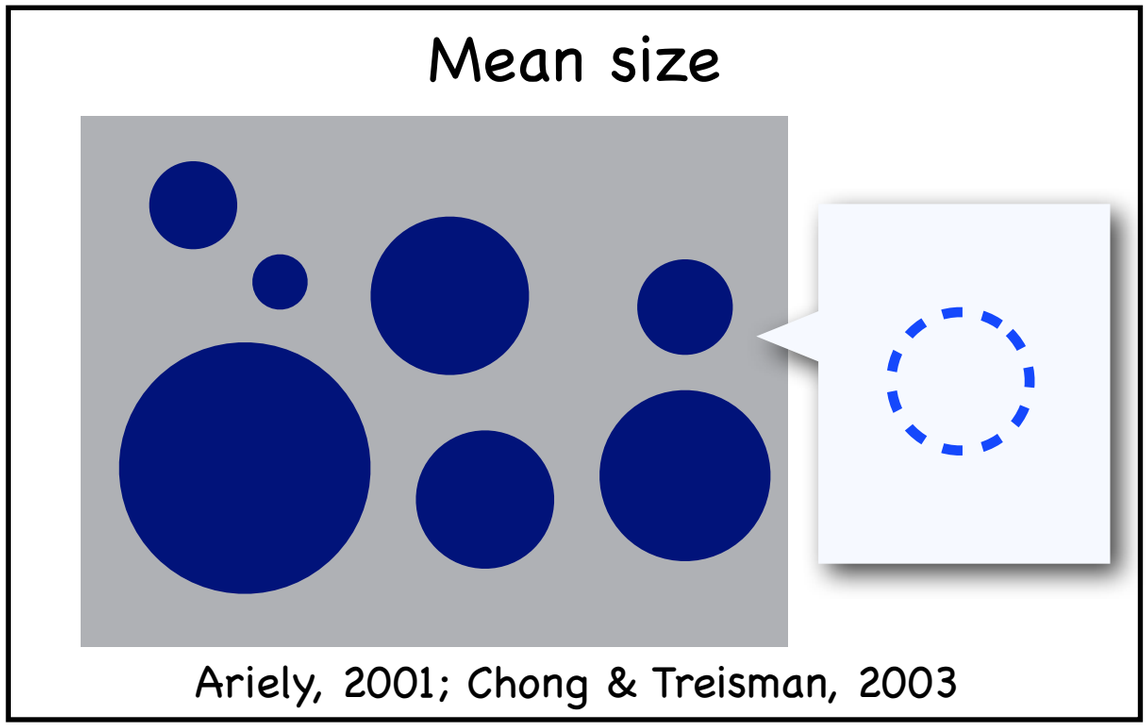

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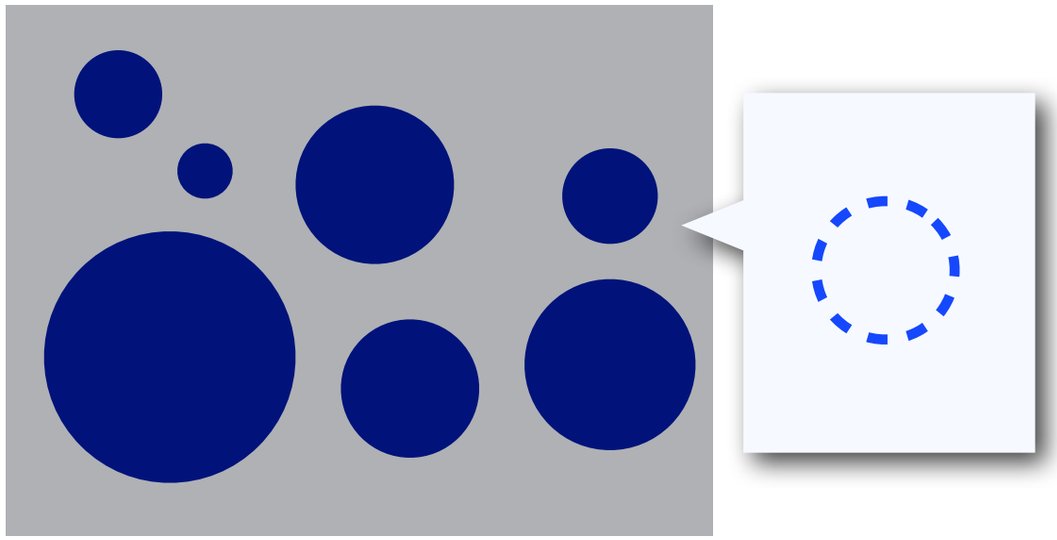

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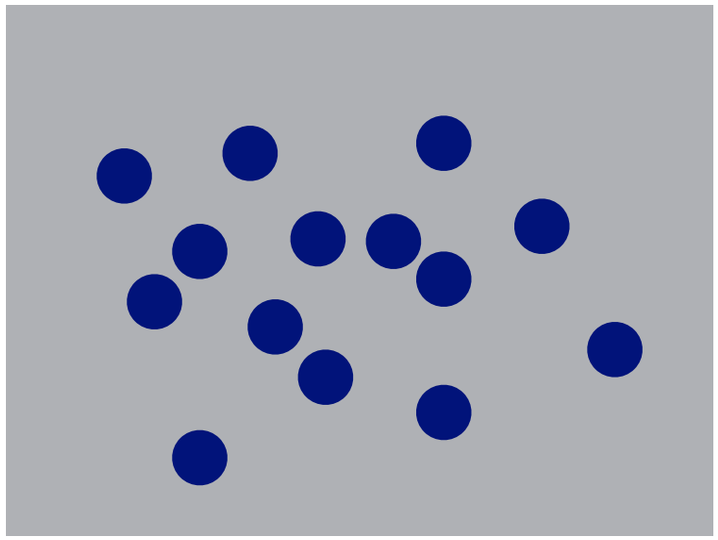
Approximate number



Halberda, Sires, & Feigenson, 2006

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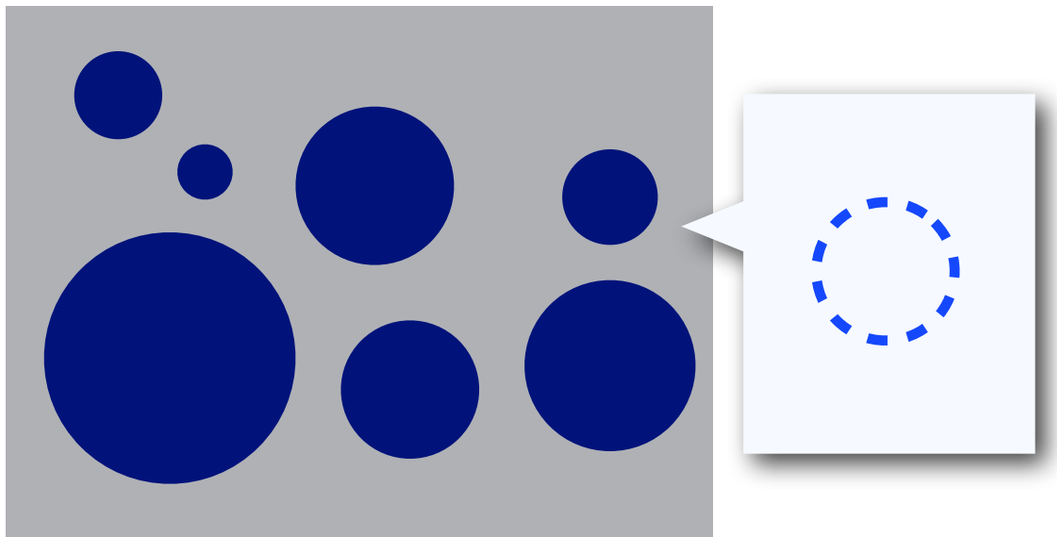

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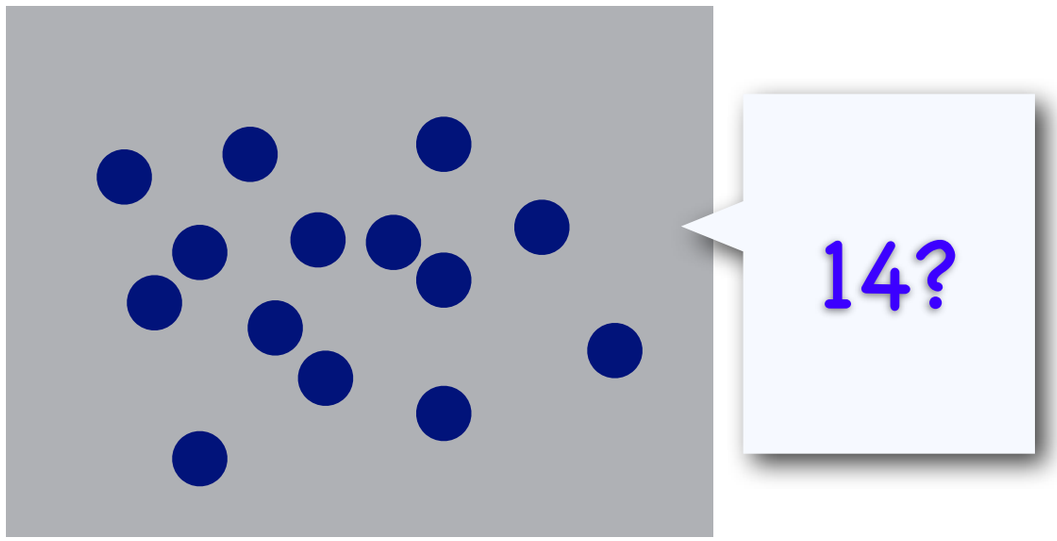

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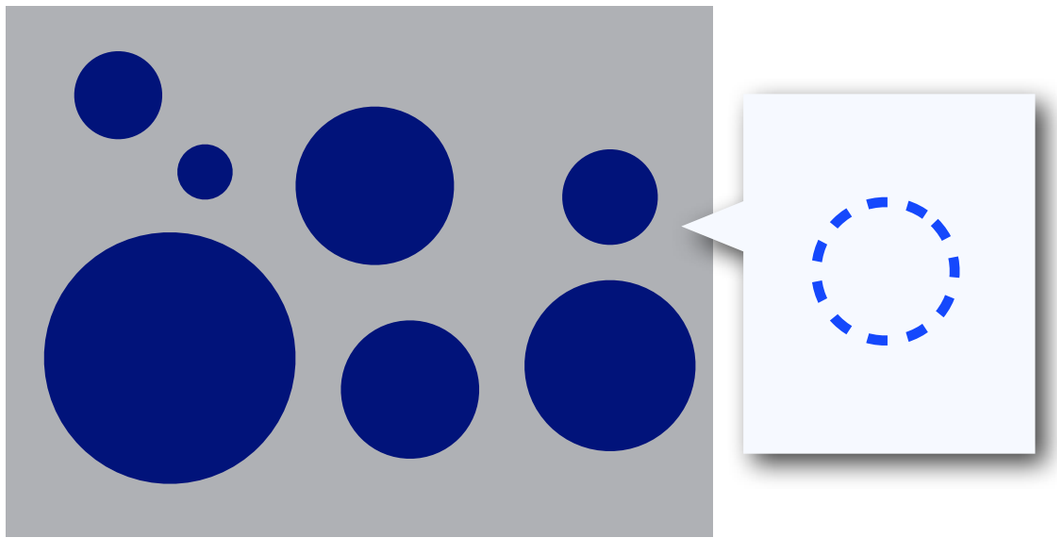

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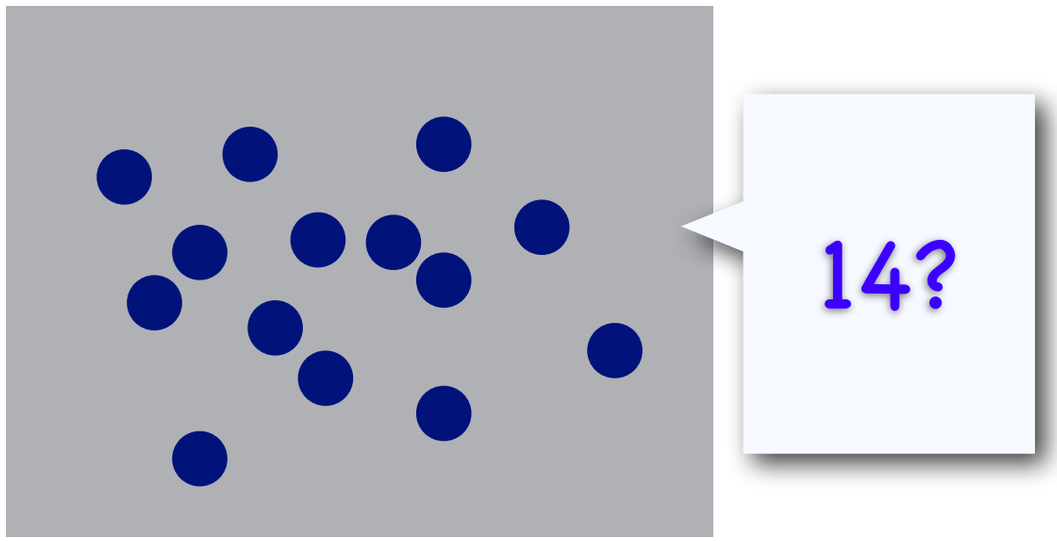

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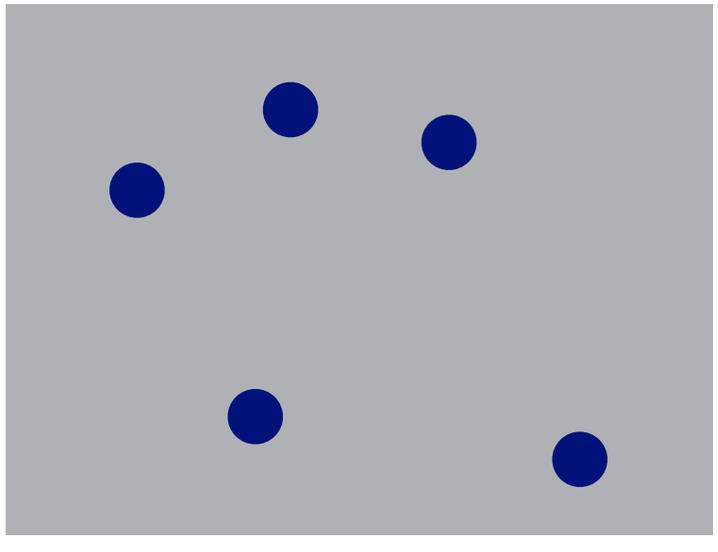
Centroid



Alvarez & Oliva, 2008

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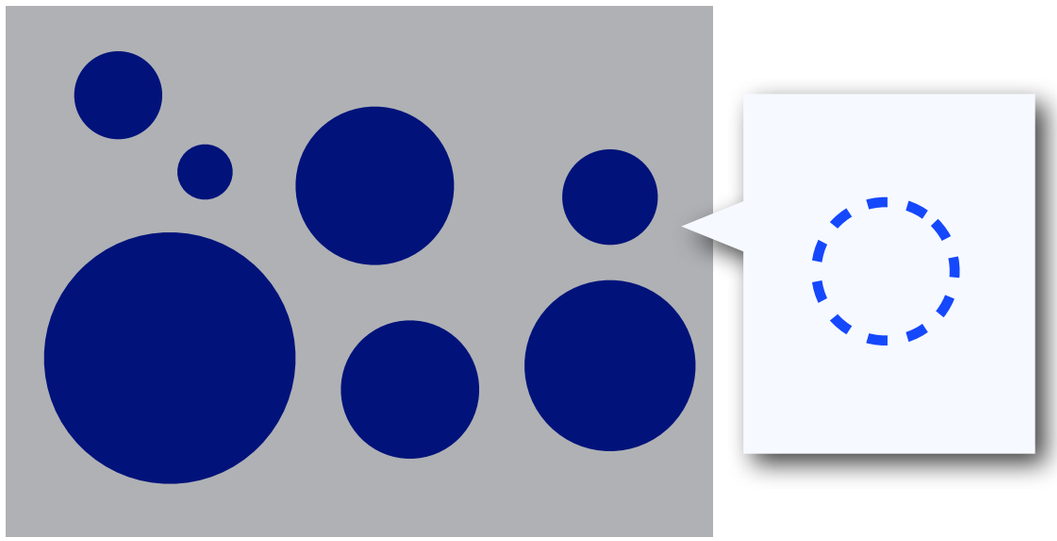

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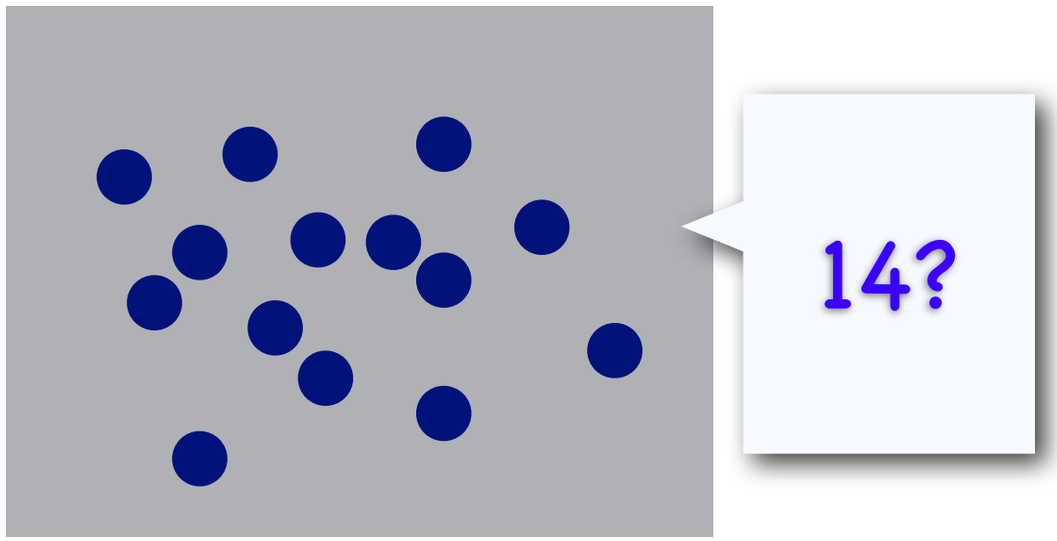

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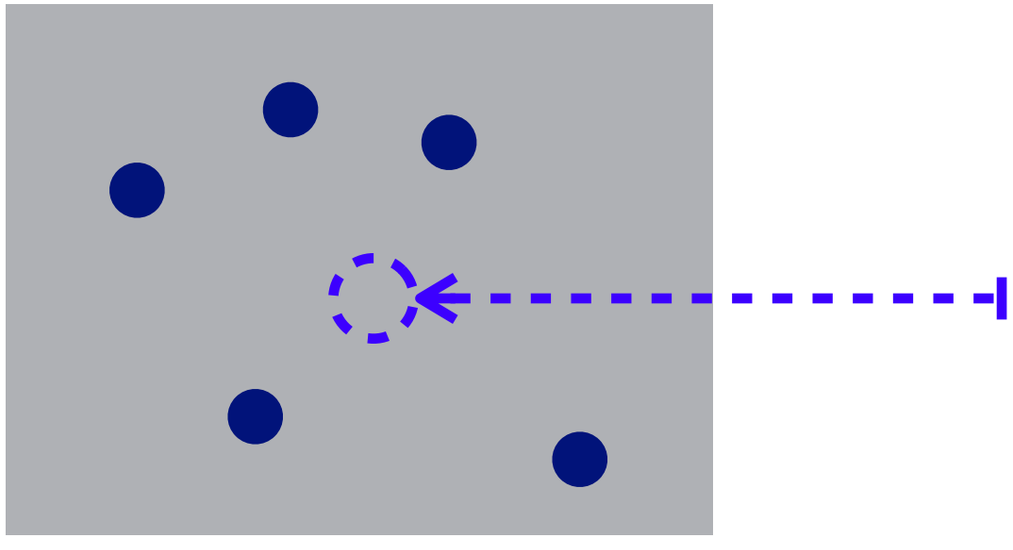

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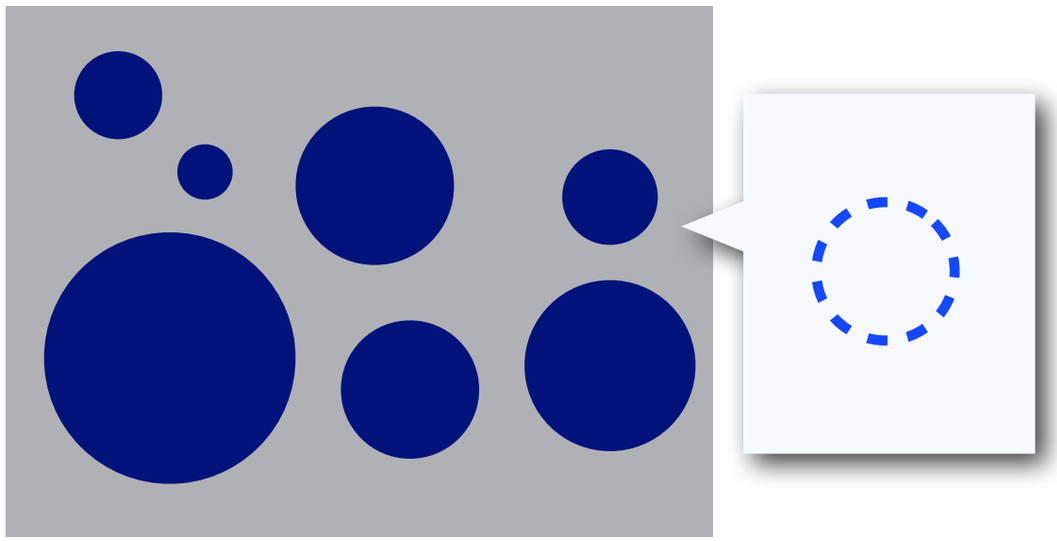

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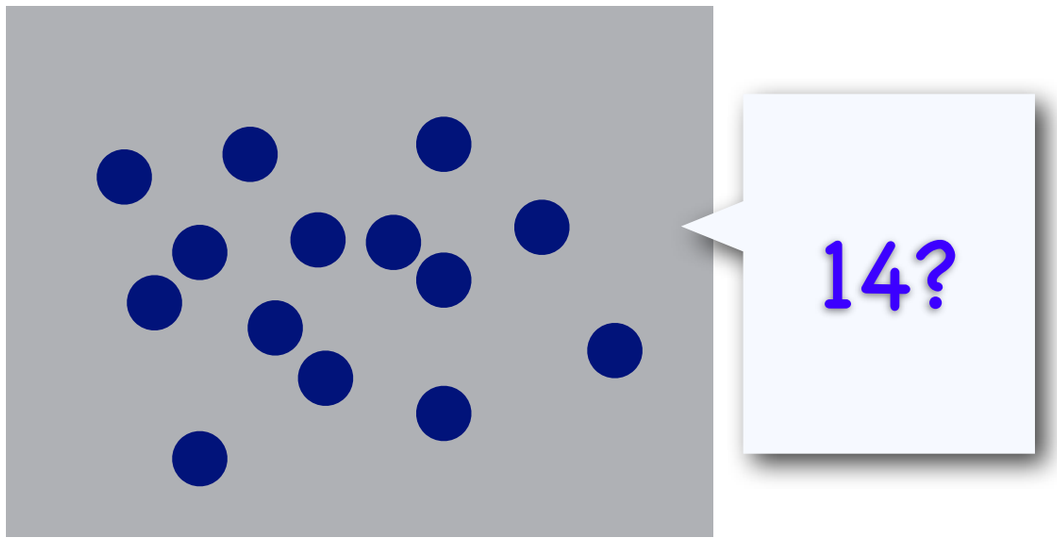

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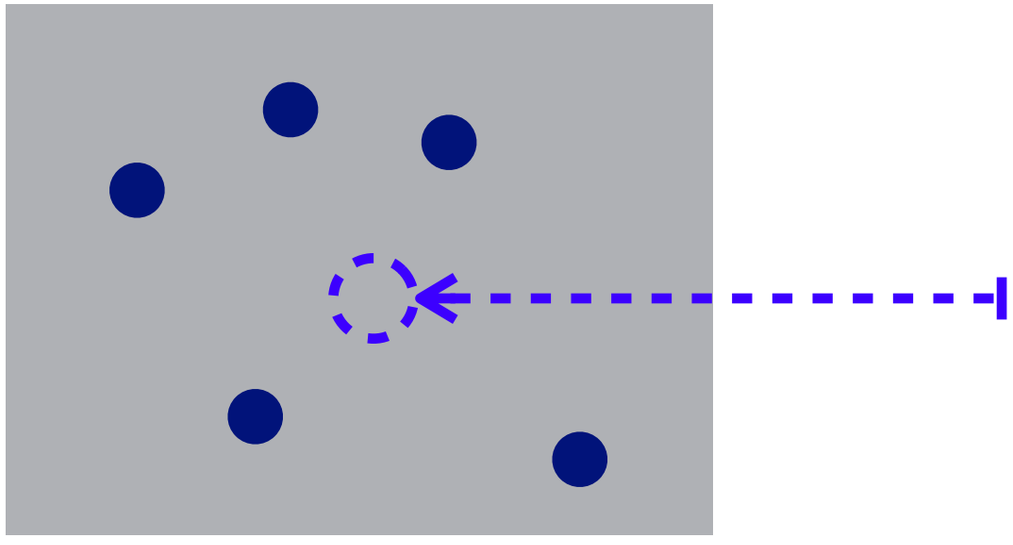

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Mean emotion

Haberman & Whitney, 2007

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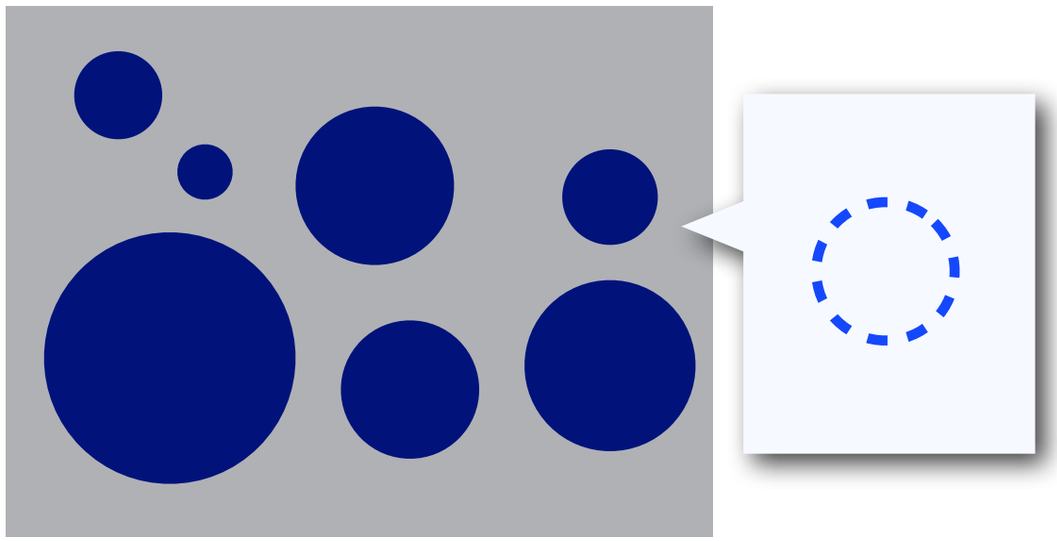

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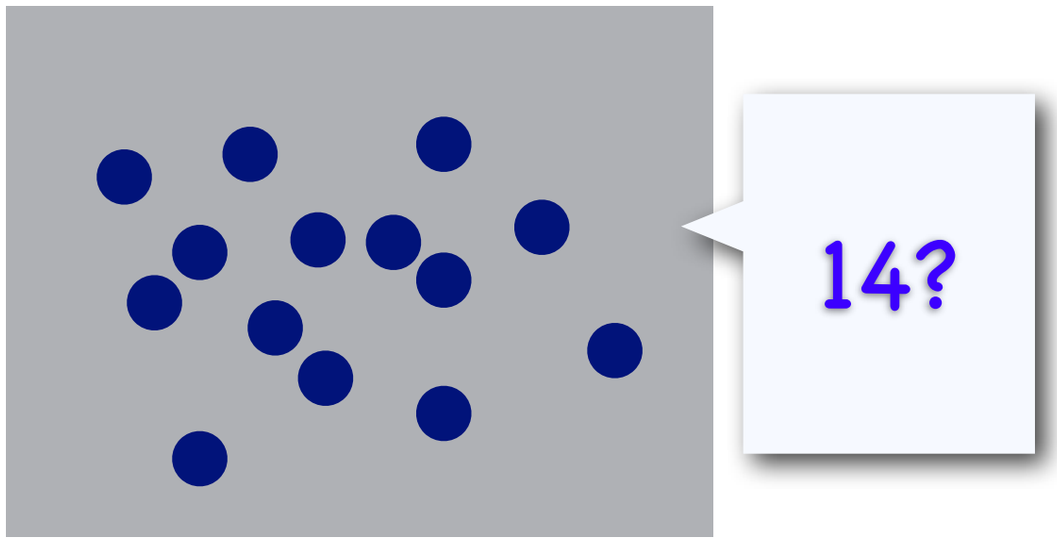

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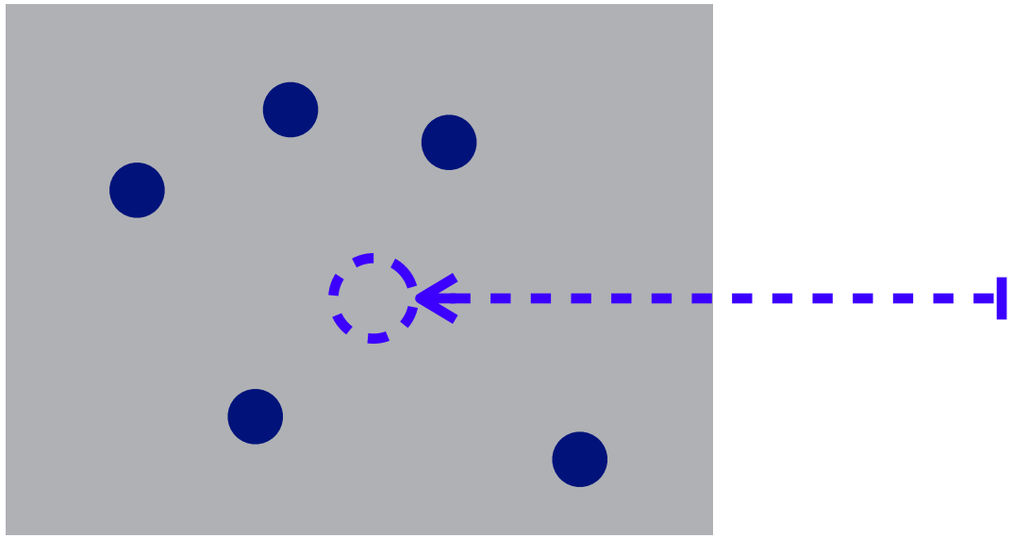

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They are useful because the natural scenes often contain many similar objects



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Redundancy and regularity



Ensemble representations are efficient and economical

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1) Given the limited capacity of attention and memory

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   (EX. Chunking: F-B-I-C-I-A-N-S-A vs. FBI-CIA-NSA)

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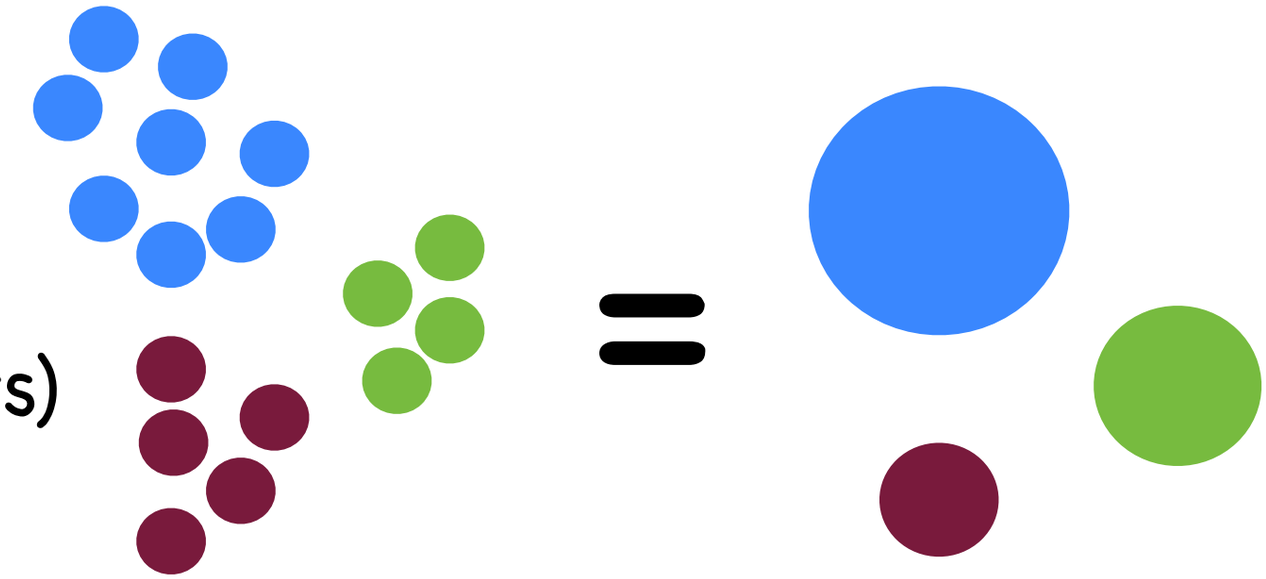
3 Sets
(17 objects)



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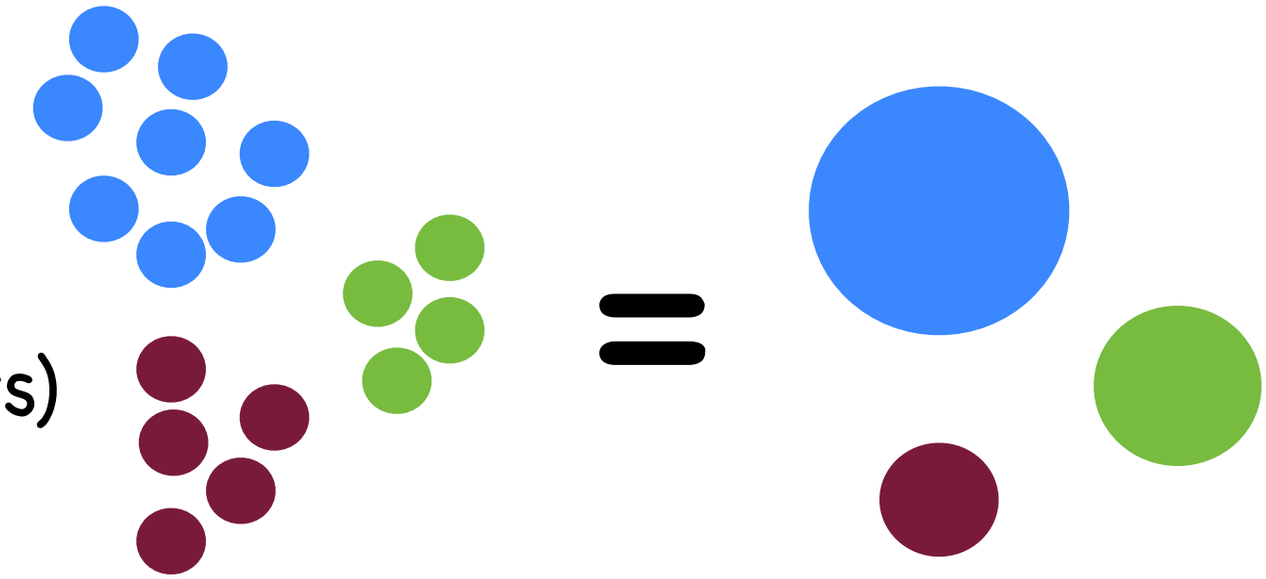

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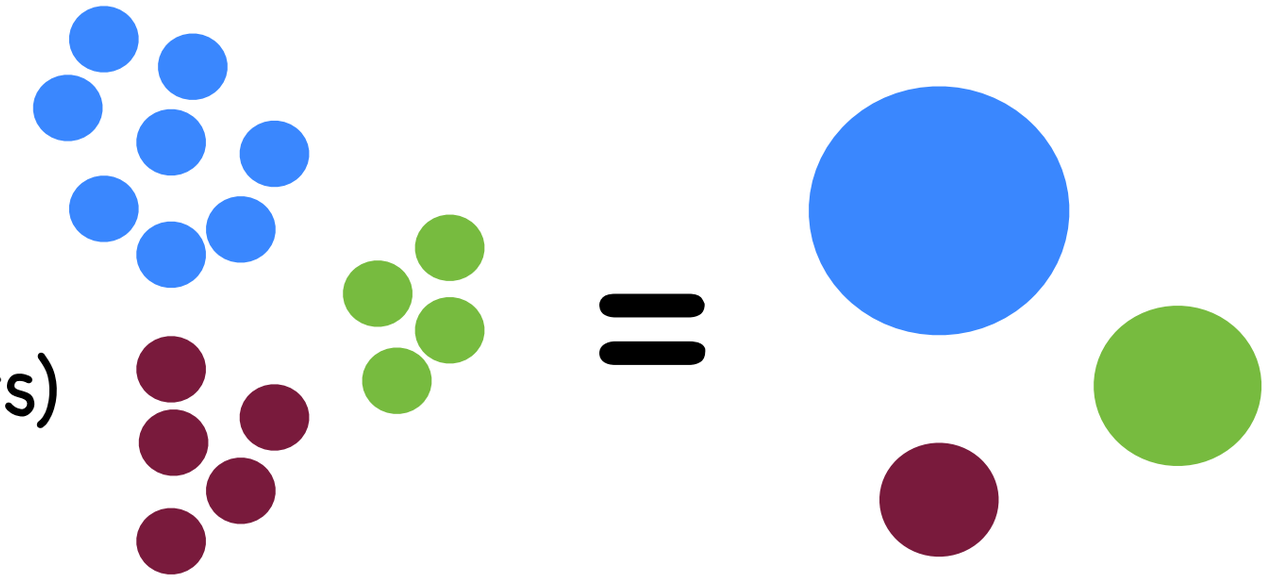

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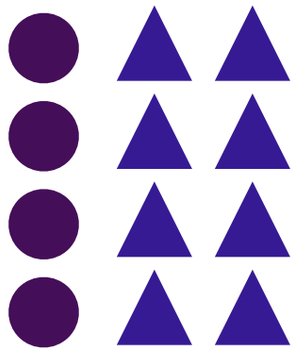
2) Given the remarkable ability to group things together



By similarity

Ensemble representations are efficient and economical

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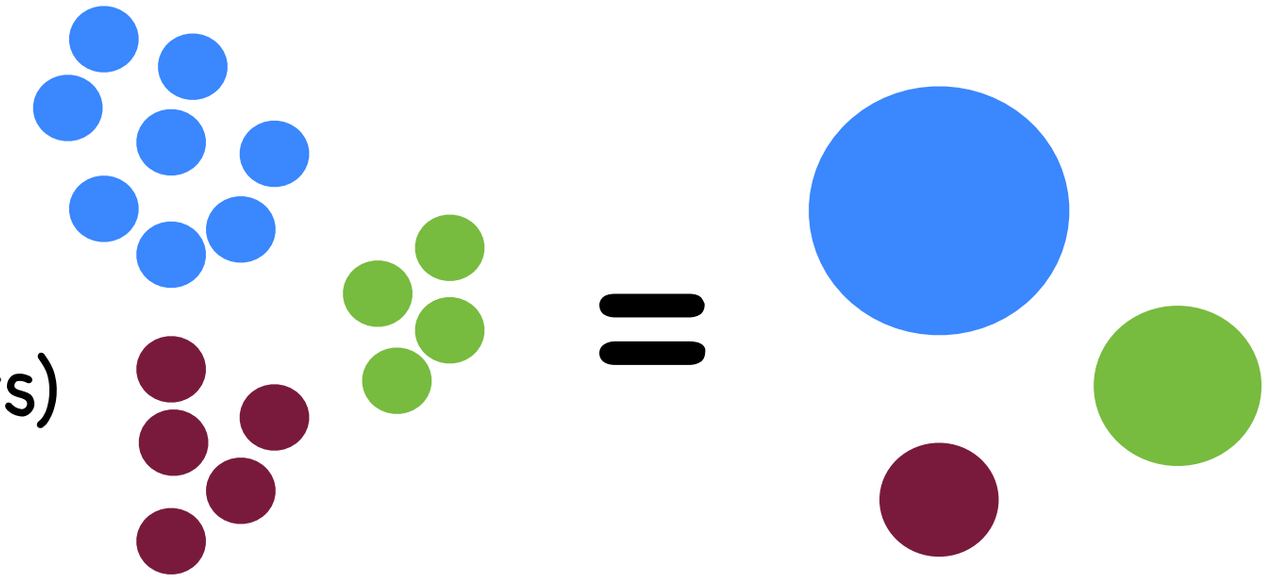
(EX. Chunking: F-B-I-C-I-A-N-S-A vs. FBI-CIA-NSA)

3 Sets
(17 objects)



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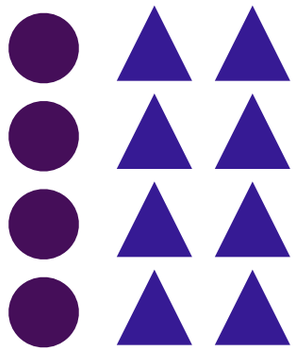

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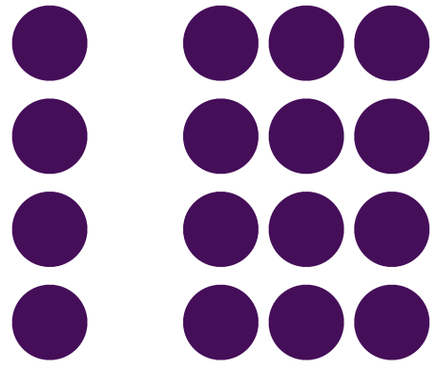

By distance

You use ensemble representations everyday

You use ensemble representations everyday

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You are very good at computing ensemble representations

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Better than you know about a single element

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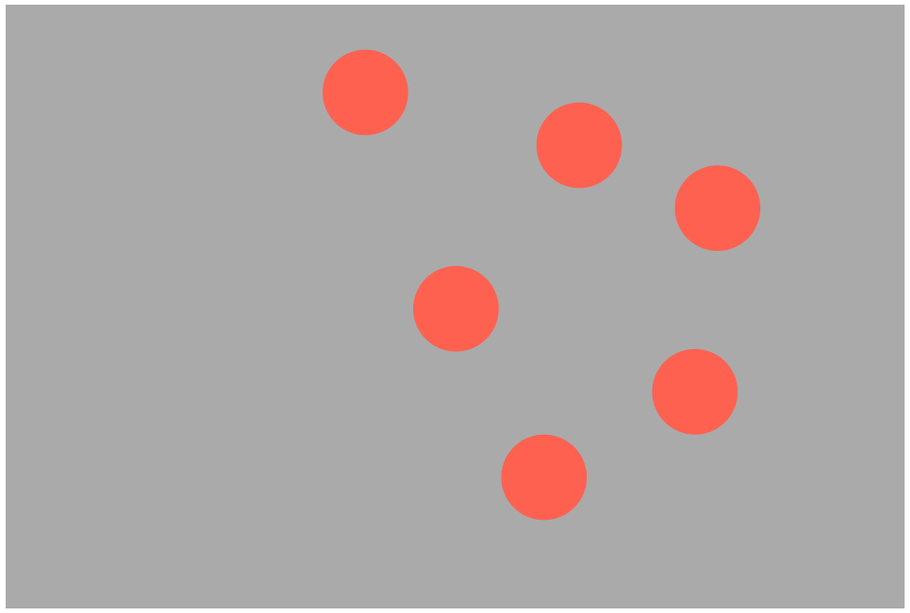

Remember all the locations
of six red dots!

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Remember all the locations
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Remember all the locations of six red dots!

Where is one missing dot?

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Remember all the locations
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Where is one missing dot?

Where is the average location
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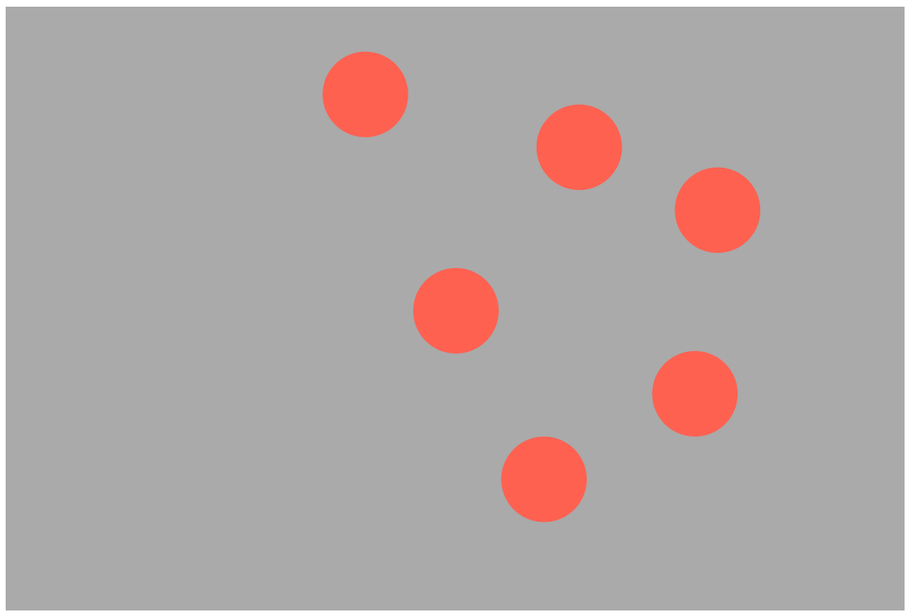

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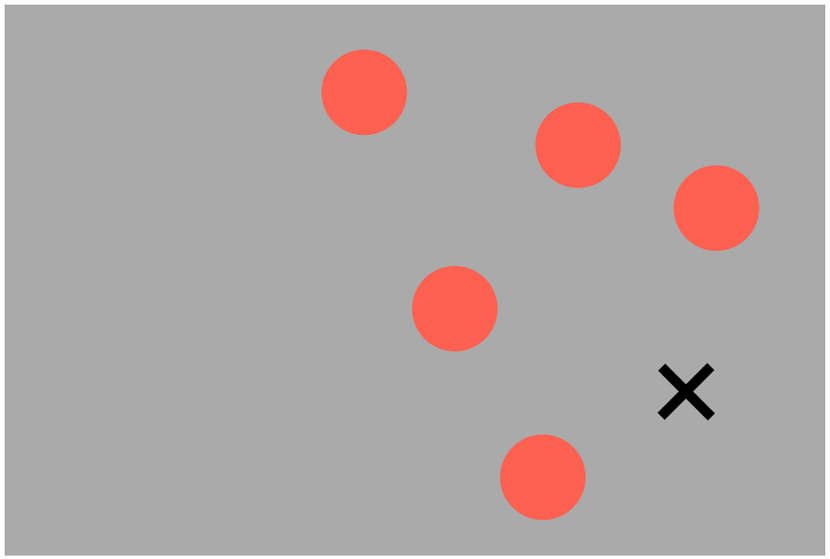

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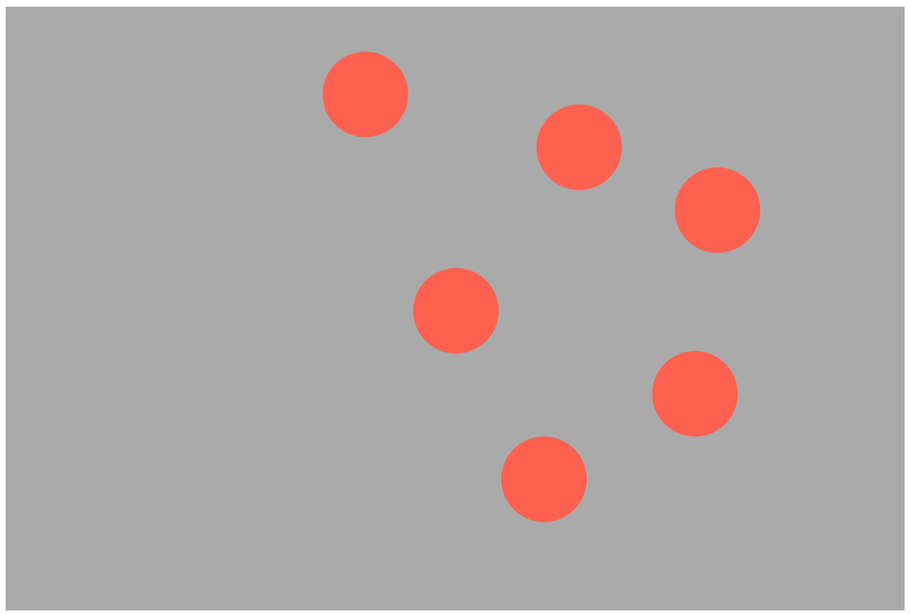

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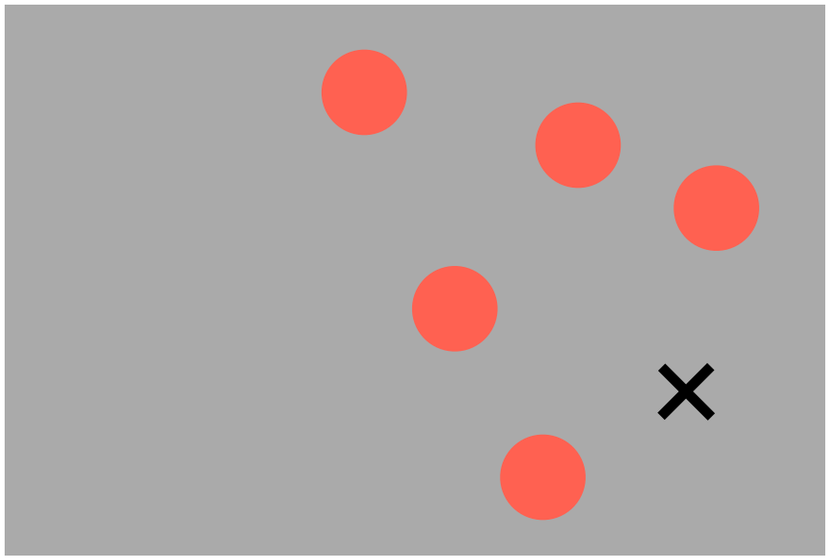

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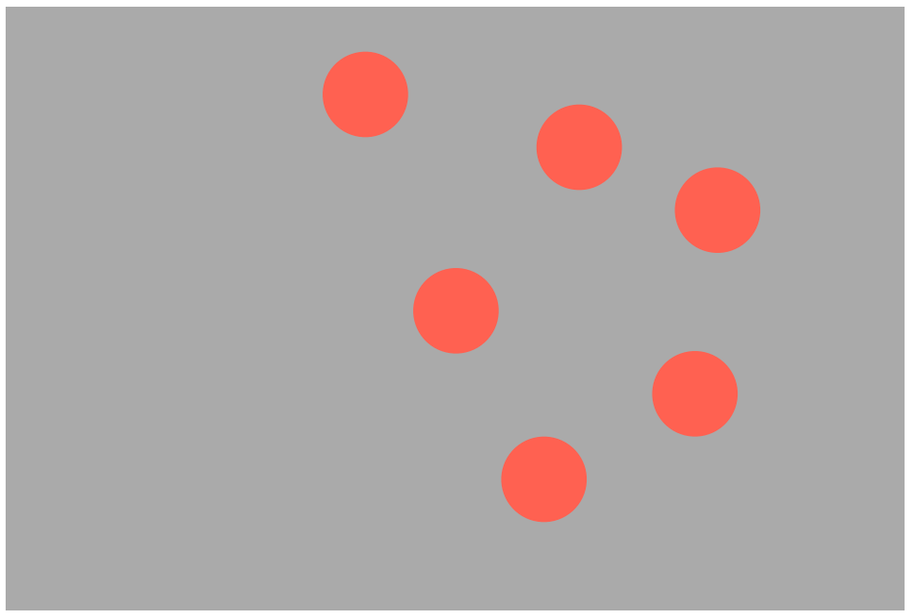

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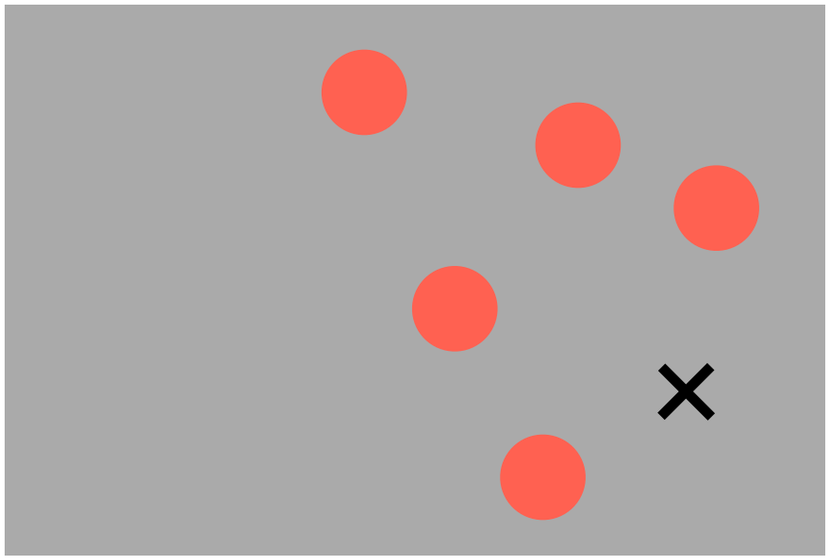

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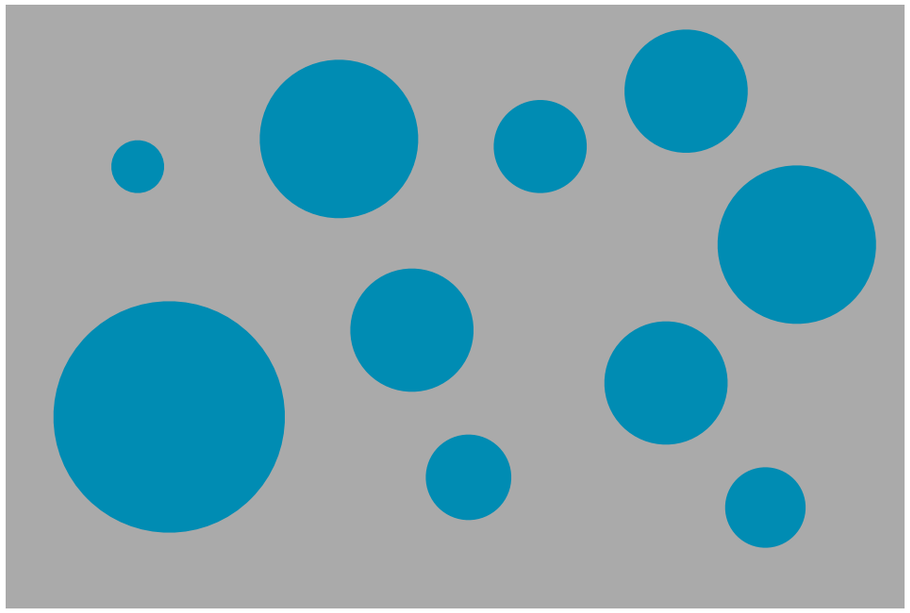

Remember all the sizes of 10 circles!

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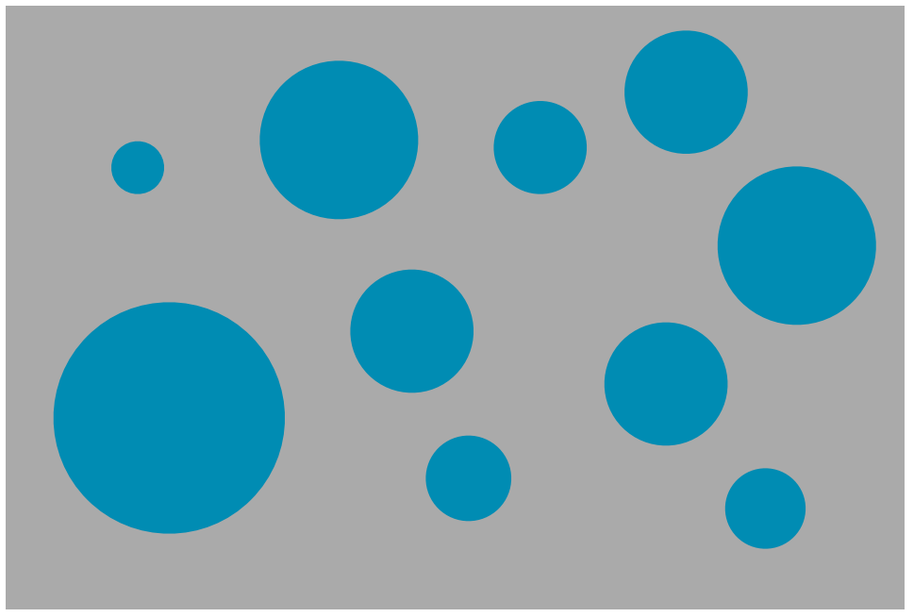

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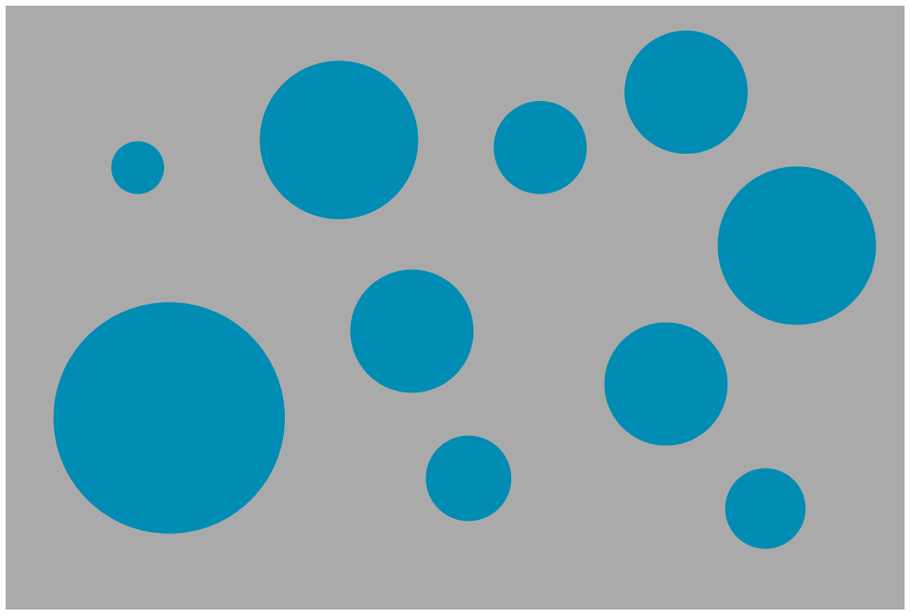

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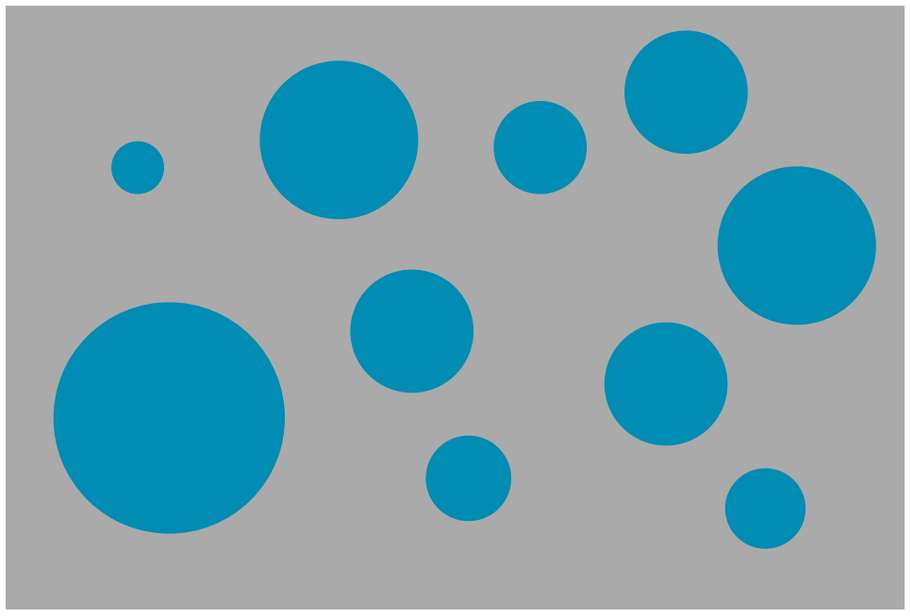

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Even babies can use ensemble representations, too

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Experimenters tested this by making infants get bored (Habituation)

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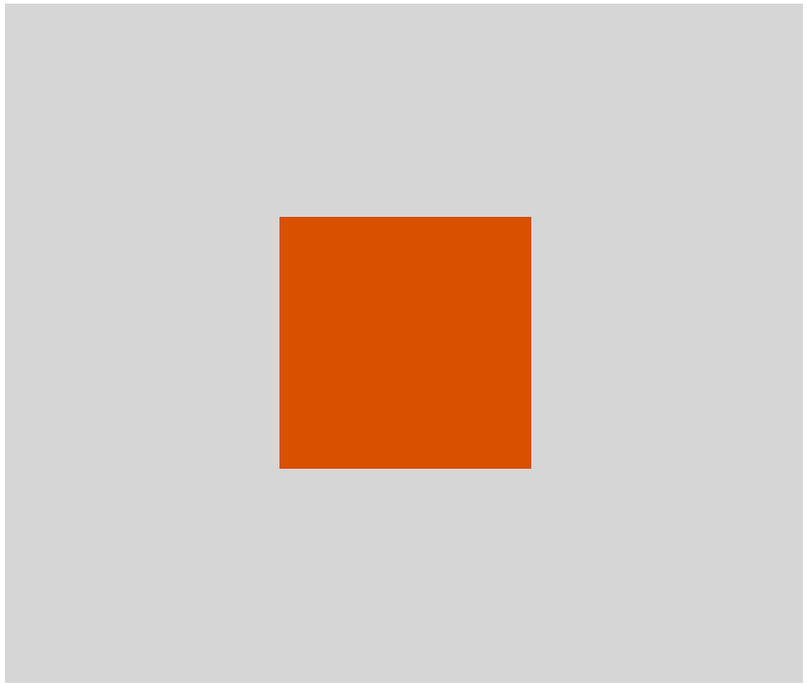

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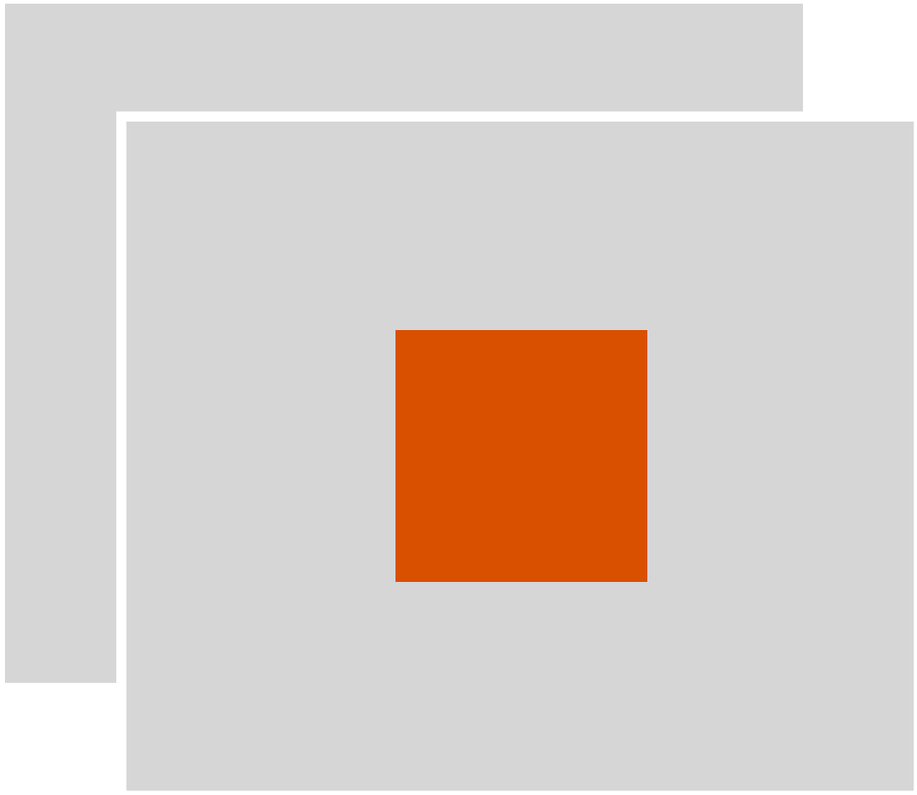

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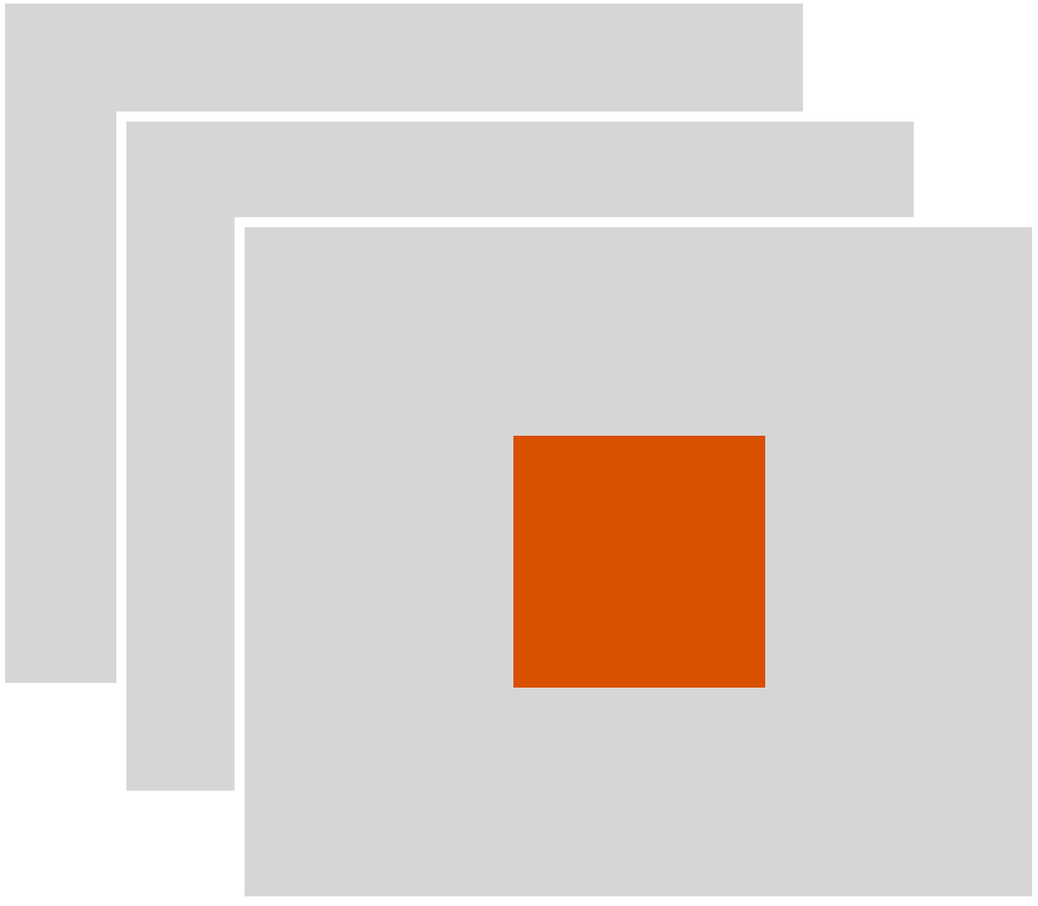

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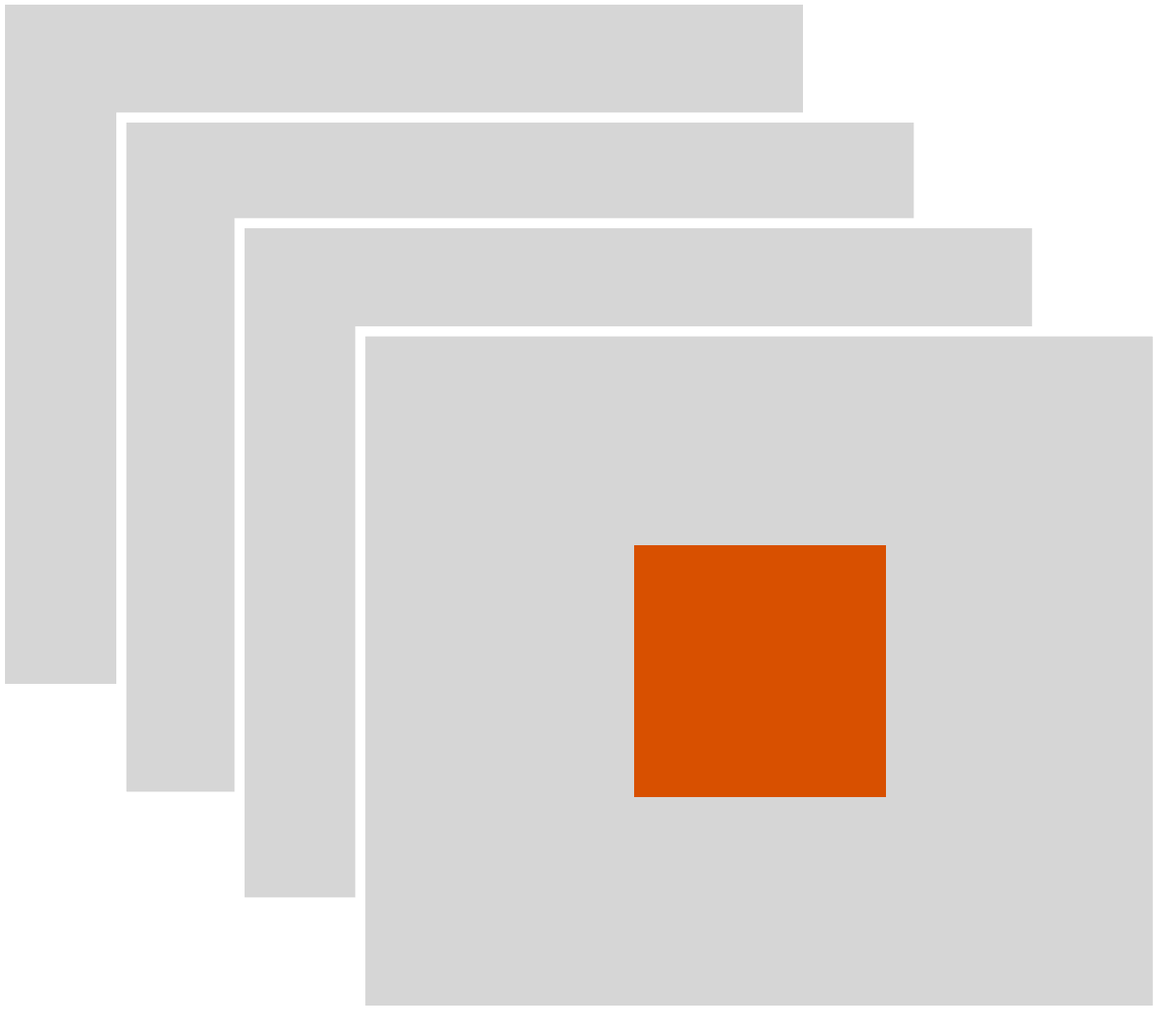

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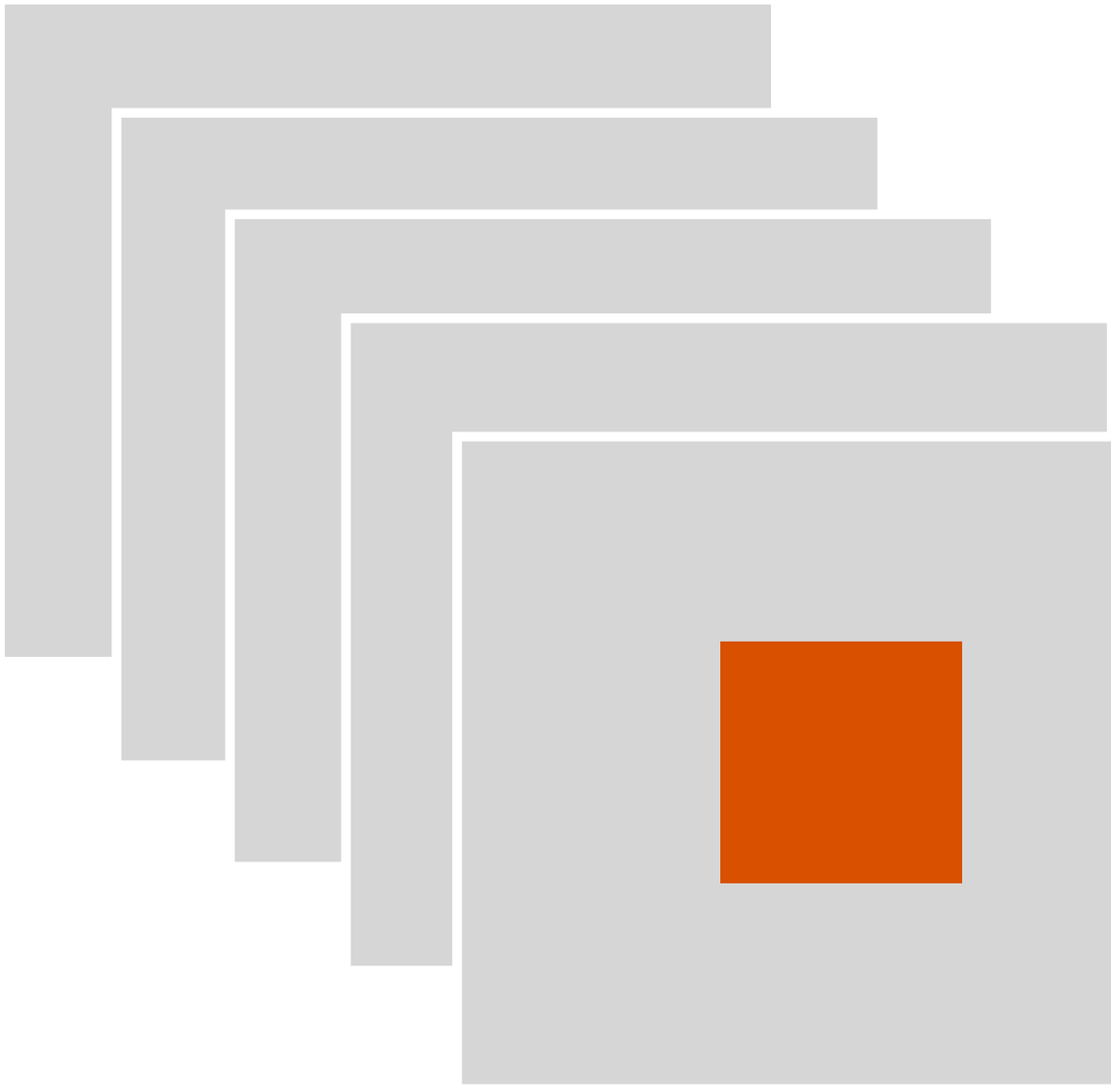

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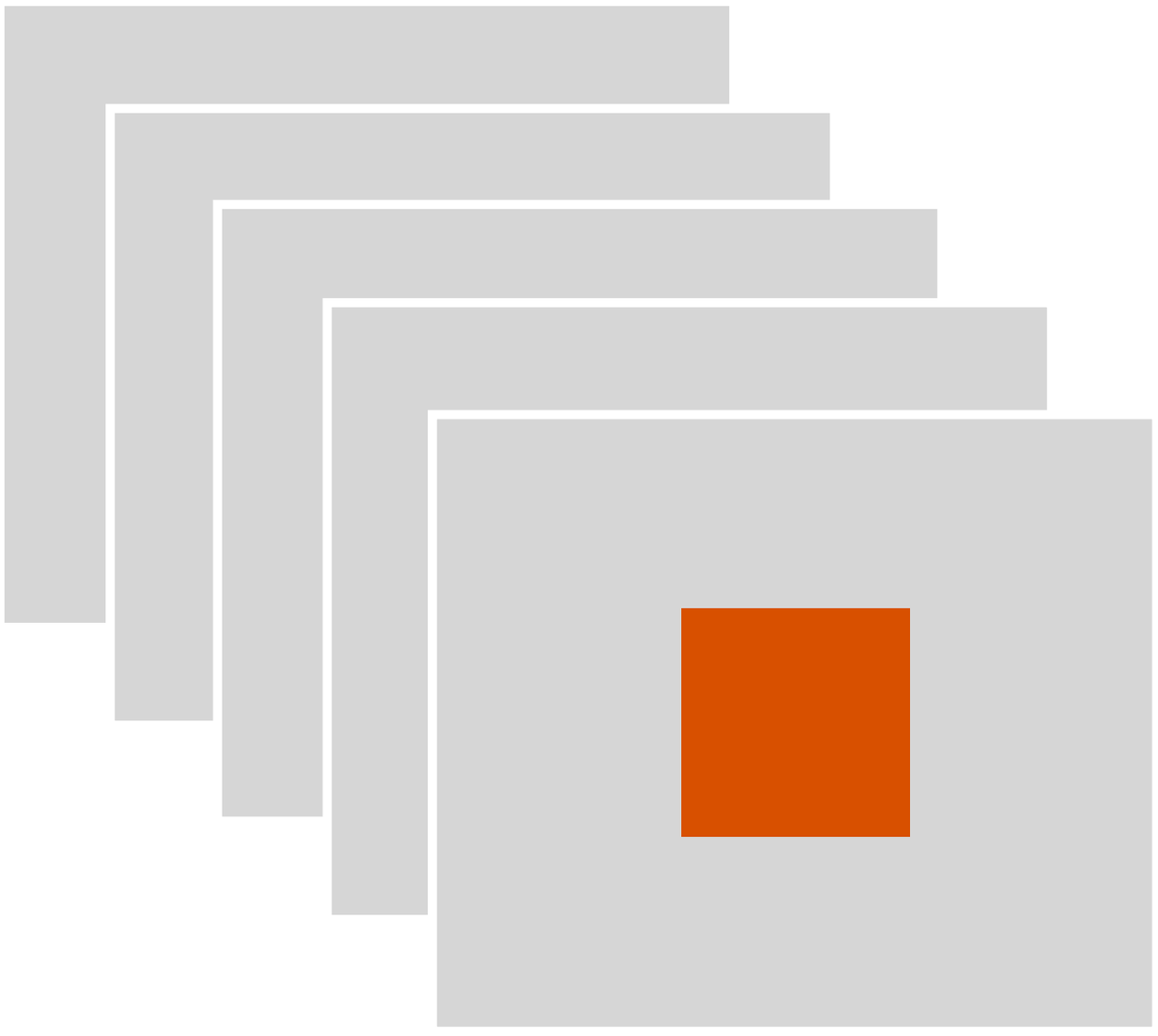

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Testing infants' ability to estimate the approximate number of items

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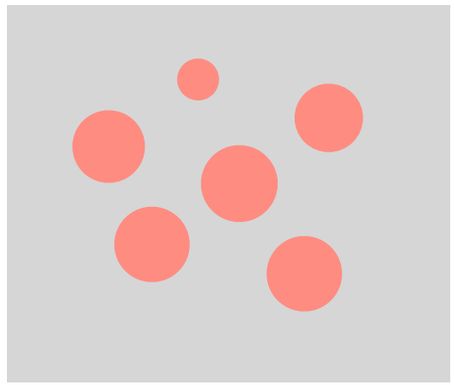

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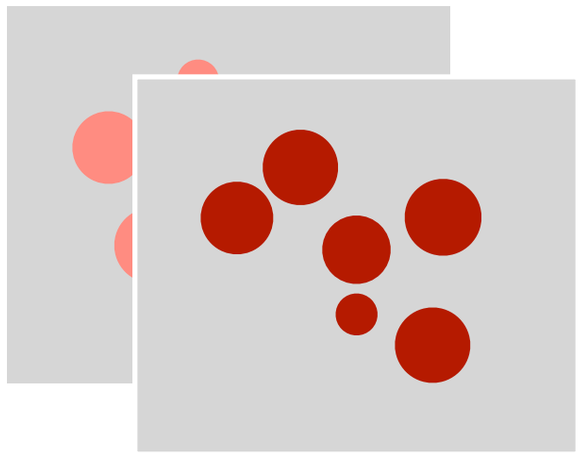

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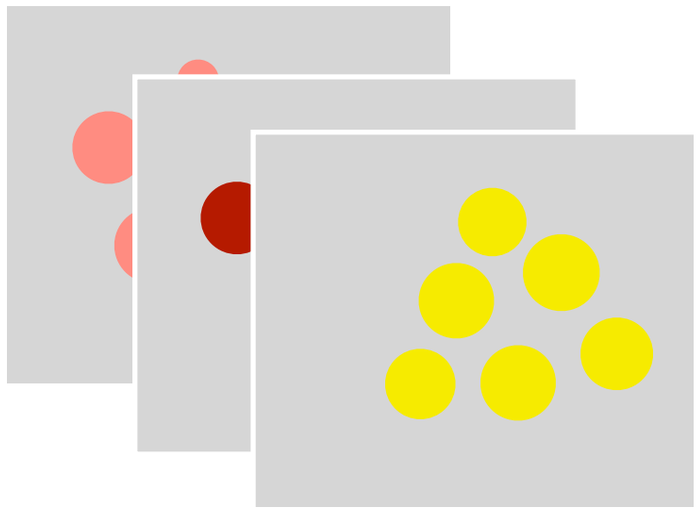

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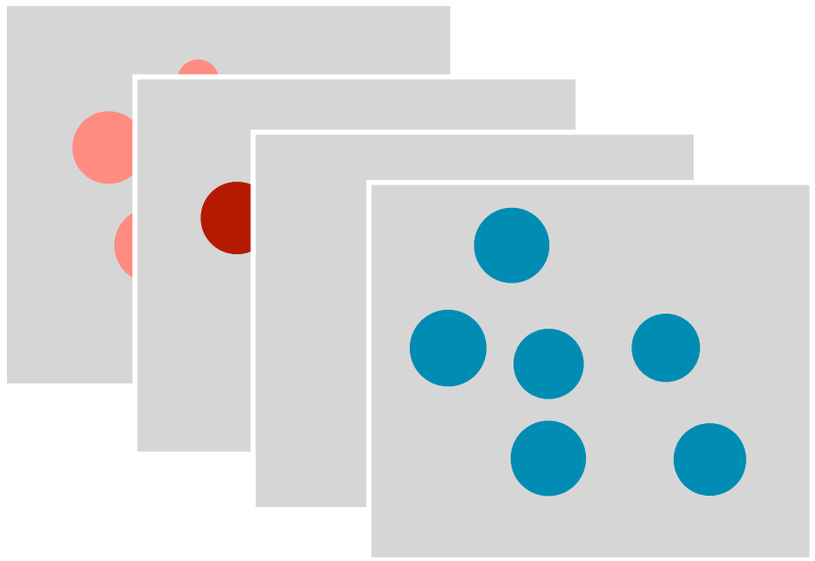

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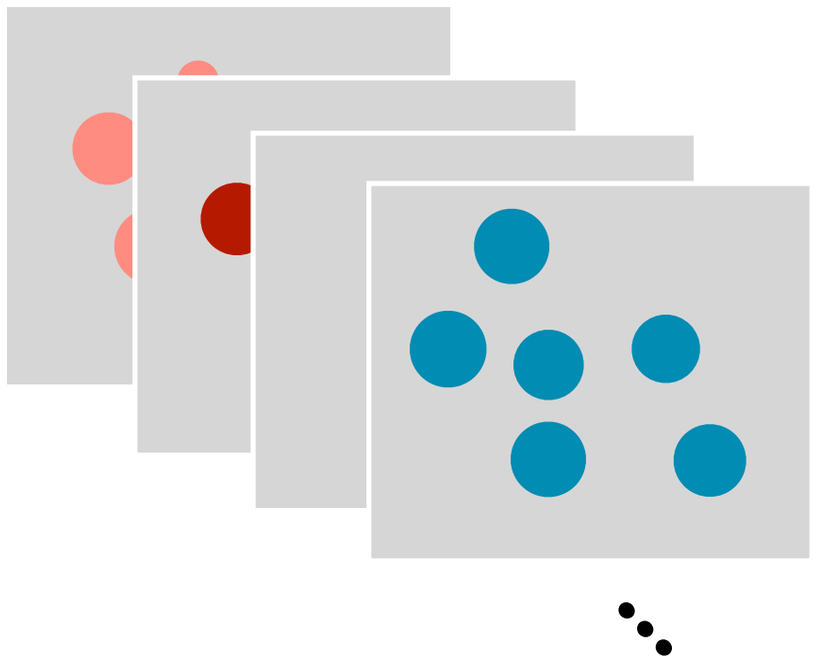

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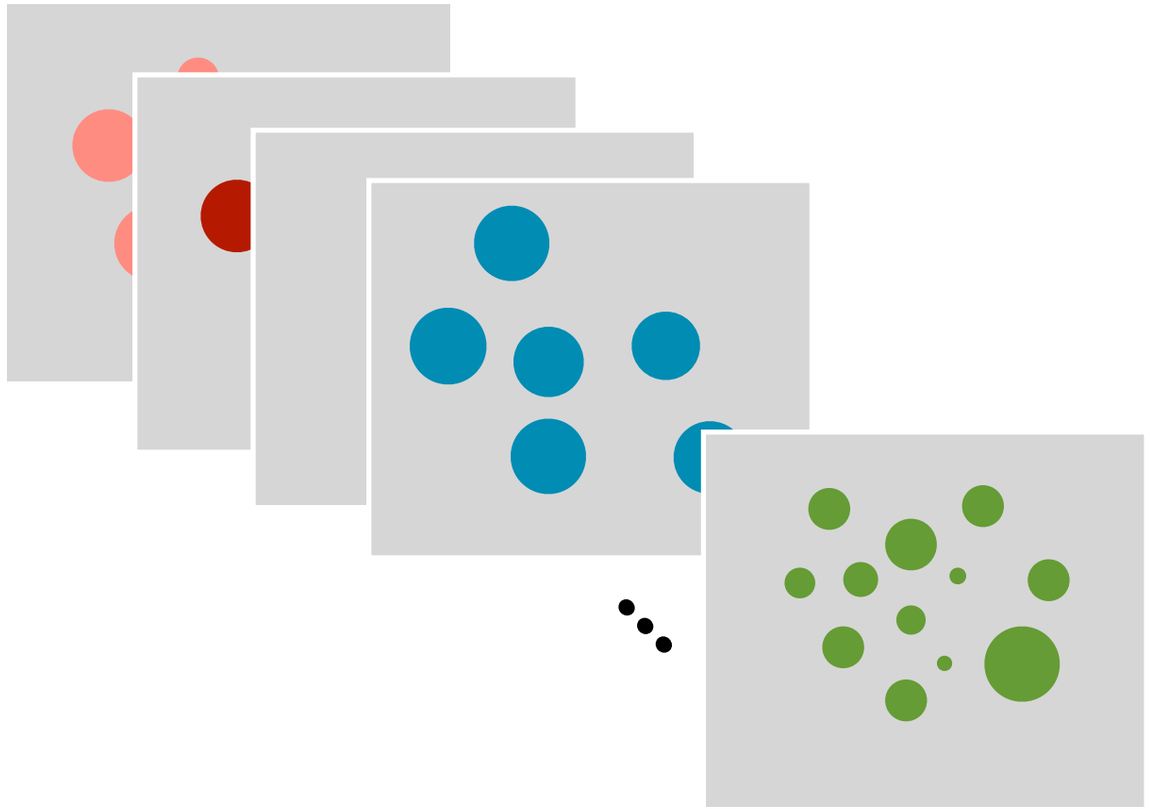

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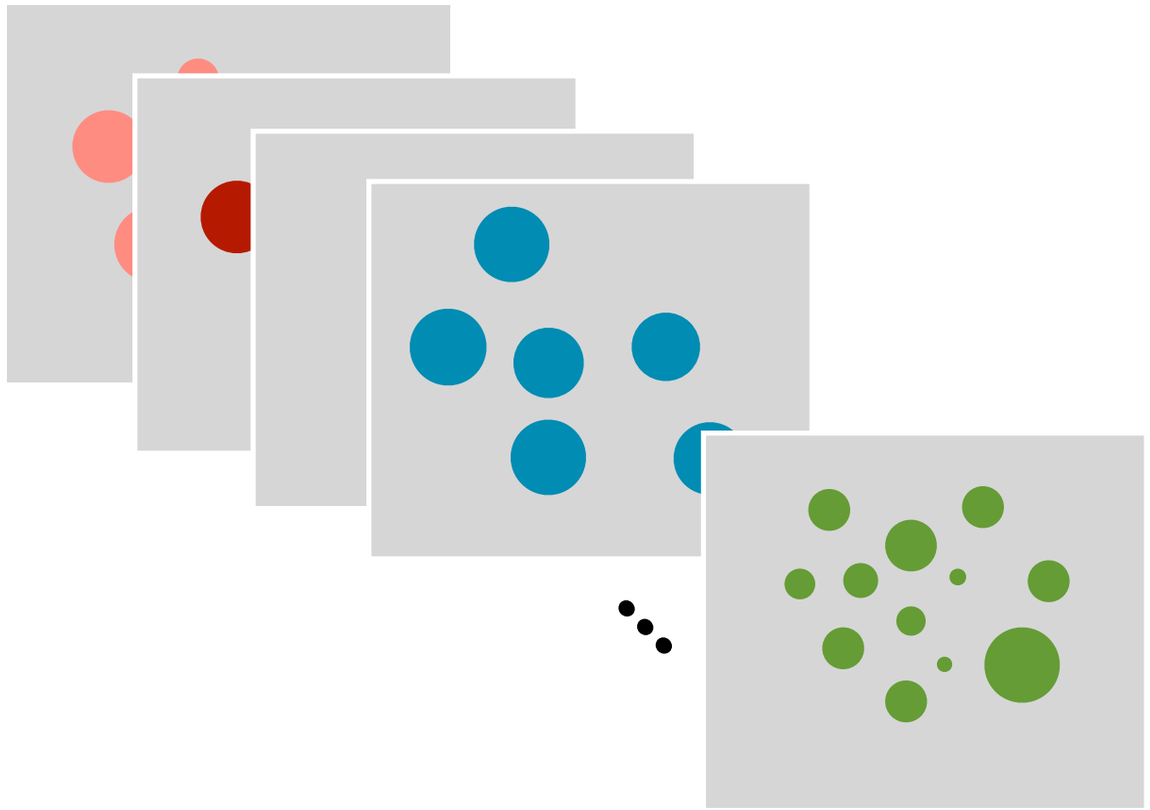

New!!!!

6-month-old infants can successfully discriminate big numbers (with the ratio of 1:2)

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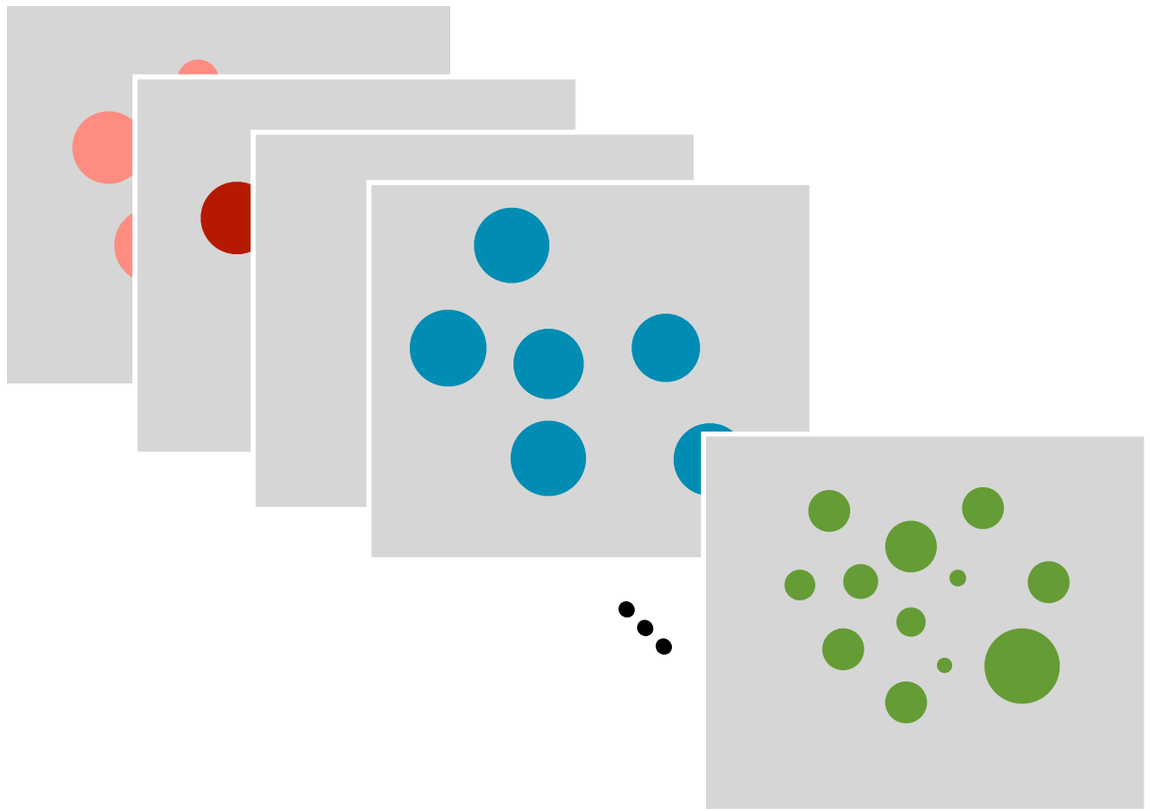

New!!!!

6-month-old infants can successfully discriminate big numbers (with the ratio of 1:2)

12-month-old infants can successfully discriminate harder ratios (e.g., 2:3 ratio: 12 vs. 18 or 16 vs. 24)

Xu & Spelke (2000)

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

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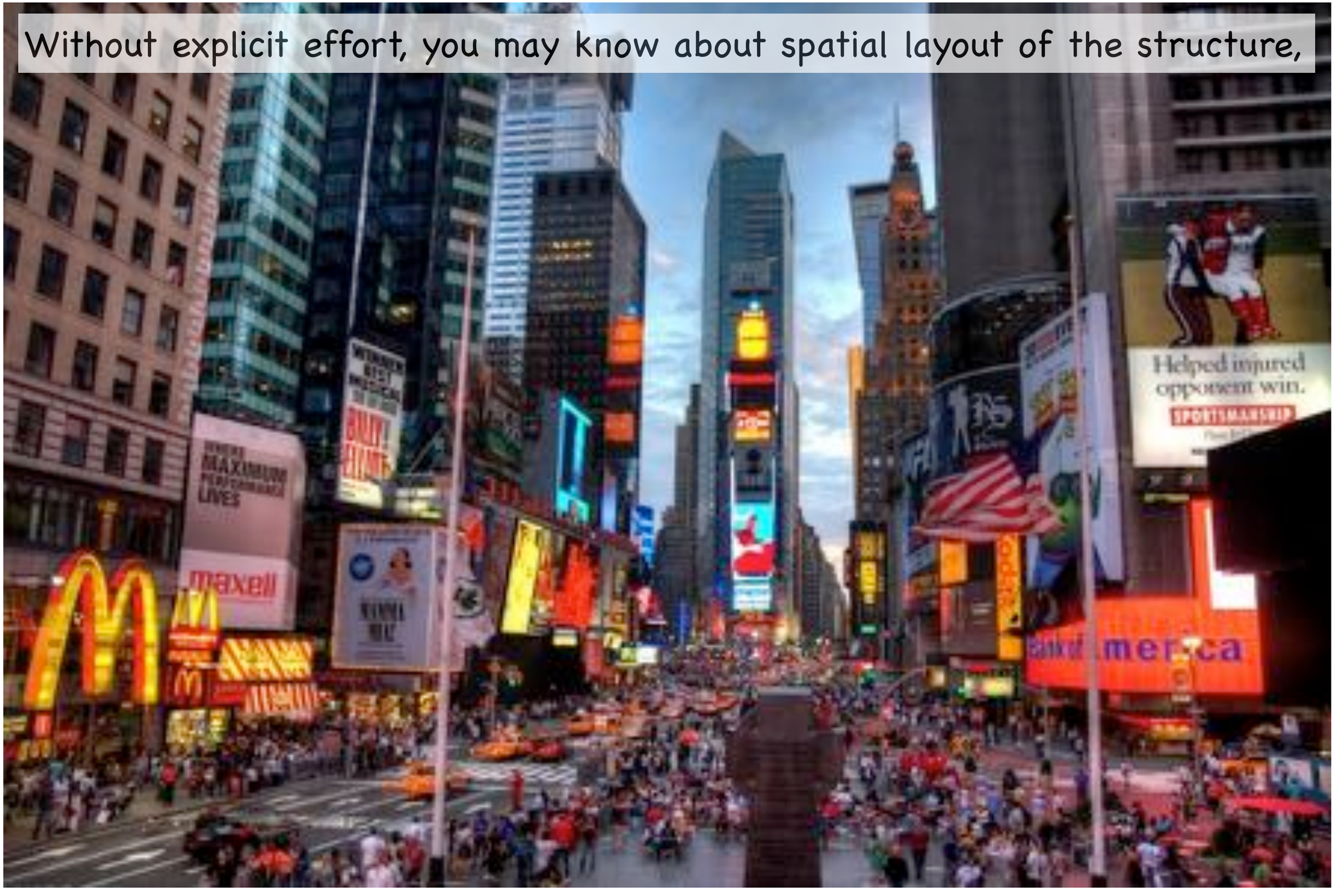

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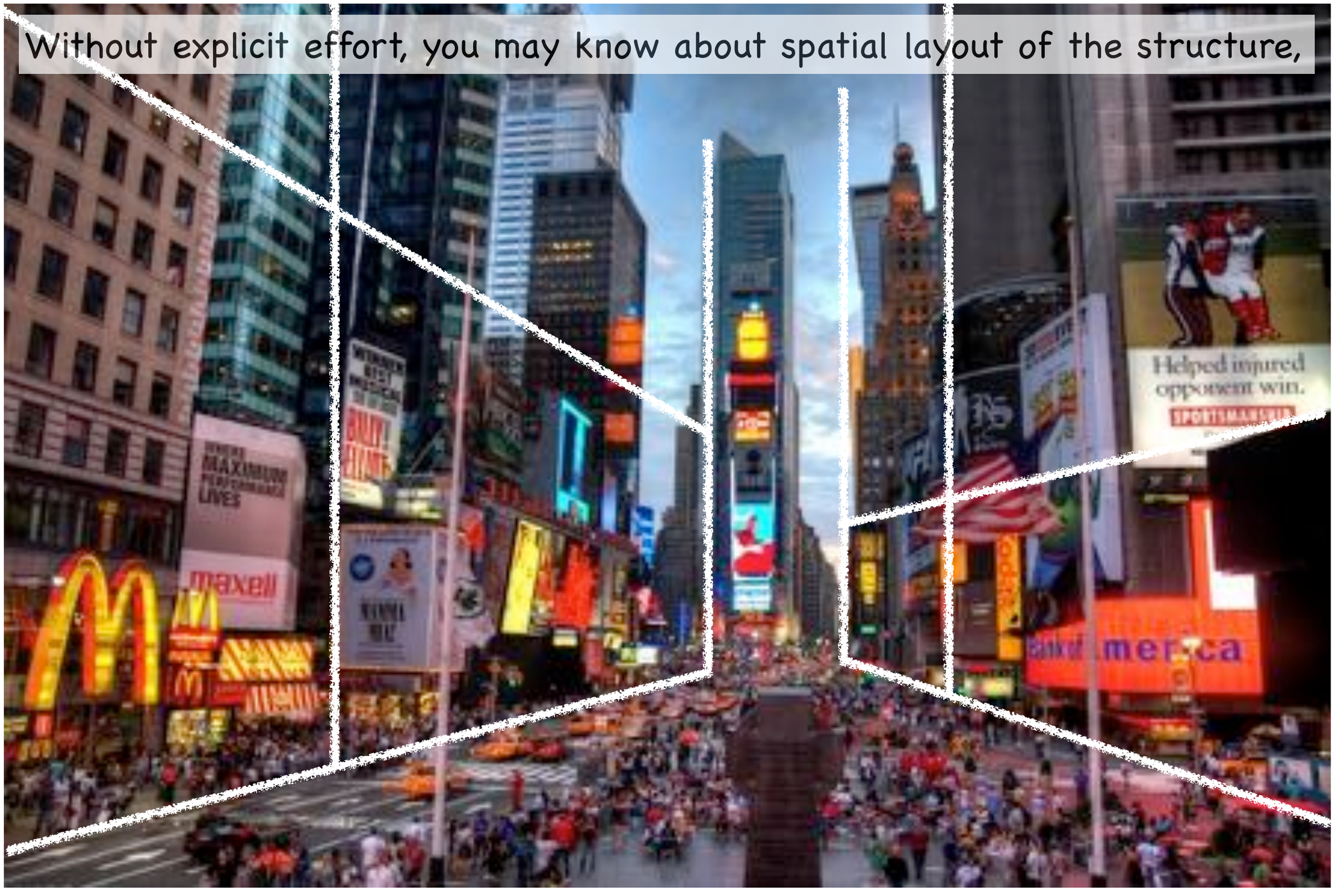

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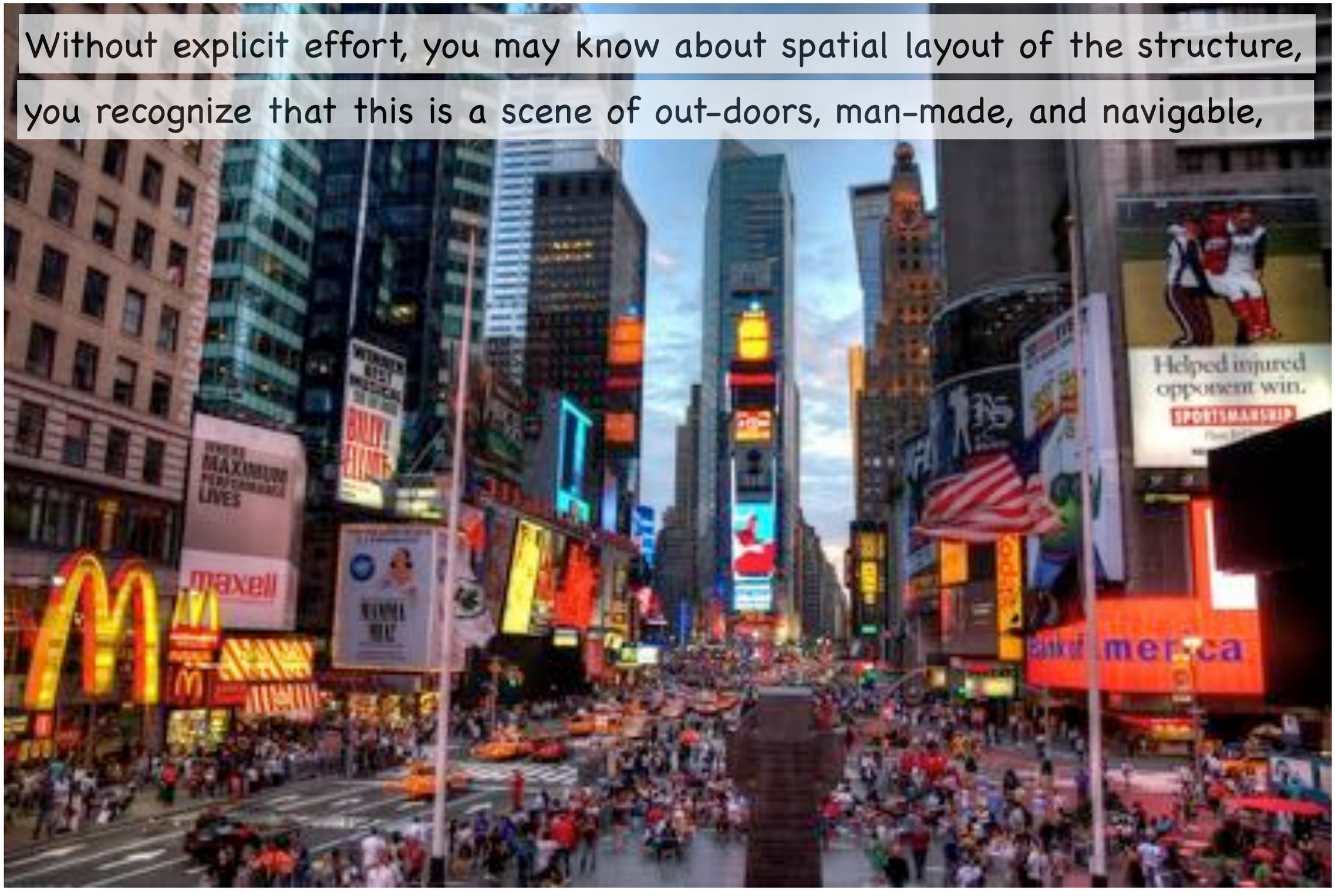

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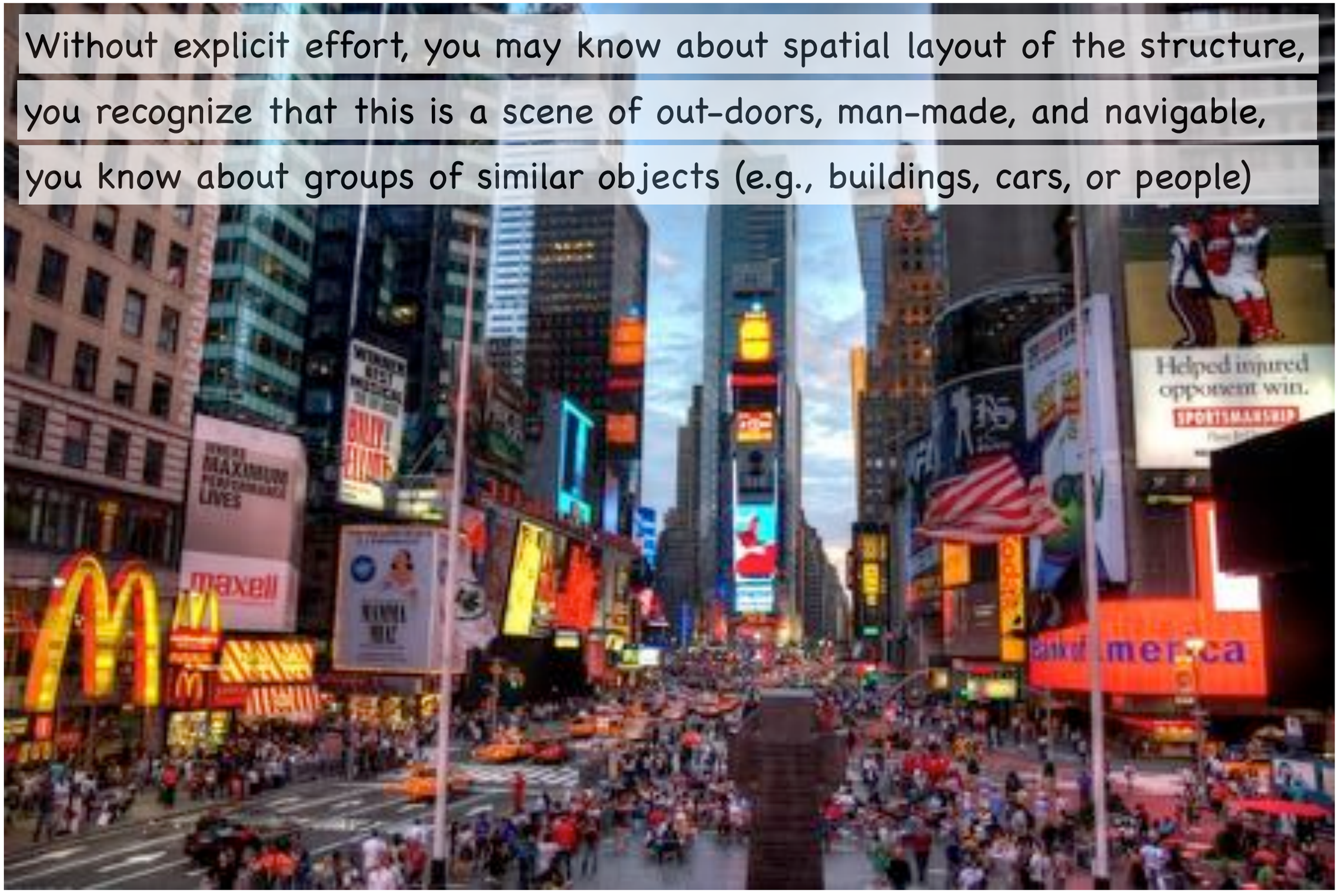

Global information help you to deal with complex visual scenes efficiently

You may not need to attend to and remember every single element of this scene in order to understand the scene

Memory for scenes

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

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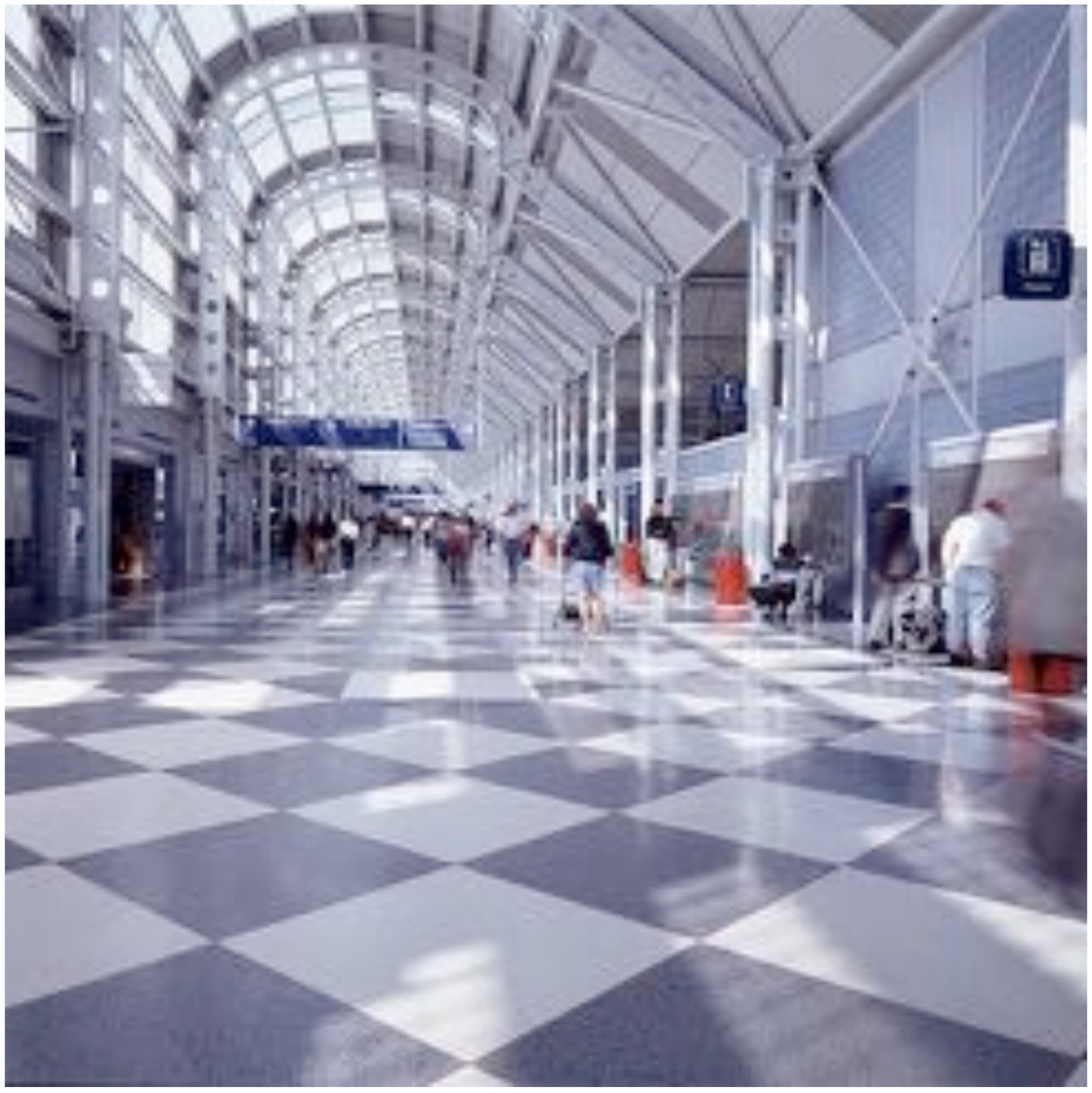

Memory for scenes is amazingly good

Standing (1973)

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Can you spot one new picture?

Standing (1973)

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Can you spot one new picture?

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

Can you spot one new picture?

Standing (1973)

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?

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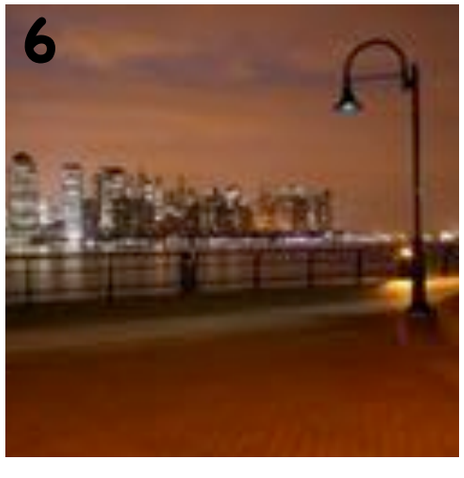

Memory for scenes is amazingly good

-Because you can understand visual scenes fast and efficiently

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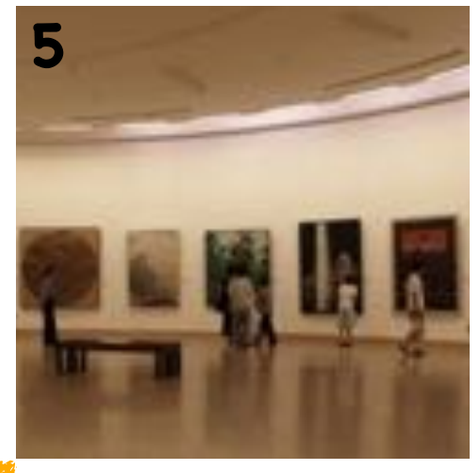
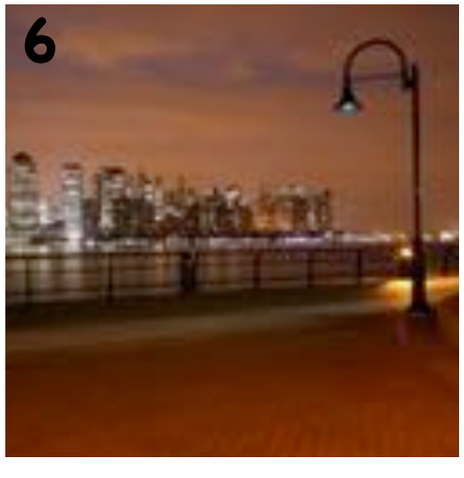


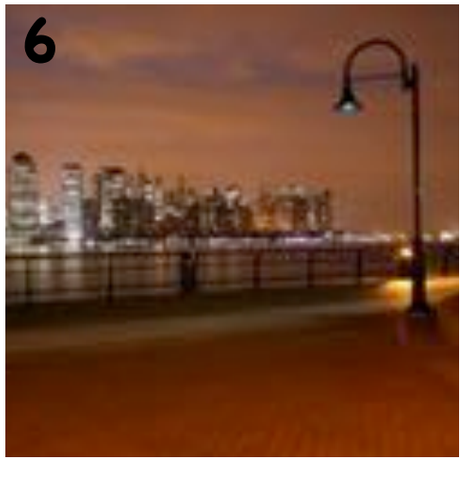


Memory for scenes is amazingly good

-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?



Boundary extension

People tend to remember having seen a greater expanse of a scene than was actually shown

Intraub & Hoggman (1992)

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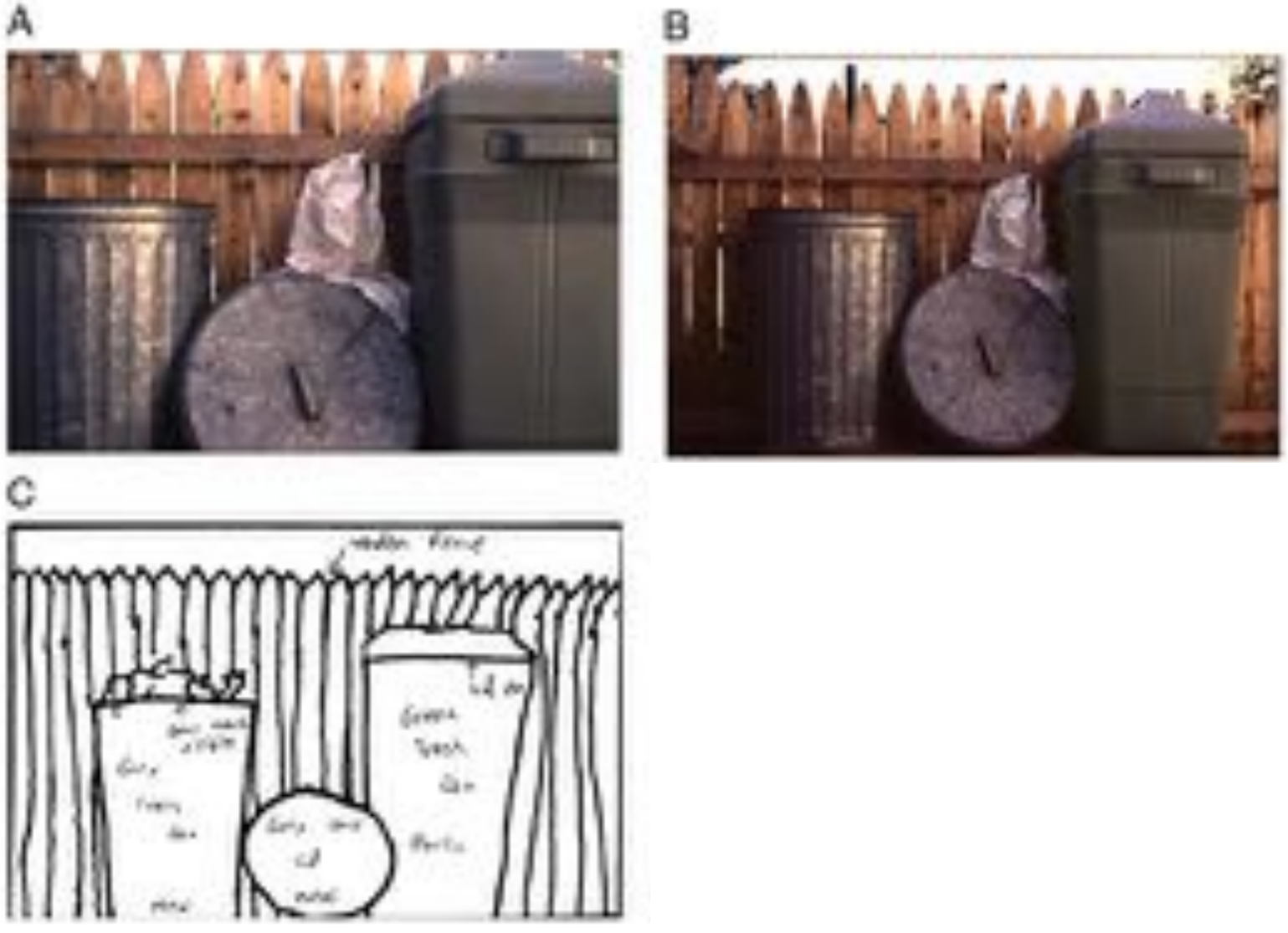

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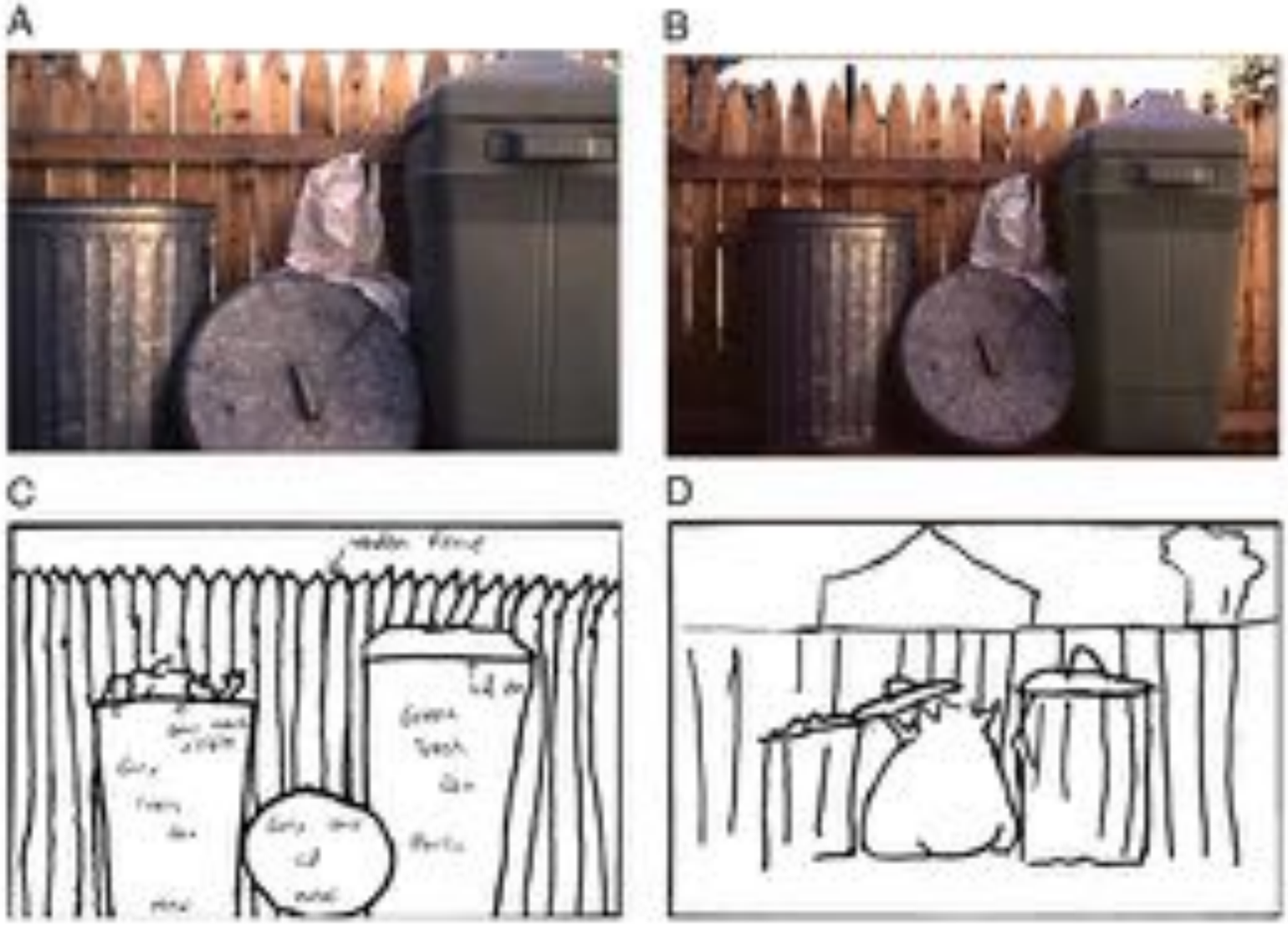

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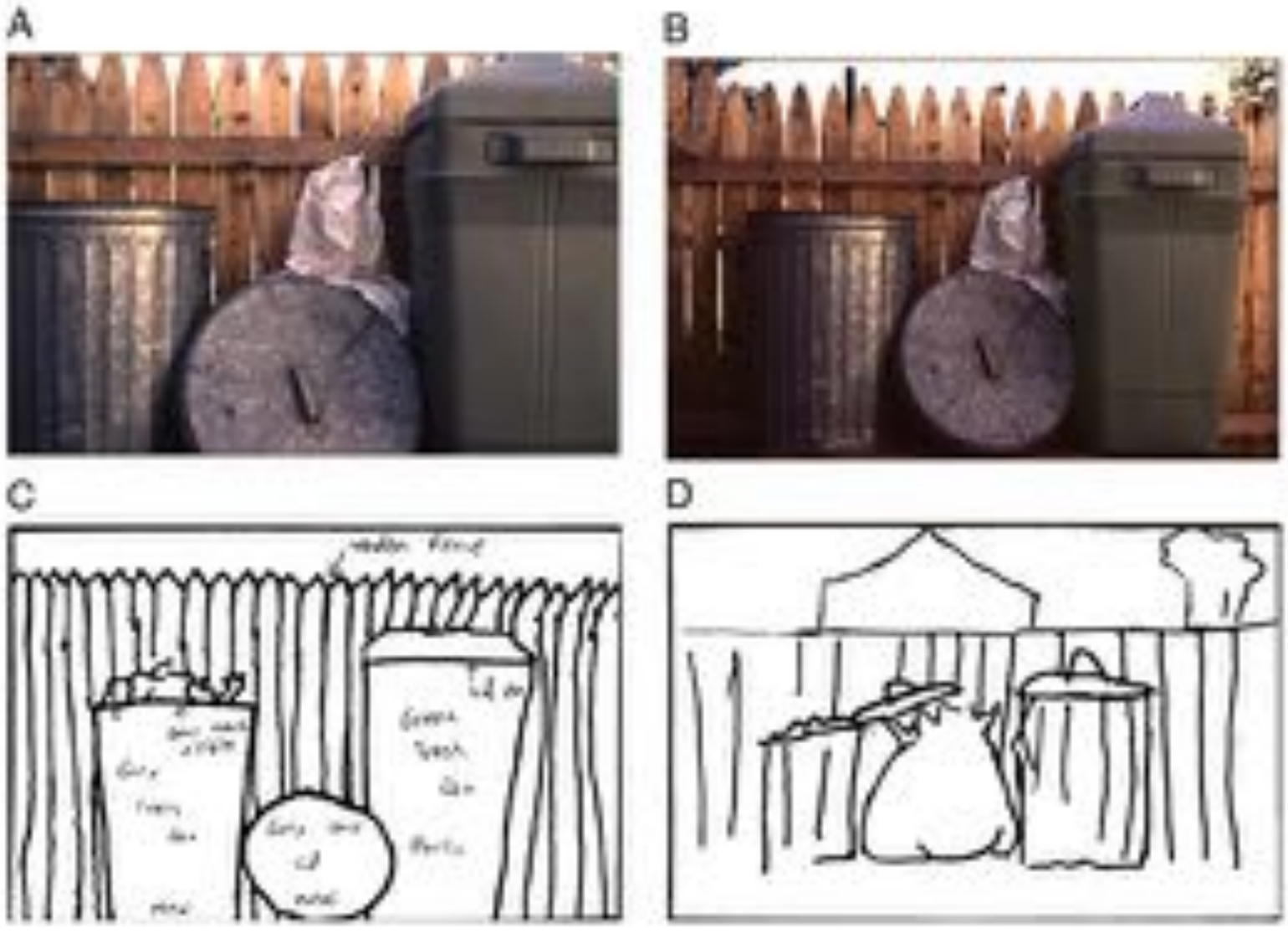

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Neural basis for scene perception

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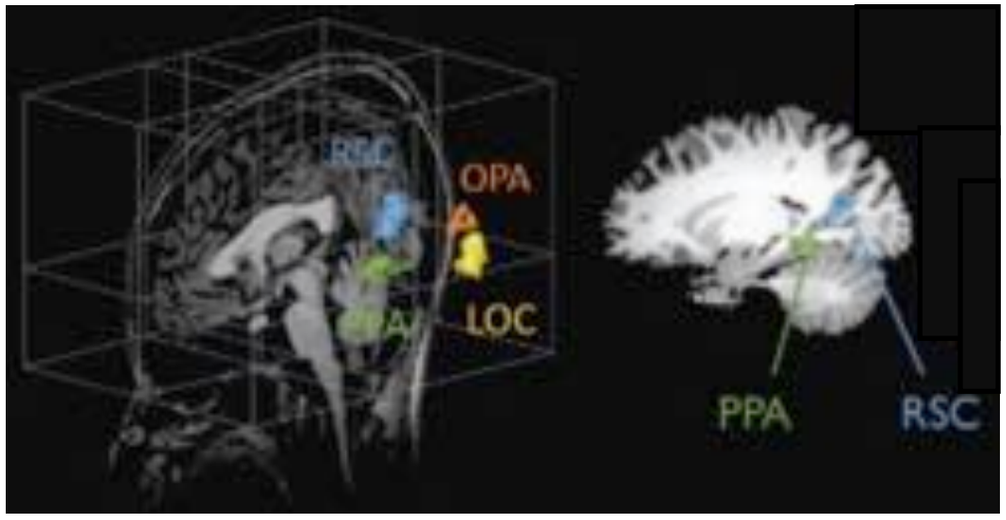
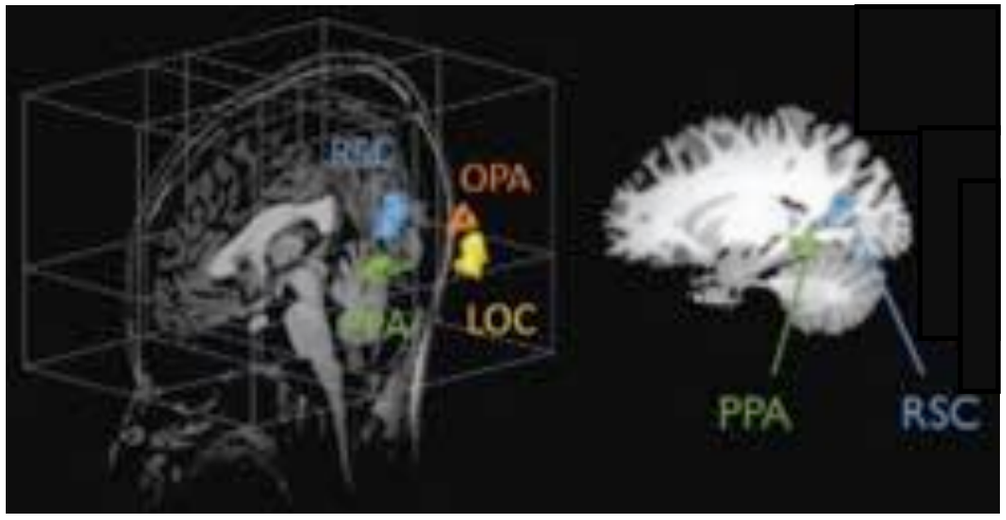


Parahippocampal place area (PPA)

Retrosplenial complex (RSC)

Neural basis for scene perception



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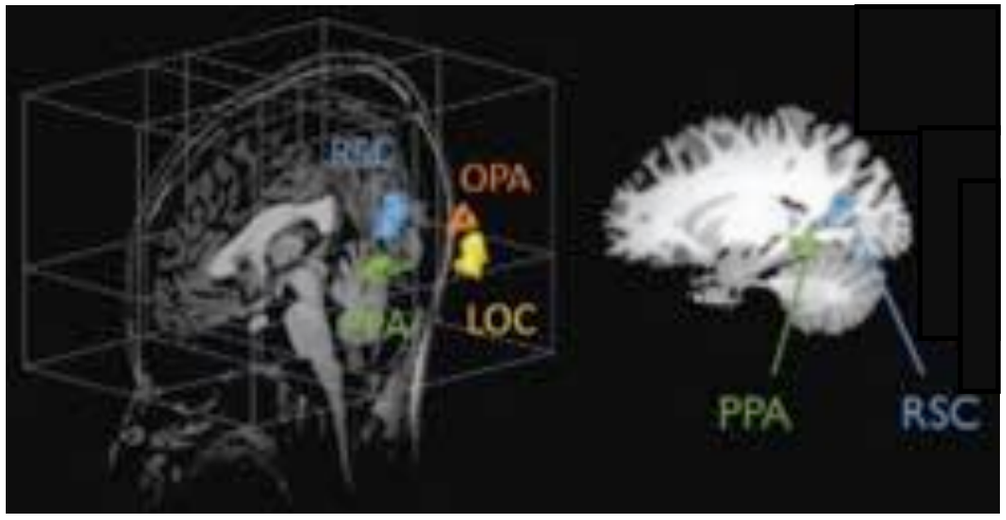

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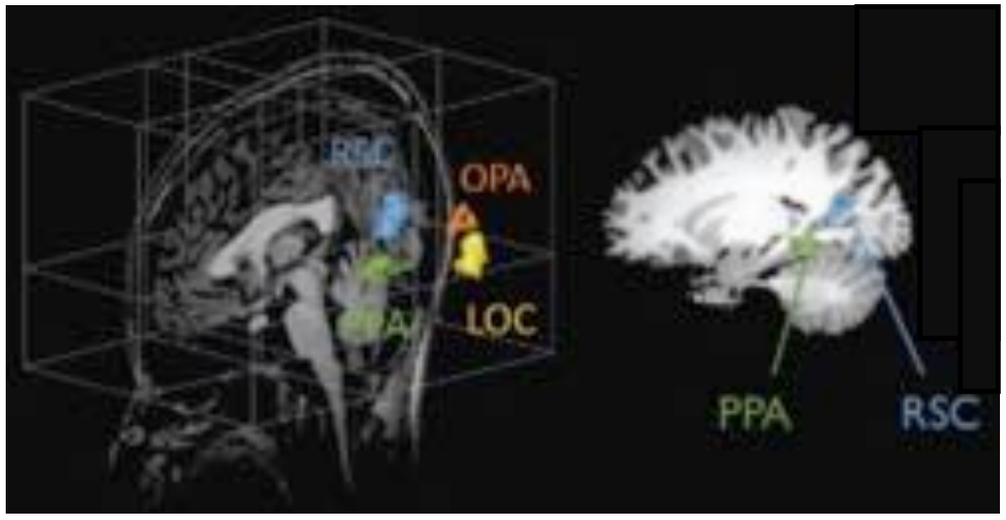
Complimentary functions of the PPA and RSC

Neural basis for scene perception



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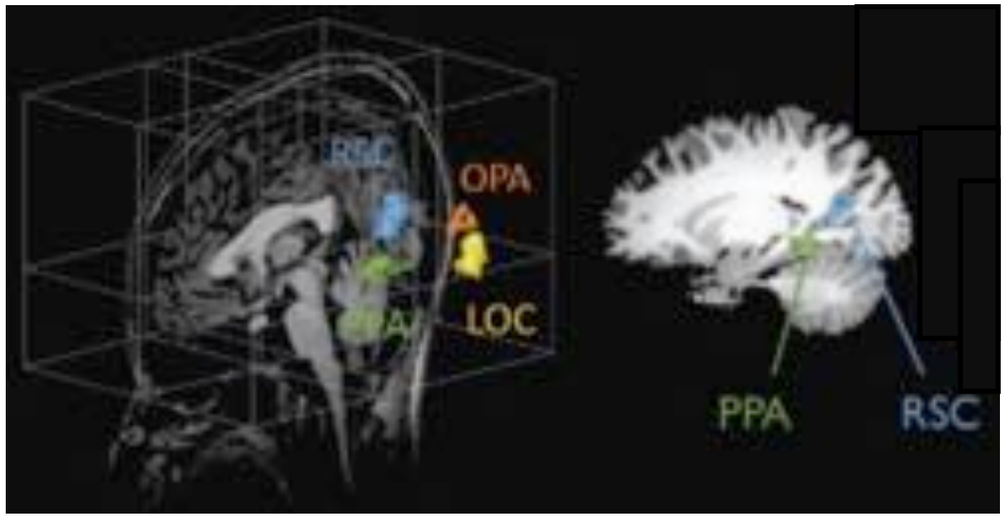
- PPA treats each view of panoramic scene as different images (Viewpoint-specific representation)

Neural basis for scene perception



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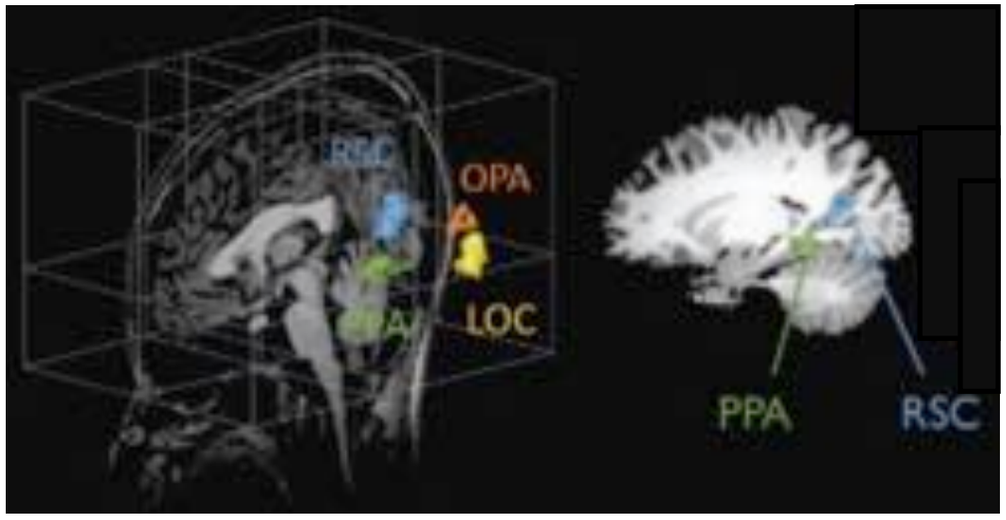

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Retrosplenial complex (RSC)

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

2] Effect by unseen stimulus
- Subliminal perception
- Attention attracted by suppressed image

3] Global processing for scene perception
- Fast, non-selective
- Gist, Spatial layout, Ensemble representations
- Remarkable memory for scenes (however, boundary extension!)
- Neural basis for scene perception: PPA & RSC (complementary & integrative)

Next week...