

Attention and scene representations

Todd S. Horowitz

Visual Attention Laboratory
Brigham and Women's Hospital
Harvard Medical School

Santa Fe Institute, October 9, 2007





Jeremy M. Wolfe



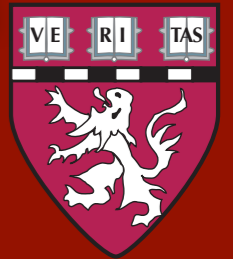
Kristin O. Michod



Jennifer S. DiMase

Brigham & Women's Hospital

Harvard Medical School



University of Delaware



Helene Intraub



Karen K. Daniels



Yale University



Marvin M. Chun



Justin A. Jungé



Brian J. Scholl





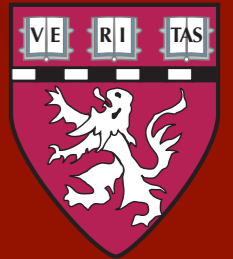
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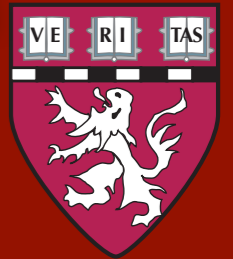


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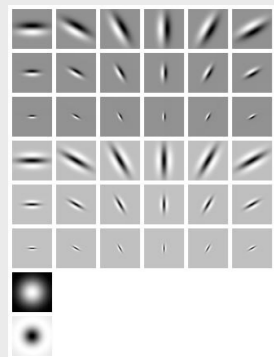
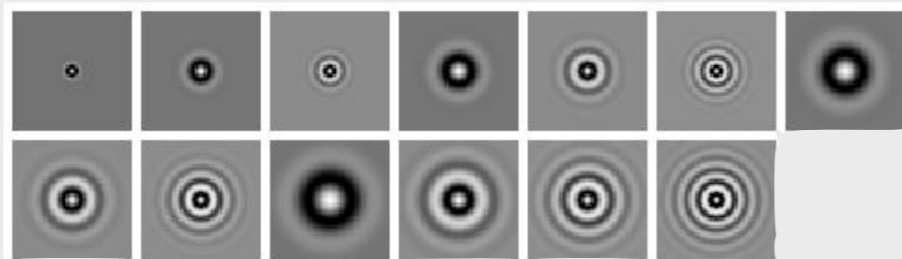
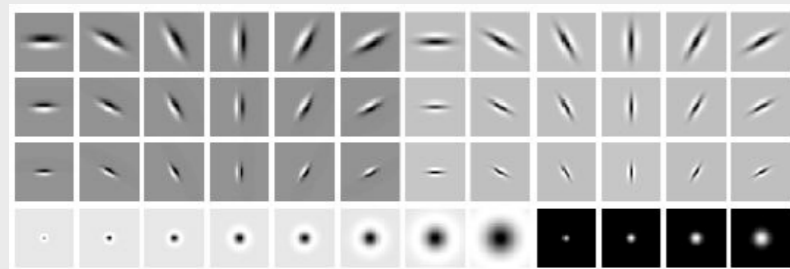


Jennifer S. DiMase

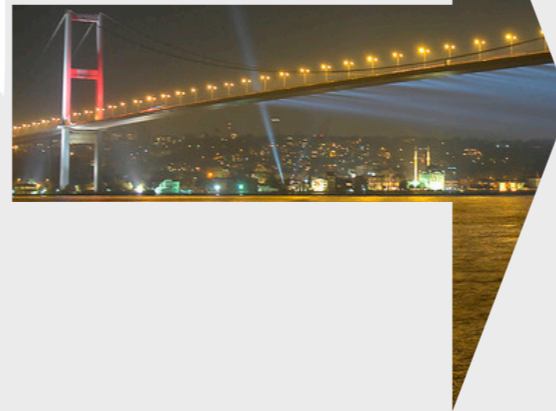


high-level perception and low-level vision vision: bridging the semantic gap

low-level vision



high-level perception



textures

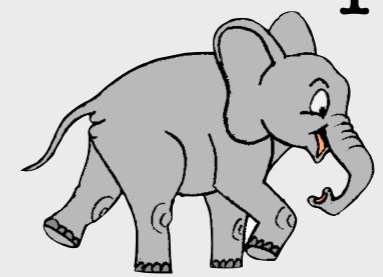
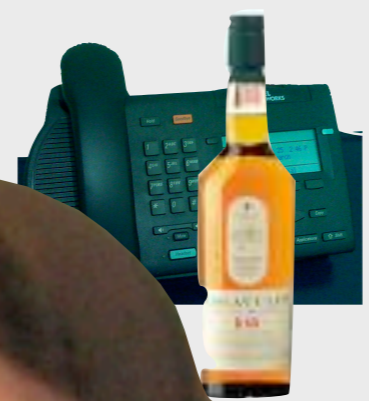
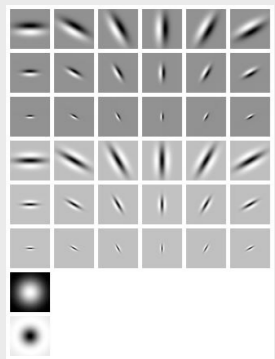
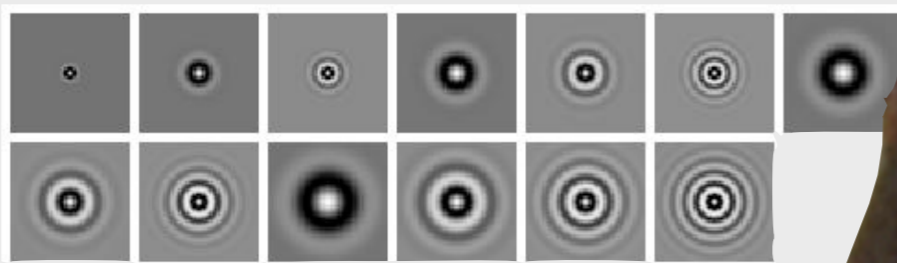
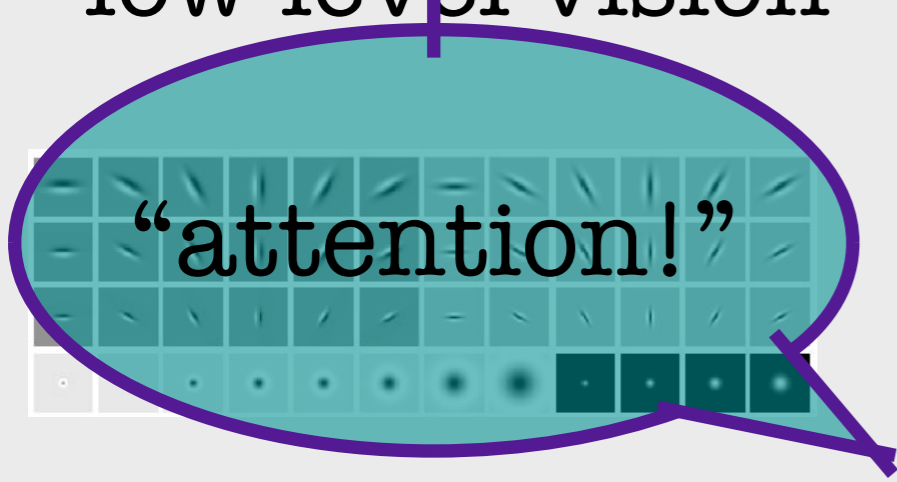


scenes

high-level perception and low-level vision vision: bridging the semantic gap

low-level vision

high-level perception



objects



textures



scenes

overview

scene memory and gist



boundary extension



scene memory



high
capacity

Shepard
(1967)
Standing
(1973)
Potter
(1976)

scene memory



high
capacity

Shepard
(1967)
Standing
(1973)
Potter
(1976)

old or new?



old or new?



old or new?



old or new?



memory = “gist”



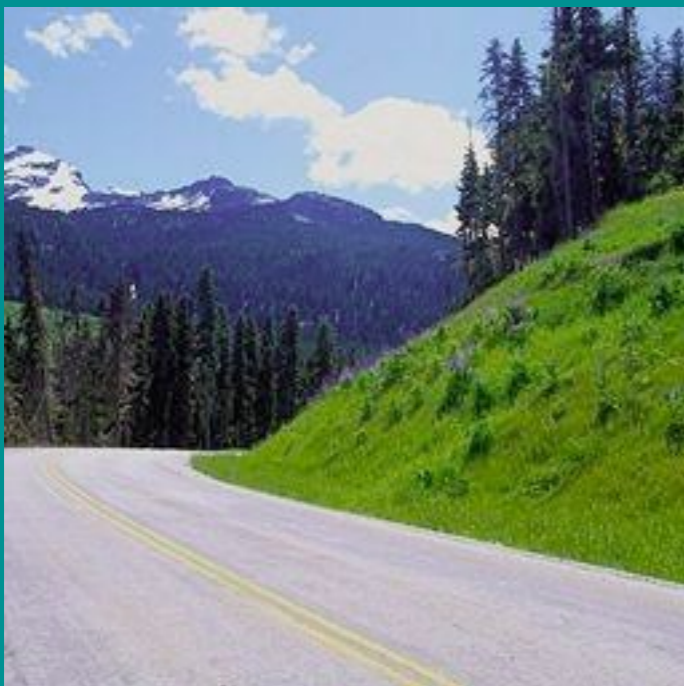
what is “gist”?

verbal gist



“a street scene in a subtropical city”

verbal gist is similar for many scenes



what is “gist”?

visual gist



what is “gist”?

putative
gist
components



color
orientation
size

Chong &
Treisman (2003)

feature
statistics

what is “gist”?

putative
gist
components



spatial
envelope
(Oliva &
Torralba)

feature
statistics

layout

what is “gist”?

putative
gist
components



trees

buildings

mailbox

feature
statistics

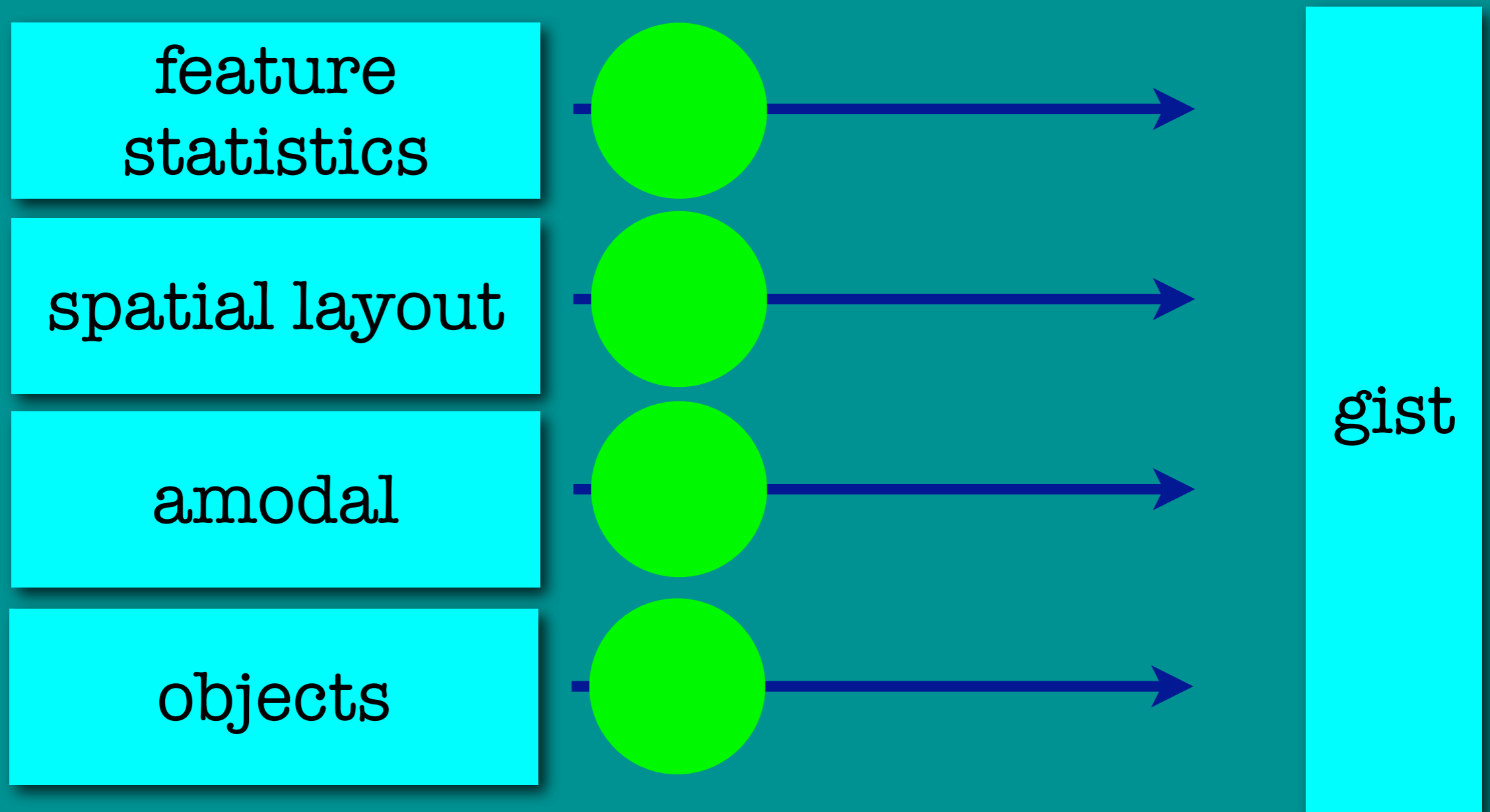
layout

objects

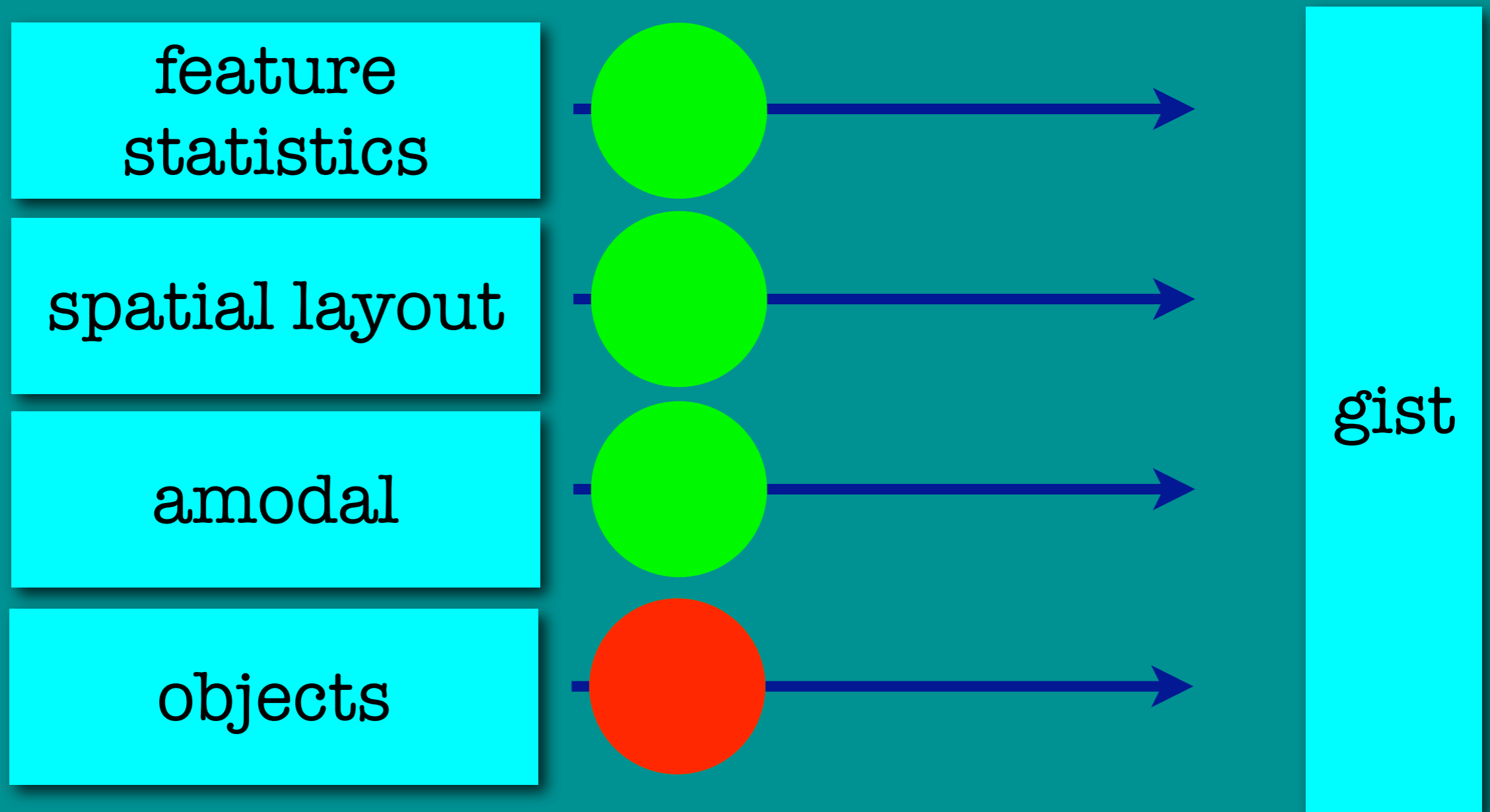
Wolfe (1998)

what is the role of attention in
scene memory?

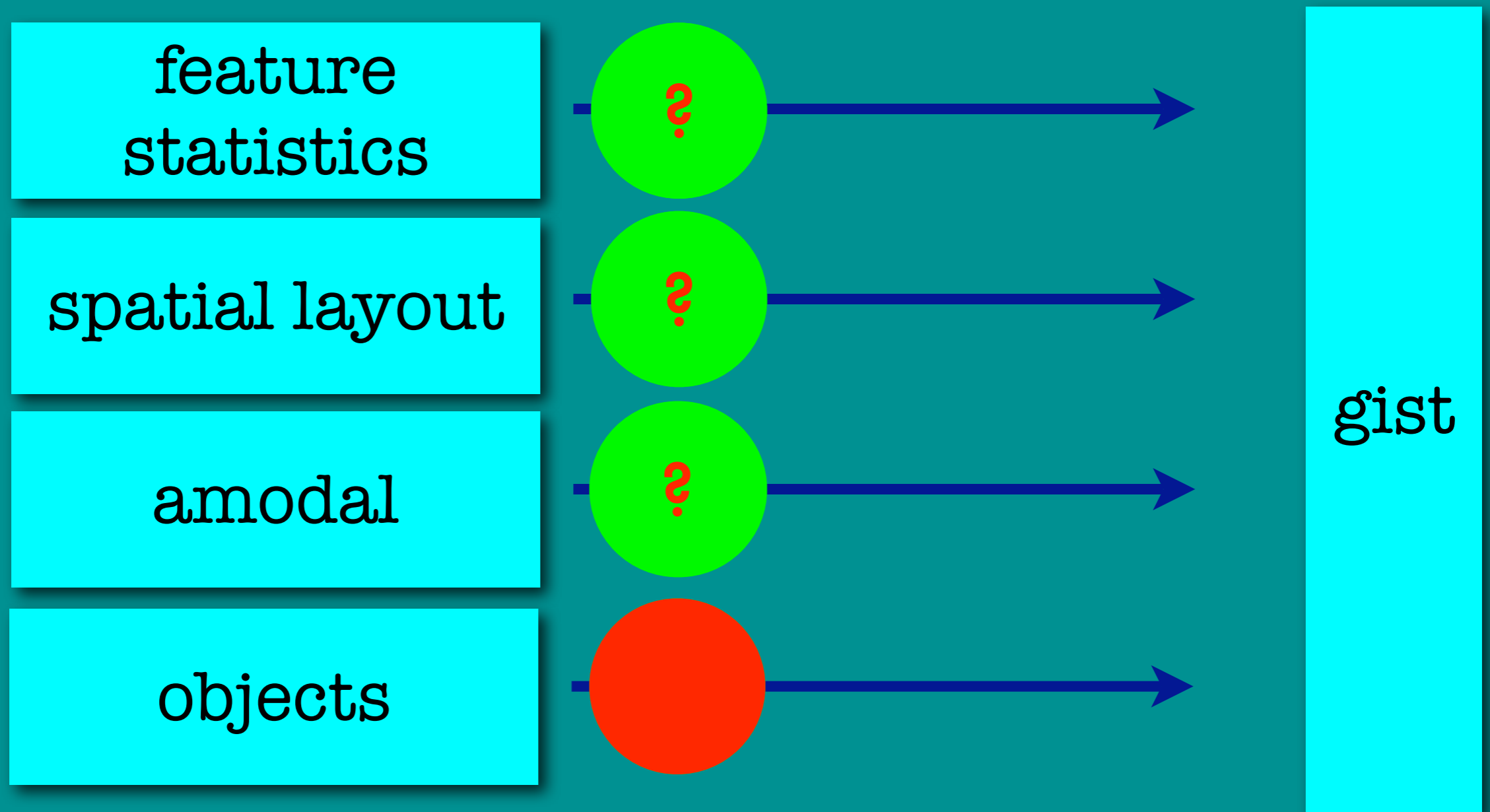
with attention



with attention

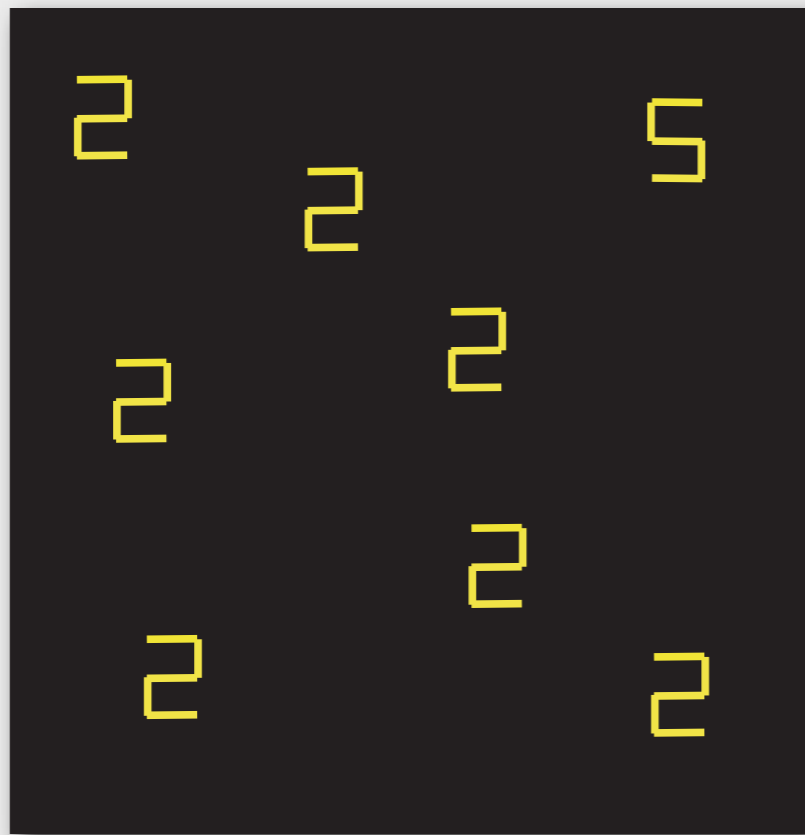


with attention



occupying visual attention

Wolfe, Horowitz, & Michod (2007).
Vision Research



How many 5s?
(0, 1, 2)

inefficient “spatial configuration” search task

occupying visual attention

Wolfe, Horowitz, & Michod (2007).
Vision Research



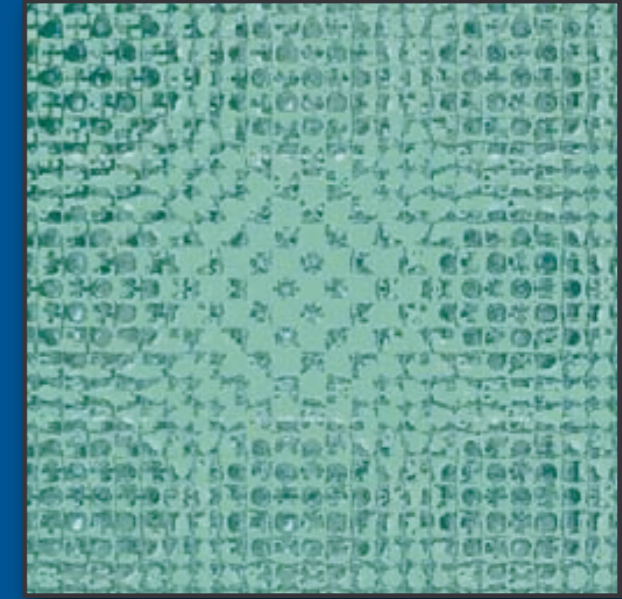
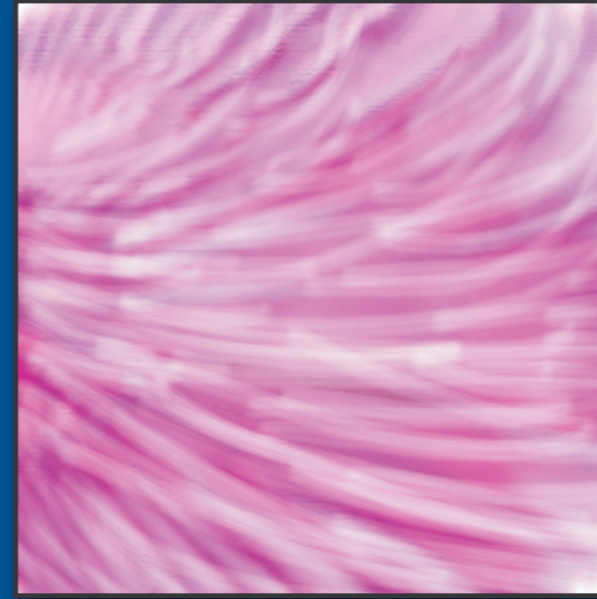
How many 5s?
(0, 1, 2)

inefficient “spatial configuration” search task

scenes



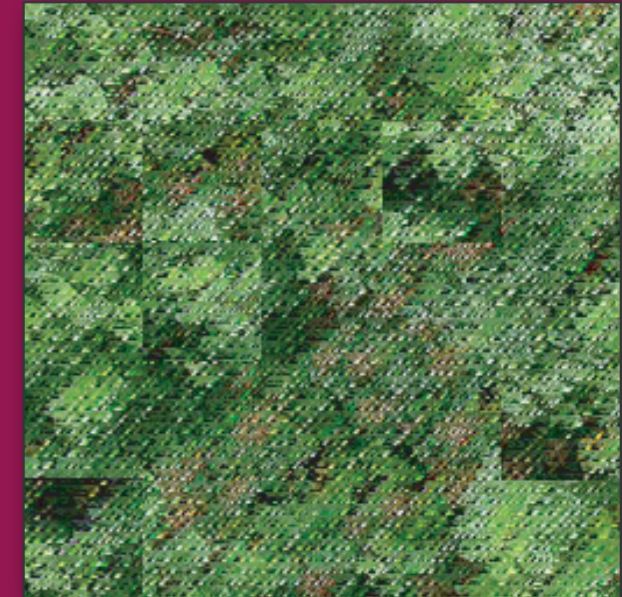
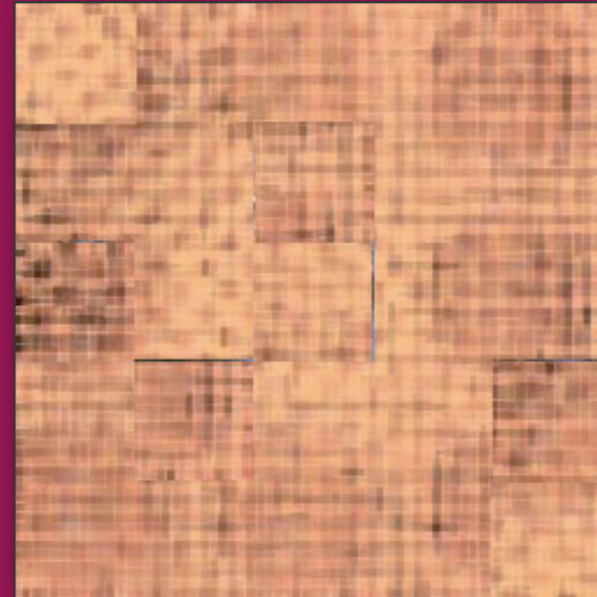
textures



shuffled scenes



shuffled textures

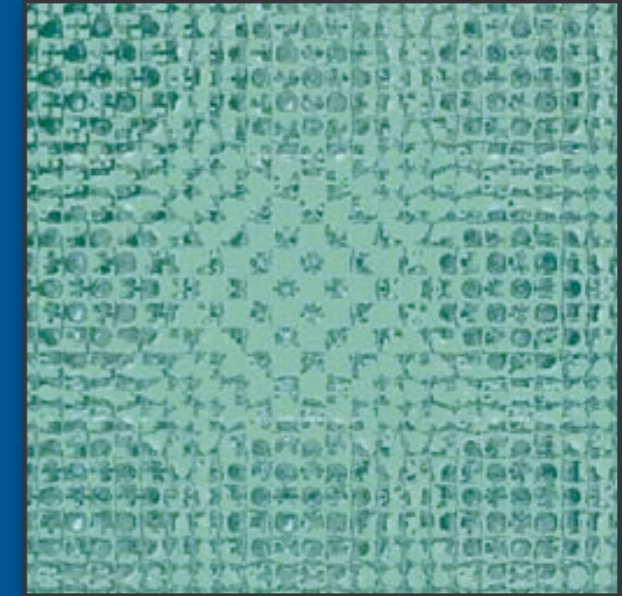


scenes

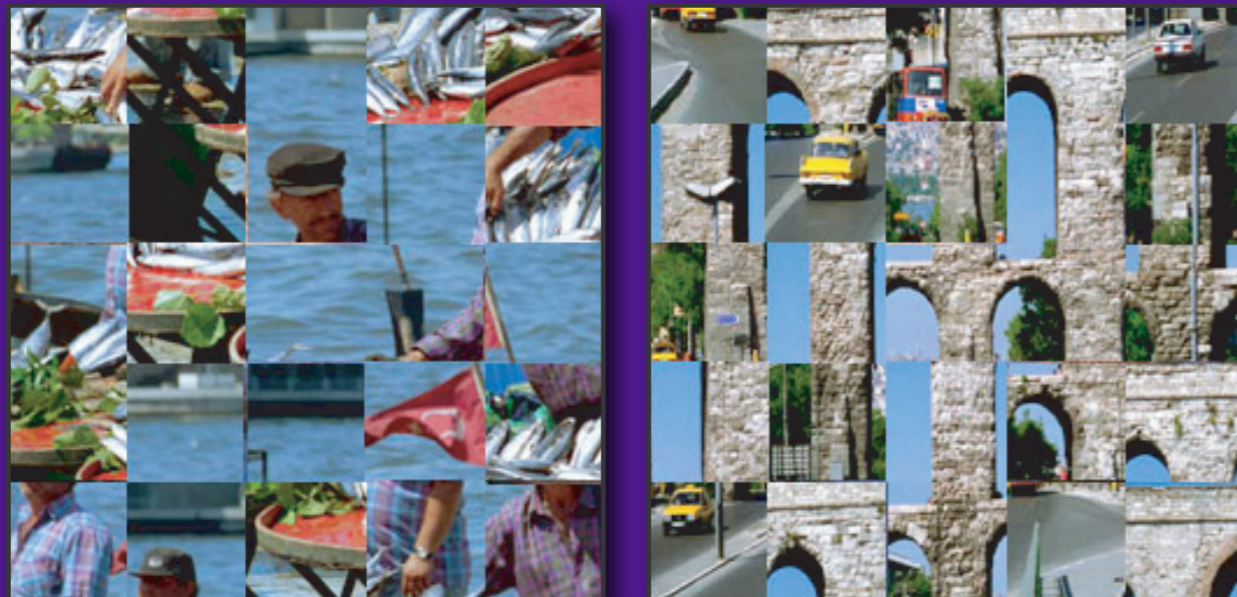
objects and layout



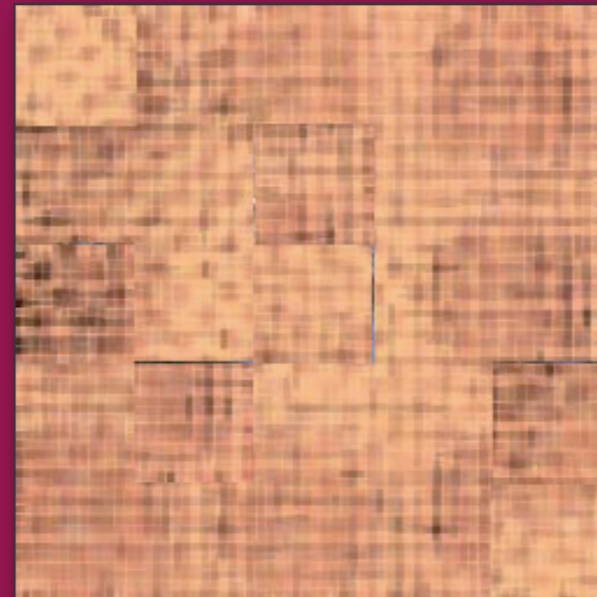
textures



shuffled scenes



shuffled textures



scenes

objects and layout

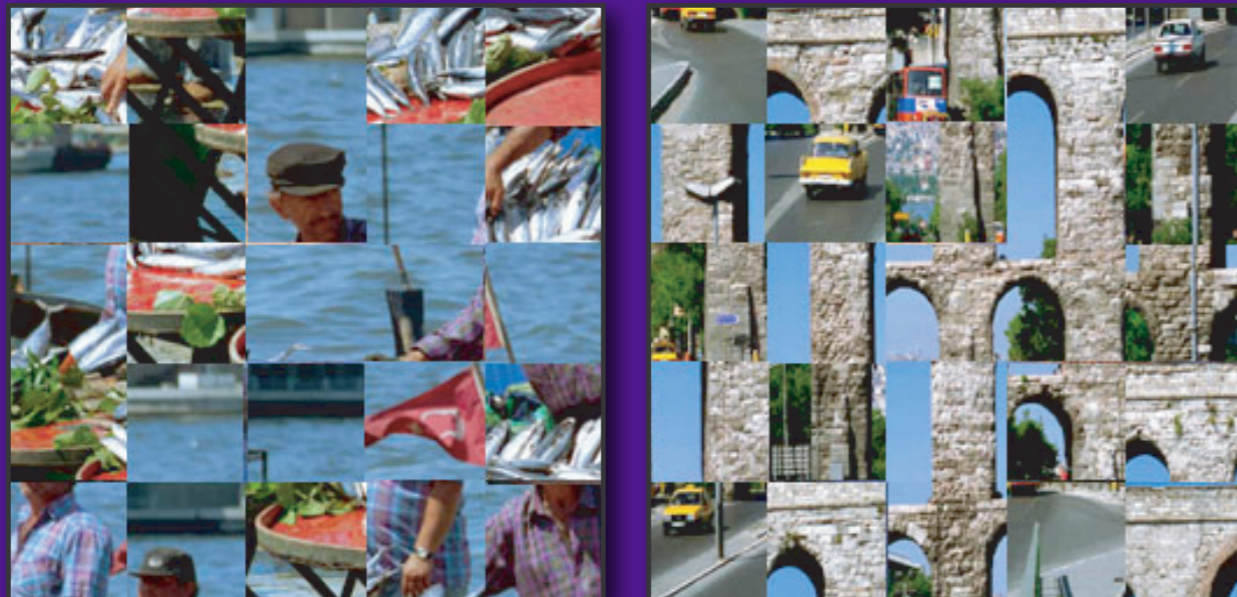


textures

no objects, no layout



shuffled scenes



shuffled textures



scenes

objects and layout



textures

no objects, no layout



shuffled scenes

objects, but no layout



shuffled textures



scenes

objects and layout



textures

no objects, no layout



shuffled scenes

objects, but no layout



shuffled textures

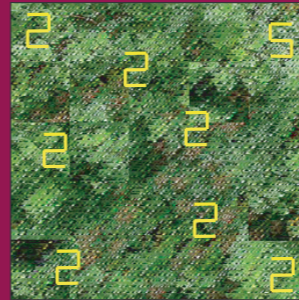
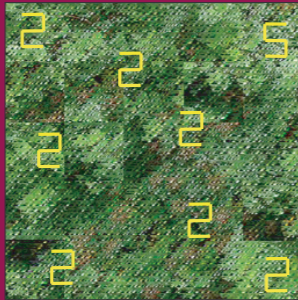
no objects, no layout



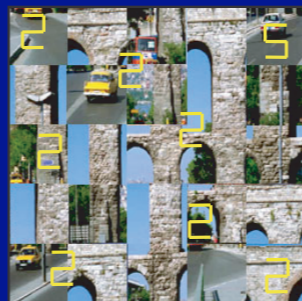
design

picture memory
alone

picture memory
w/search



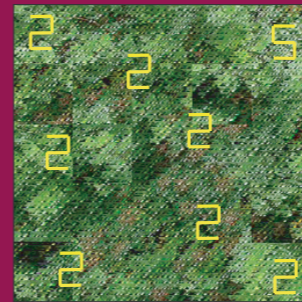
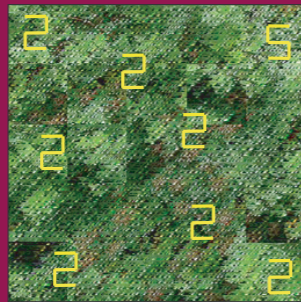
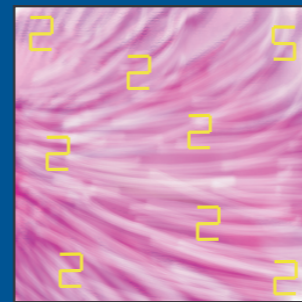
search alone



design

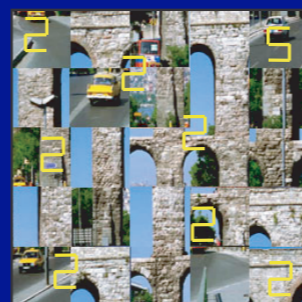
picture memory
alone

picture memory
w/search



control for
central
interference?

search alone



design

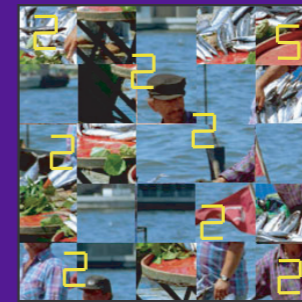
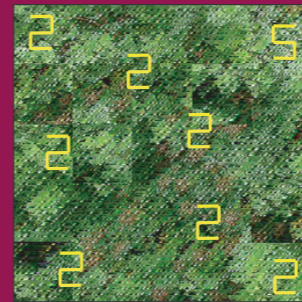
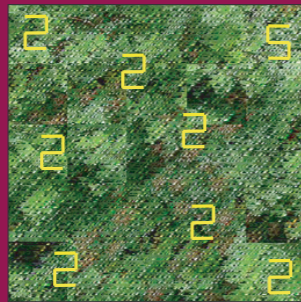
picture memory
alone



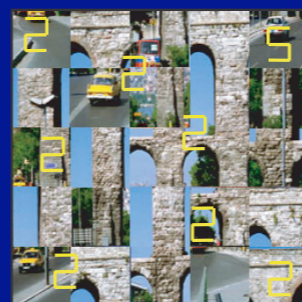
picture memory
w/search



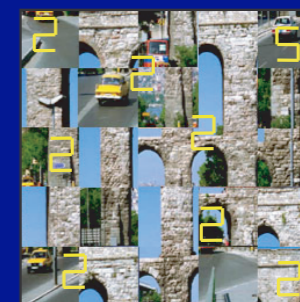
picture memory
w/tone



search alone



tone alone



training phase

Wolfe, Horowitz, &
Michod (2007).
Vision Research



500 ms

How many targets?
0, 1 or 2

32 trials
per
condition

test phase

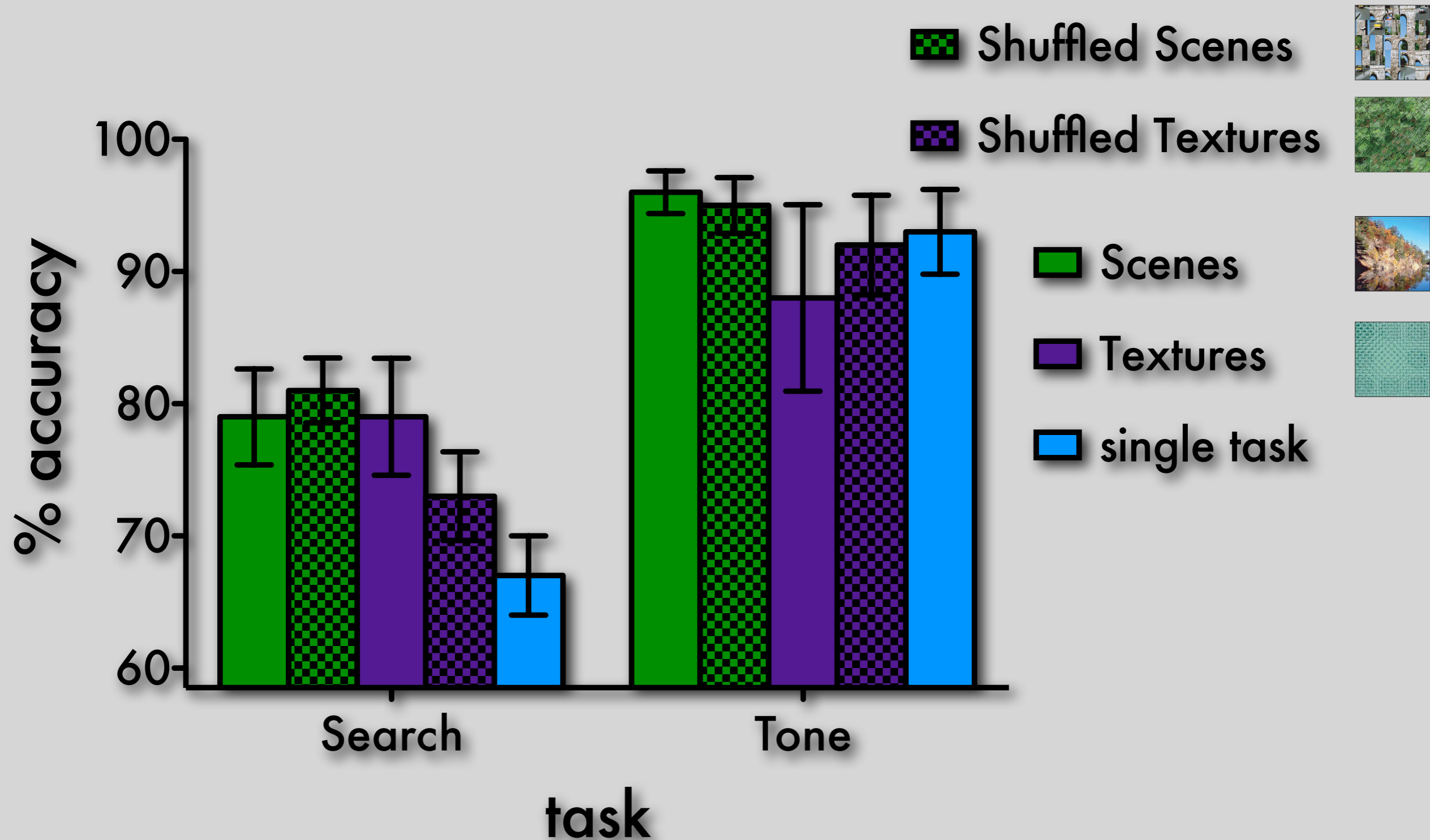
Wolfe, Horowitz, &
Michod (2007).
Vision Research

16 old, 16
new



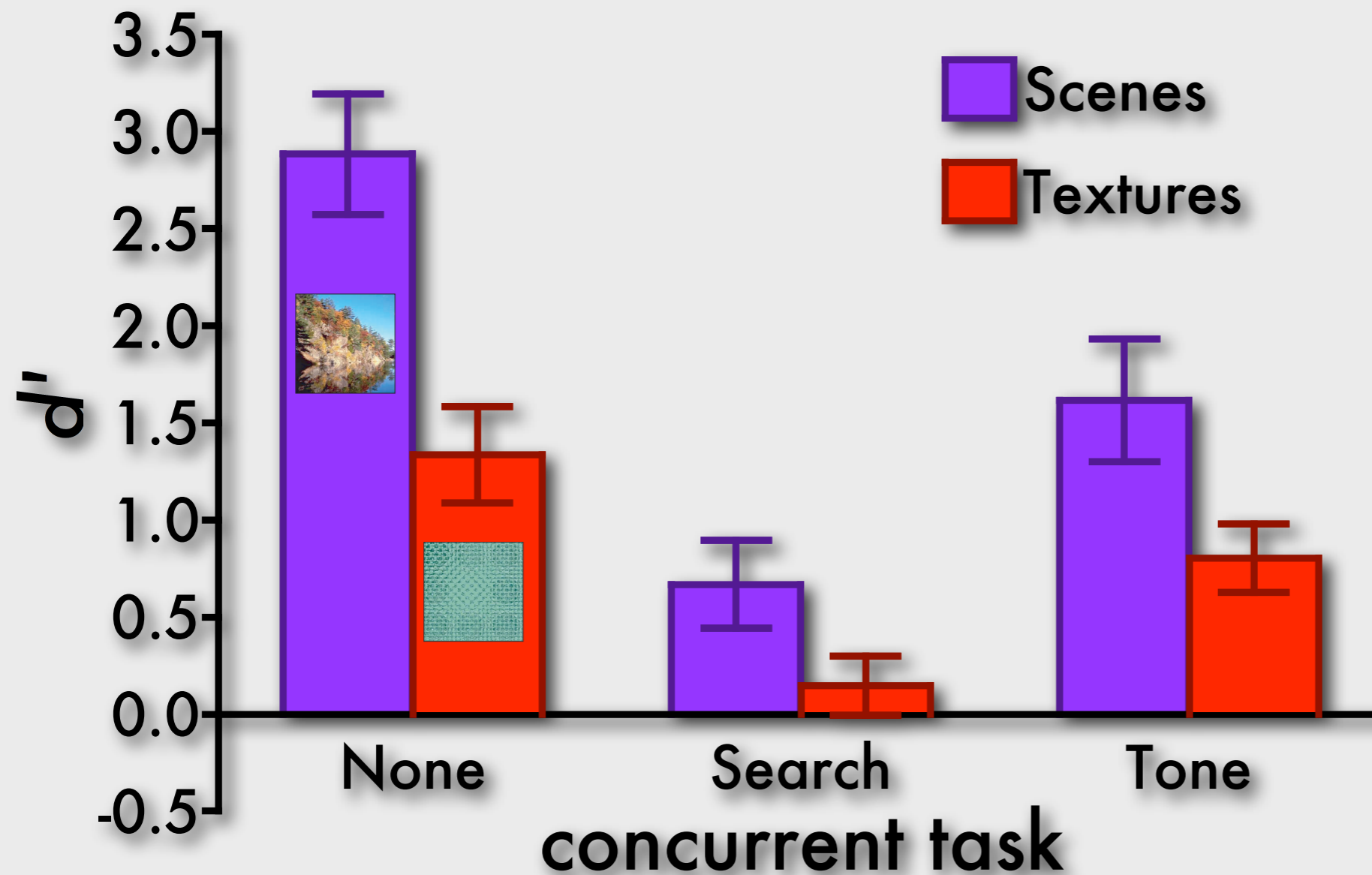
old or new?

concurrent task performance



memory for intact images

Wolfe, Horowitz, &
Michod (2007).
Vision Research



scenes >
textures

dual-task
interference

specifically
visual
interference

N = 14

memory for shuffled images

Wolfe, Horowitz, &
Michod (2007).
Vision Research

why are scenes
remembered better
than textures?

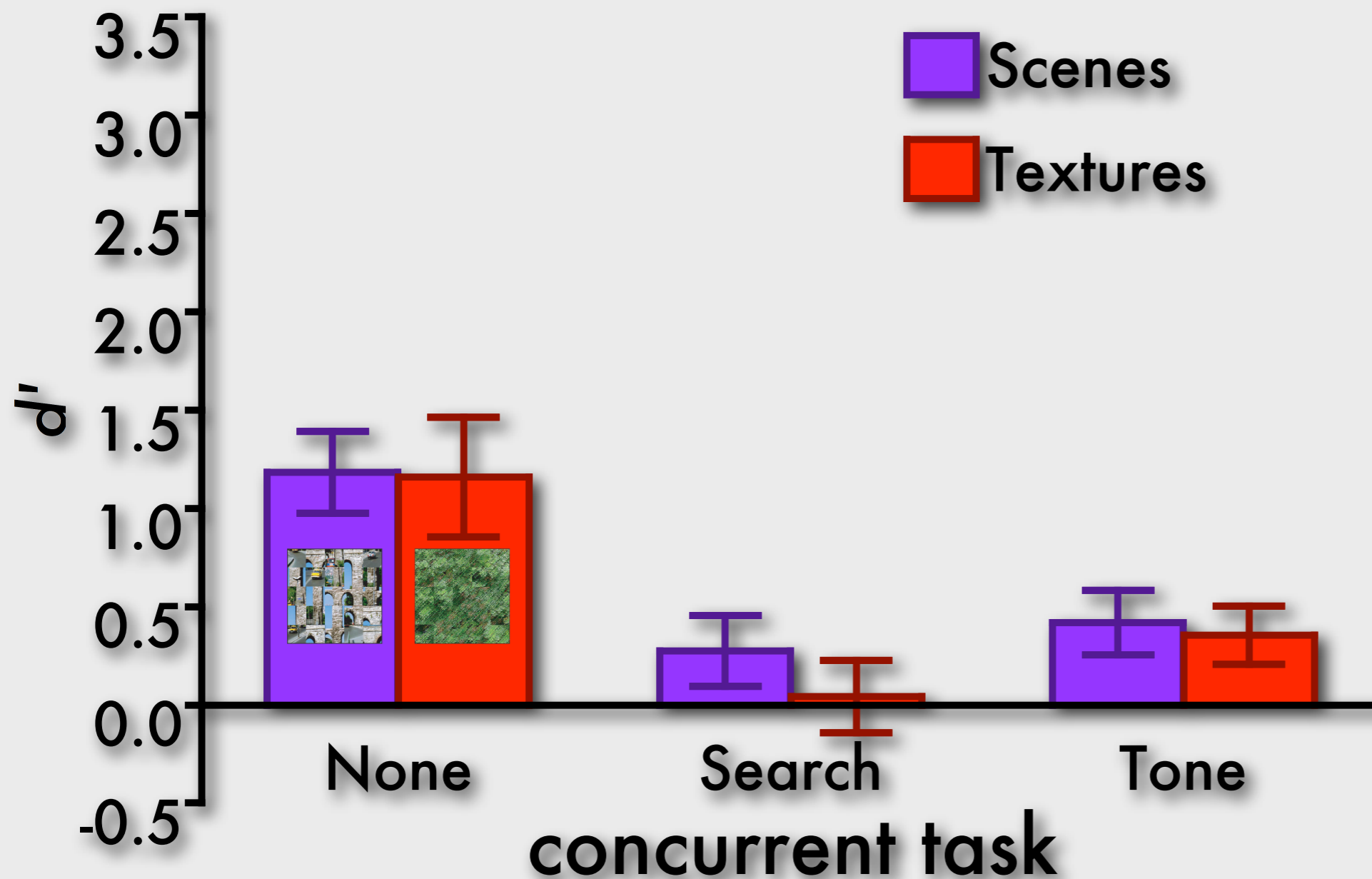
scenes =
textures

dual-task
interference

specifically
visual
interference

memory for shuffled images

Wolfe, Horowitz, & Michod (2007).
Vision Research



scenes =
textures

dual-task
interference

specifically
visual
interference

interim conclusions

Wolfe, Horowitz, &
Michod (2007).
Vision Research

- Successful scene memory requires attention
- Scenes are defined by layout, not objects
- Consolidation or encoding?

training phase

Wolfe, Horowitz, &
Michod (2007).
Vision Research



125 ms



375 ms

or

How many targets?
0, 1 or 2

How much did you like
the picture?
0, 1 or 2

test phase

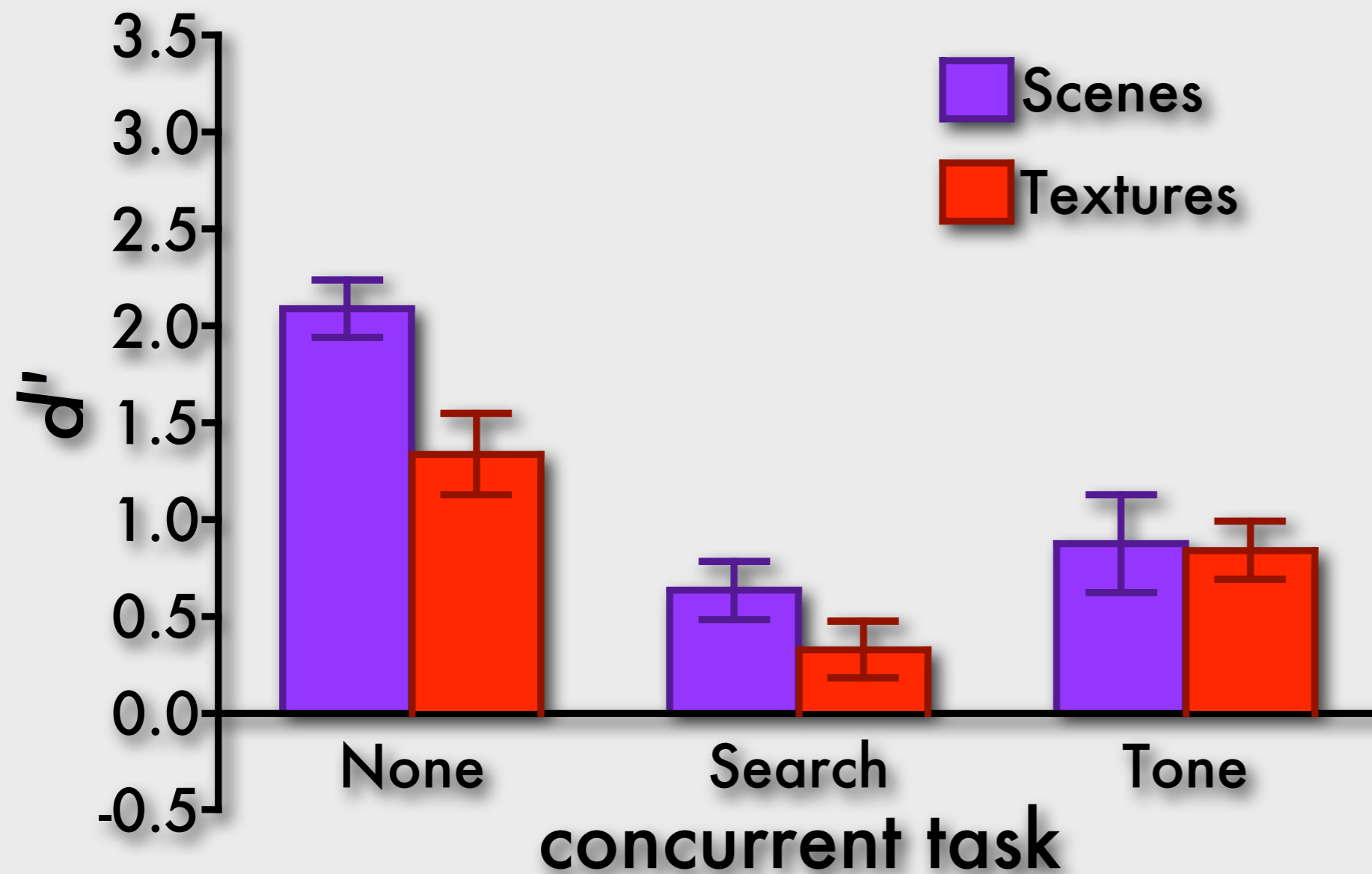
Wolfe, Horowitz, &
Michod (2007).
Vision Research



old or new?

encoding or consolidation?

Wolfe, Horowitz, & Michod (2007).
Vision Research



N = 14

interim conclusions

- Scenes are defined by layout, not objects
- Successful scene memory requires attention...
- ... for consolidation, and probably encoding

what kind of attention are we
talking about?

two visual pathways

ventral

“what”

dorsal

“where”

two attentional pathways?

ventral

“what”

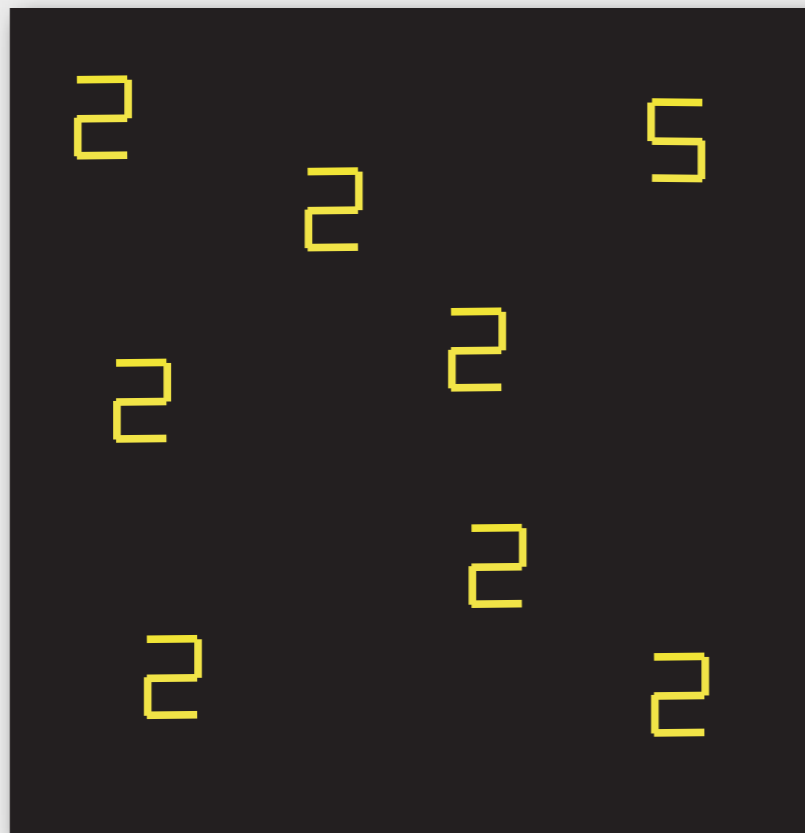
identification

dorsal

“where”

individuation

occupying visual attention



How many 5s?
(0, 1, 2)

inefficient “spatial configuration” search task

Wolfe, Horowitz, &
Michod (2007).
Vision Research

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

occupying visual attention

Jungé, DiMase,
Scholl, Chun,
Horowitz, & Wolfe
(accepted pending
revision). Vision
Research

4 targets
will blink

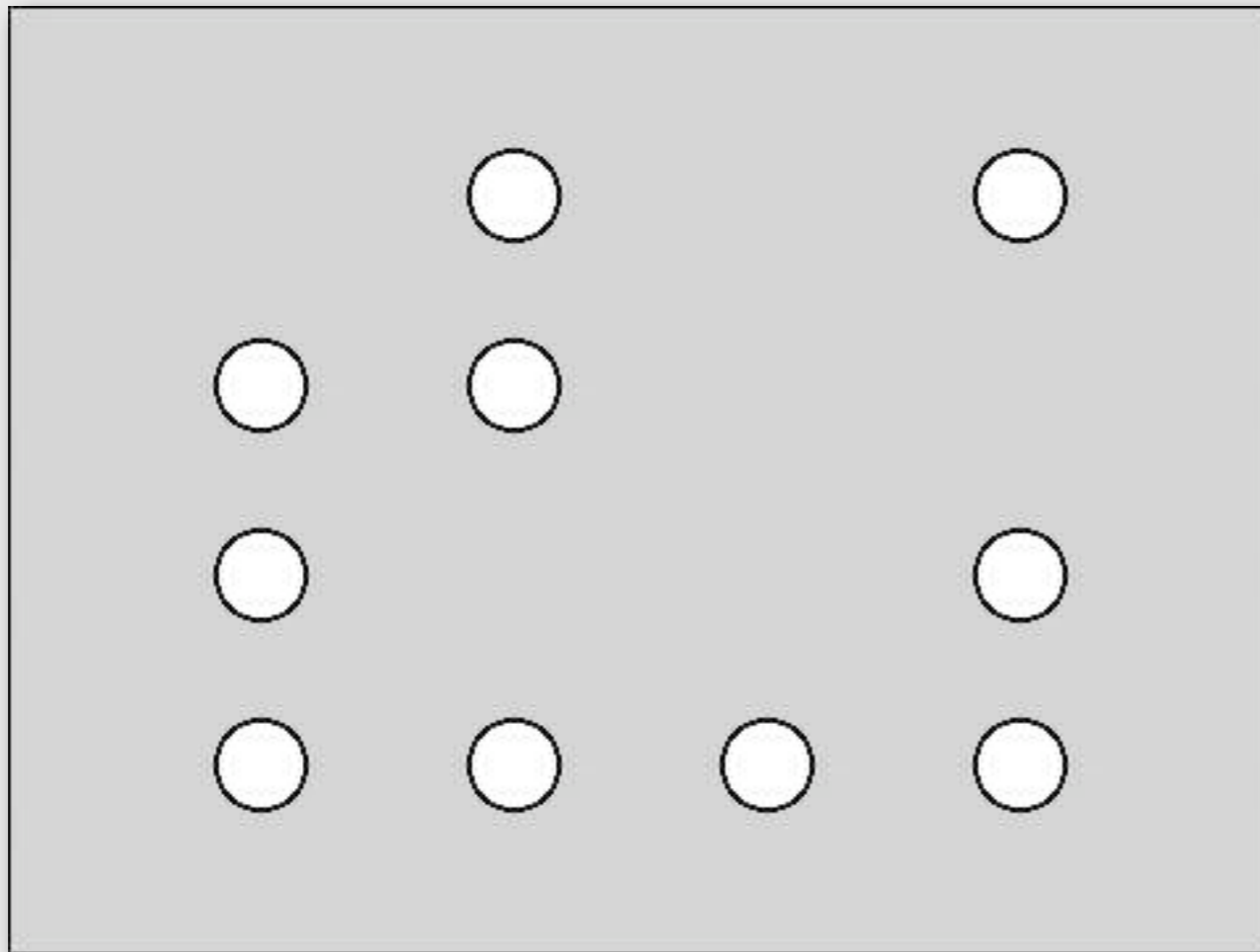
track
targets
for 5 s

targets
turn
green

multiple object tracking (MOT) task

occupying visual attention

Jungé, DiMase,
Scholl, Chun,
Horowitz, & Wolfe
(accepted pending
revision). Vision
Research



multiple object tracking (MOT) task

4 targets
will blink

track
targets
for 5 s

targets
turn
green

design

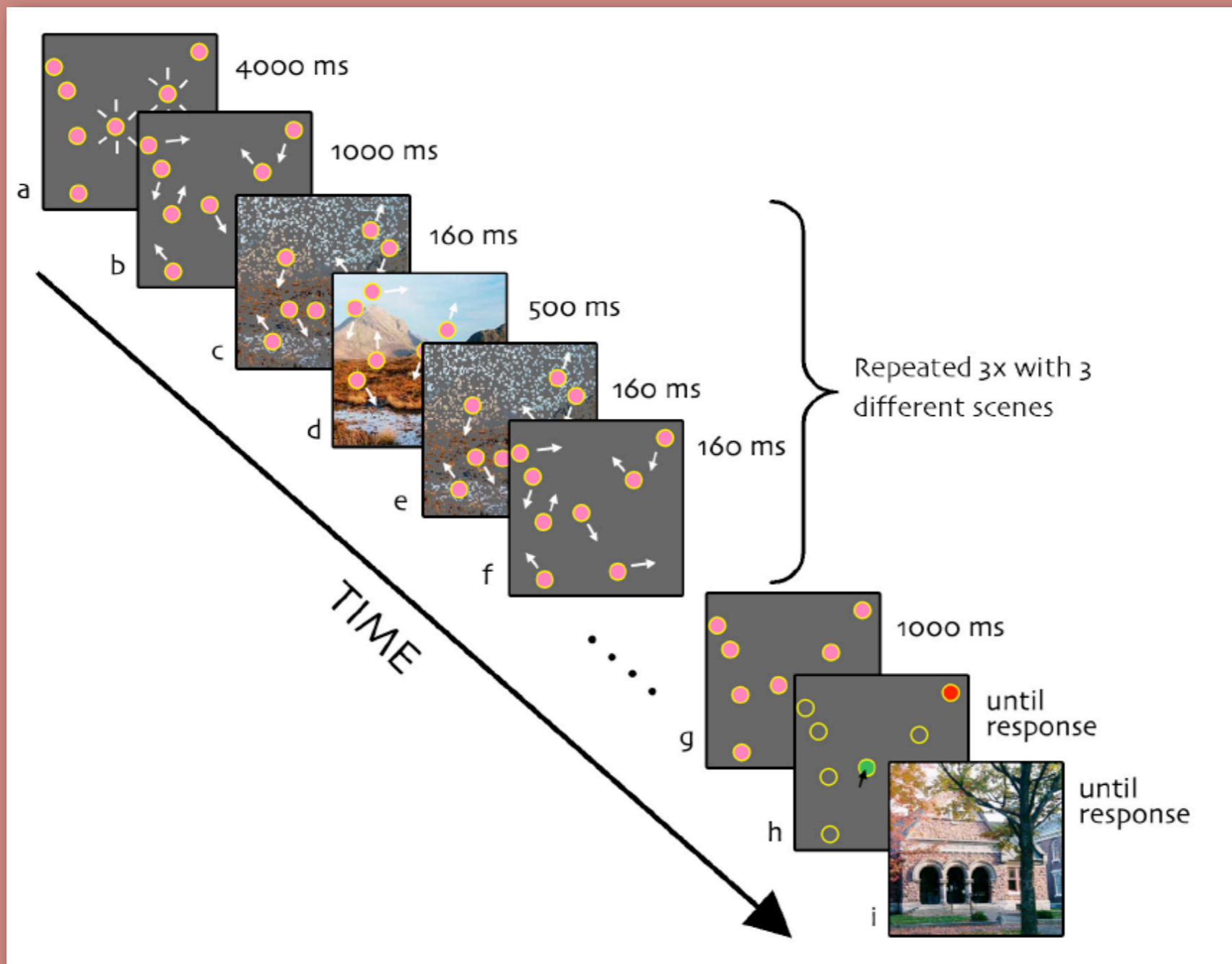
secondary task load

secondary task

	none	two	four
MOT at encoding			
tone task at encoding			
MOT at consolidation			

concurrent MOT

Jungé, DiMase,
Scholl, Chun,
Horowitz, & Wolfe
(accepted pending
revision). Vision
Research

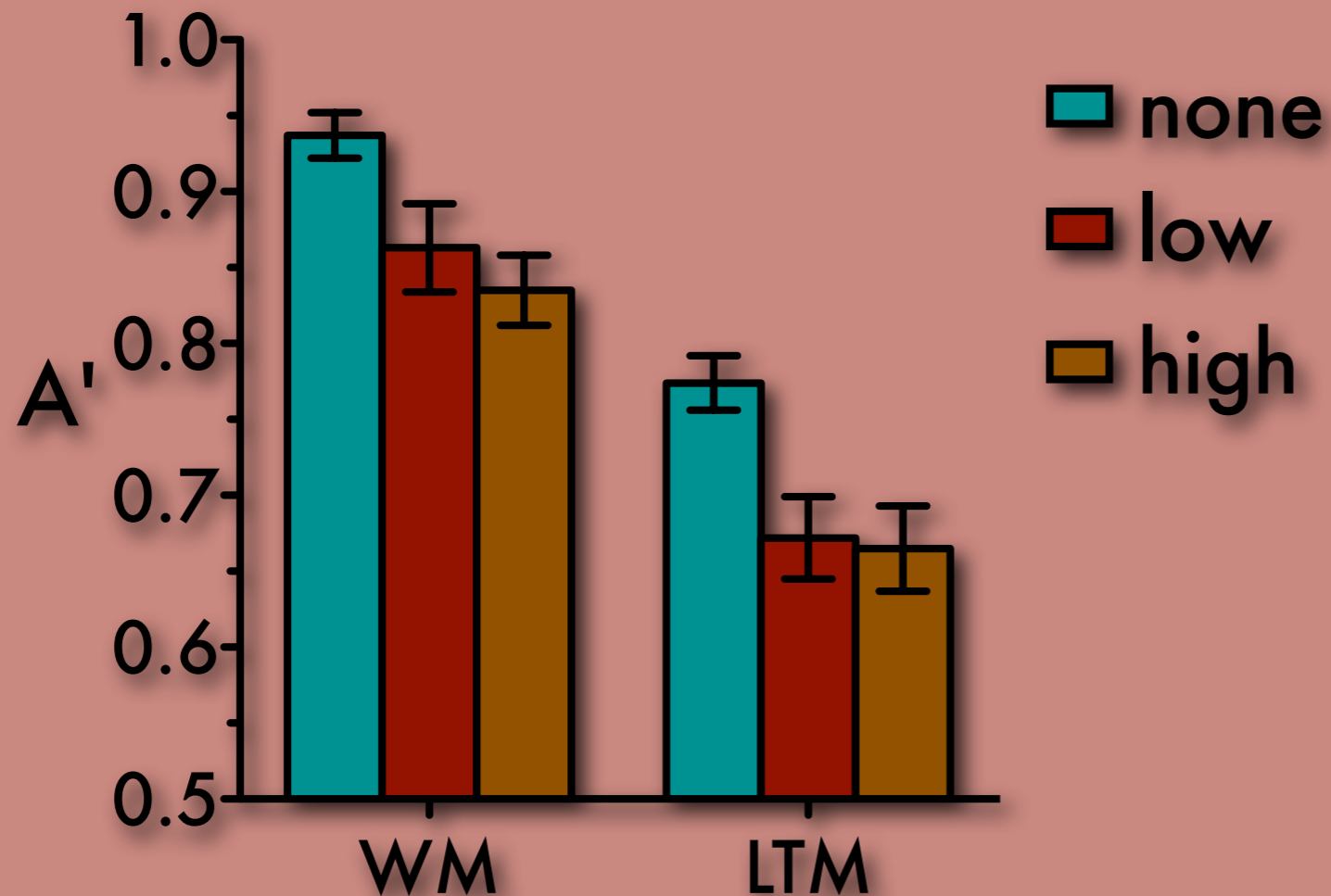


working
memory
tested at the
end of each
trial

long-term
memory
tested at the
end of
experiment

concurrent MOT

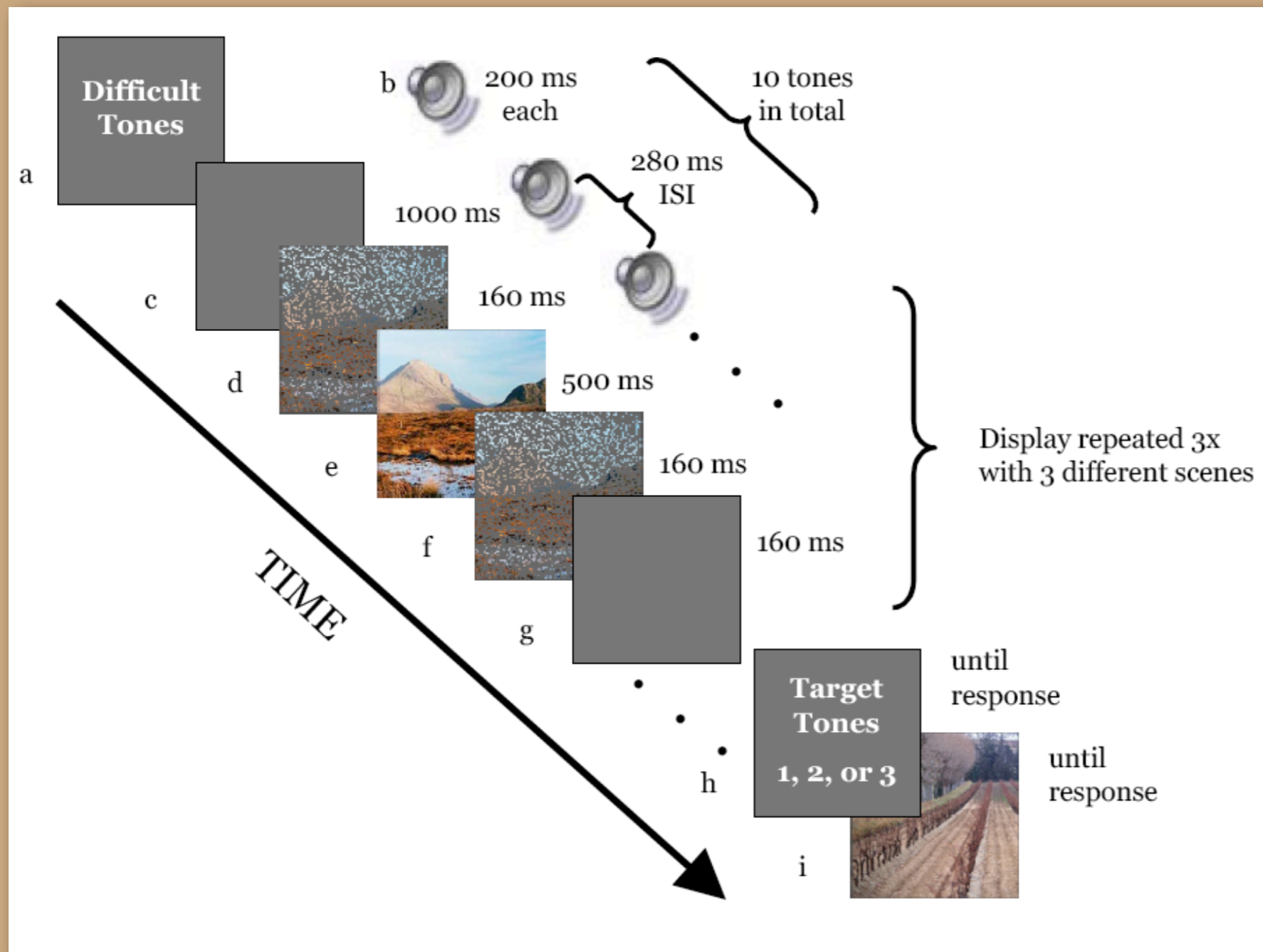
Jungé, DiMase,
Scholl, Chun,
Horowitz, & Wolfe
(accepted pending
revision). Vision
Research



MOT
interferes
with scene
memory, but
load effect is
weak or
absent

auditory baseline

Jungé, DiMase,
Scholl, Chun,
Horowitz, & Wolfe
(accepted pending
revision). Vision
Research

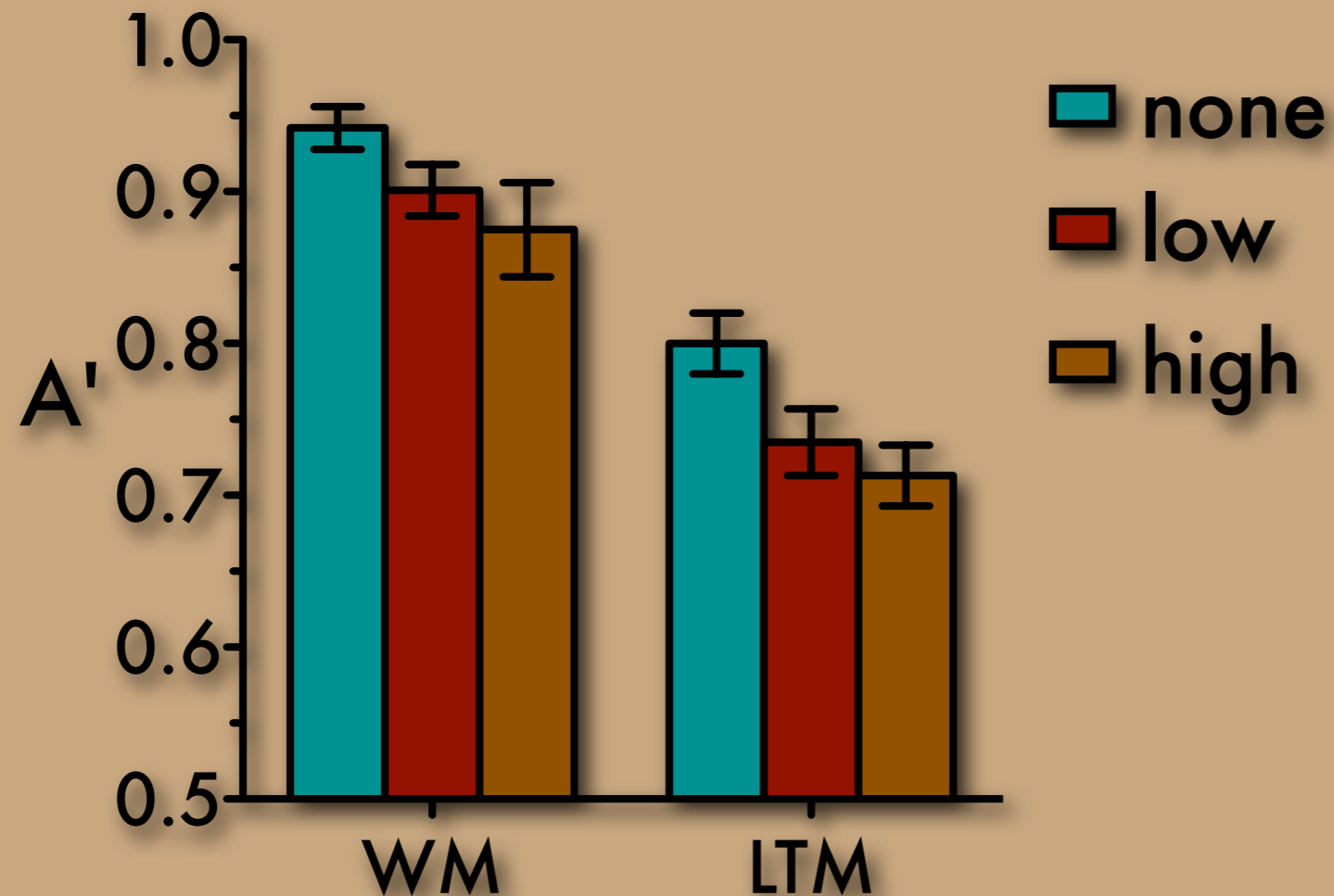


working
memory
tested at the
end of each
trial

long-term
memory
tested at the
end of
experiment

auditory baseline

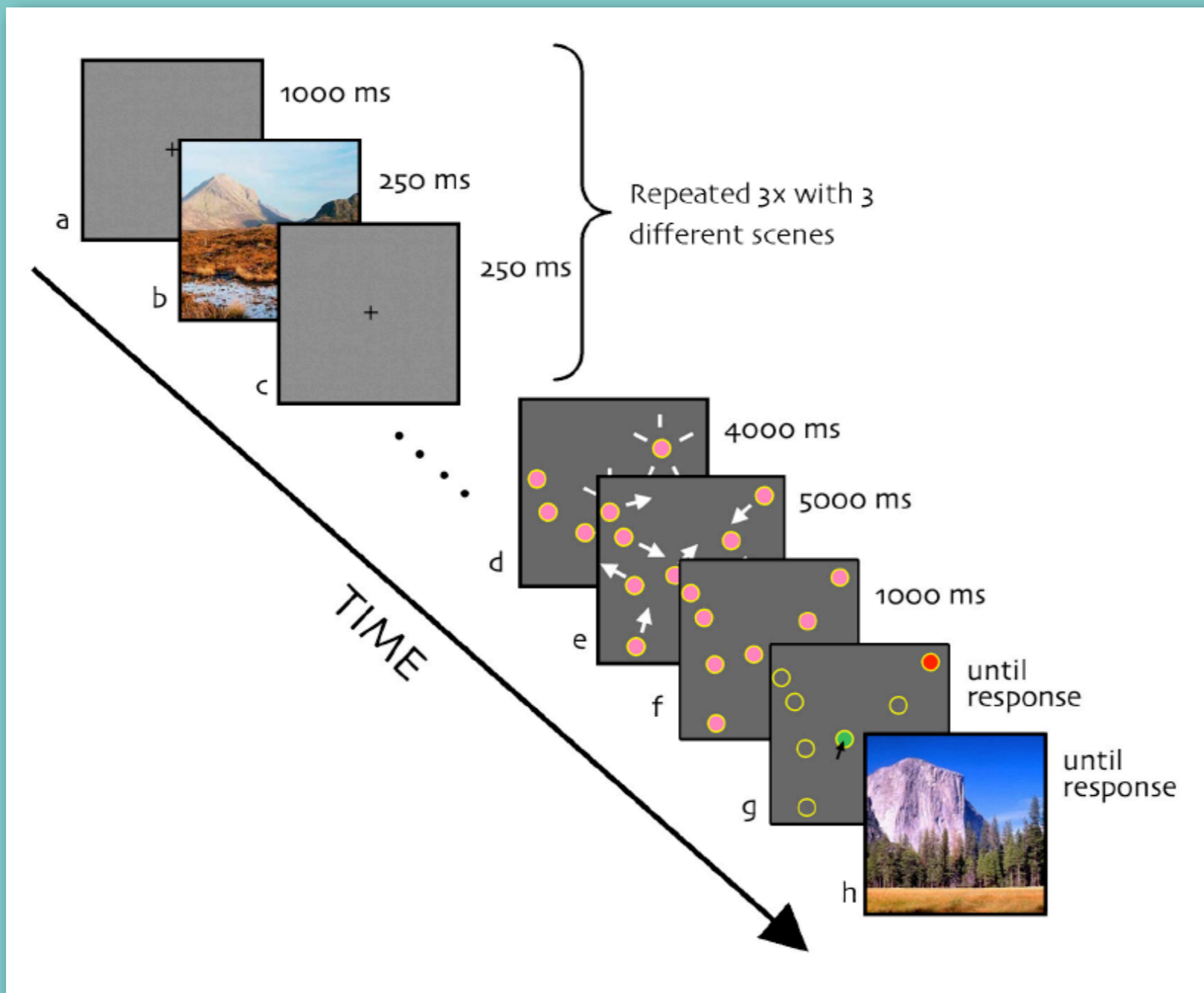
Jungé, DiMase,
Scholl, Chun,
Horowitz, & Wolfe
(accepted pending
revision). Vision
Research



tone task
interferes as
much as
MOT

MOT during consolidation

Jungé, DiMase, Scholl, Chun, Horowitz, & Wolfe (accepted pending revision). Vision Research

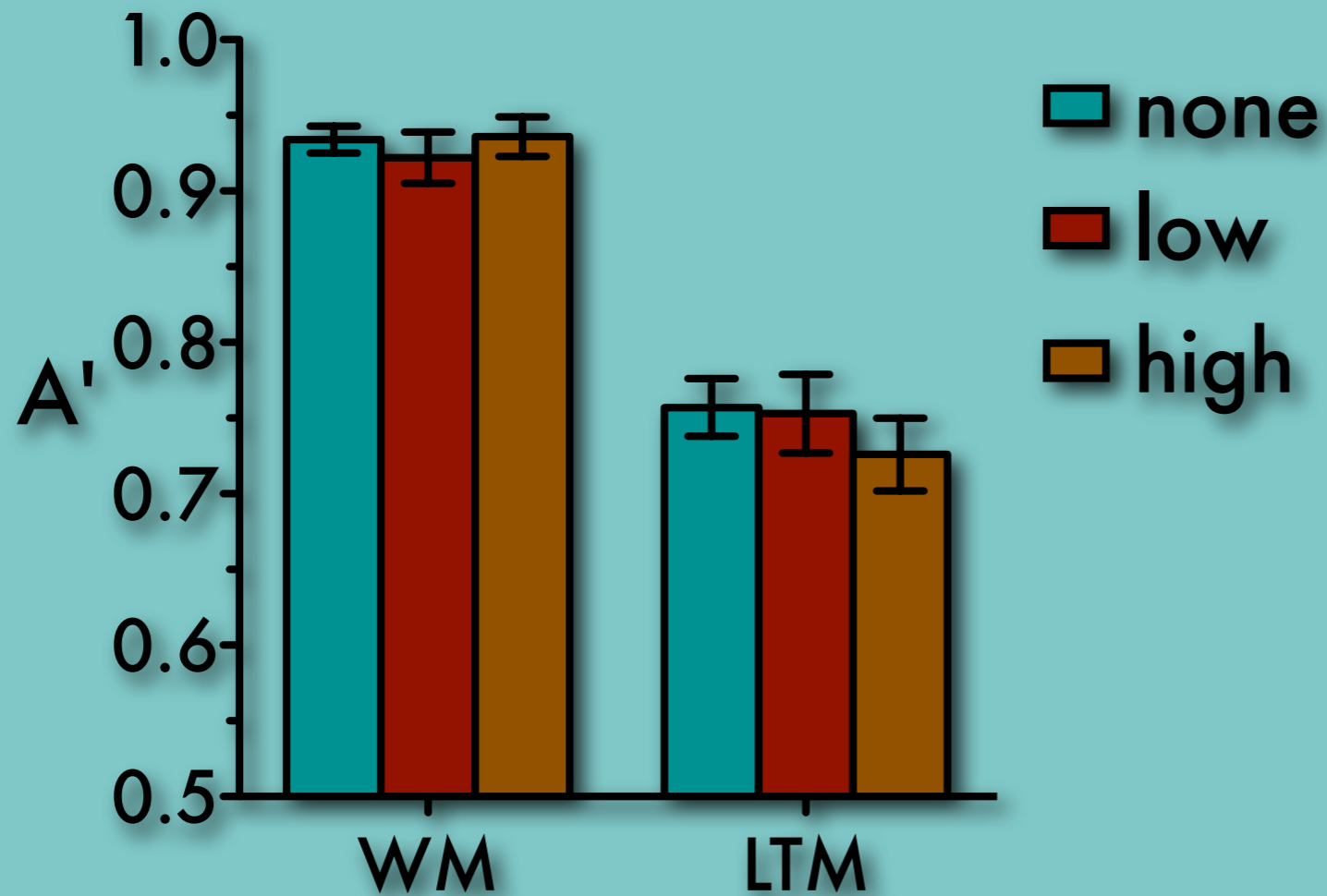


working memory tested at the end of each trial

long-term memory tested at the end of experiment

MOT during consolidation

Jungé, DiMase,
Scholl, Chun,
Horowitz, & Wolfe
(accepted pending
revision). Vision
Research



MOT has no
effect on
consolidation

interim conclusions

- Scenes are defined by layout, not objects
- Successful scene memory requires attention...
- ... for consolidation, and probably encoding
- Applies only to “ventral” attention

attention and boundary extension

picture 1

picture 1



picture 1

picture 2

picture 2



picture 2

which one did you see?

picture 1

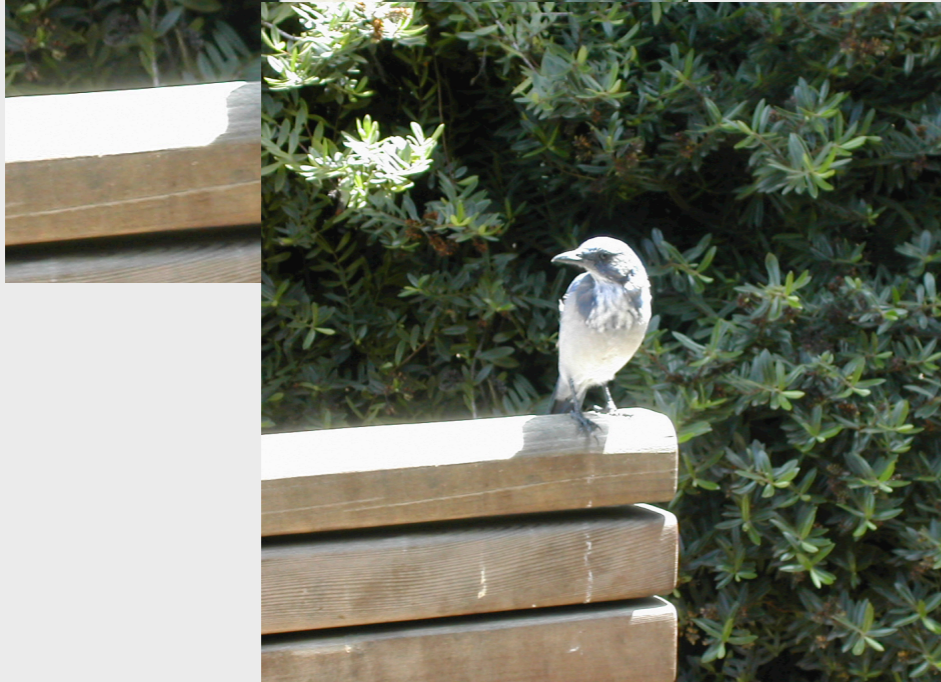
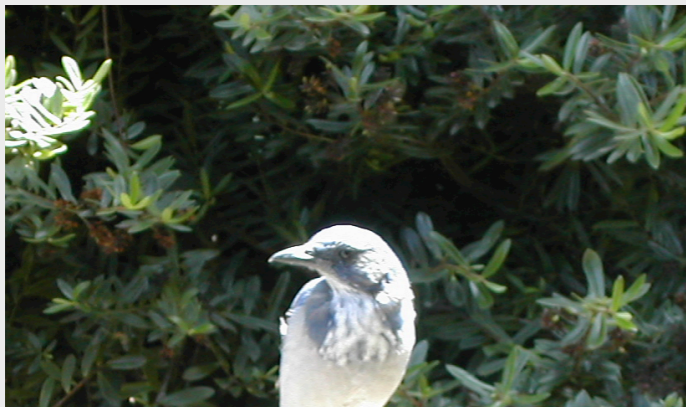


which one did you see?

picture 1



boundary extension



Intraub &
Richardson
(1989)

what is “gist”?

putative
gist
components



boundary
extension

Intraub &
Richardson
(1989)

feature
statistics

layout

objects

amodal
information

what is the role of attention in
boundary extension?

two hypotheses

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

boundary extension
requires attention

attention inhibits
boundary extension

two hypotheses

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

boundary extension
requires attention

attention inhibits
boundary extension

withdrawing attention
will reduce boundary
extension

two hypotheses

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

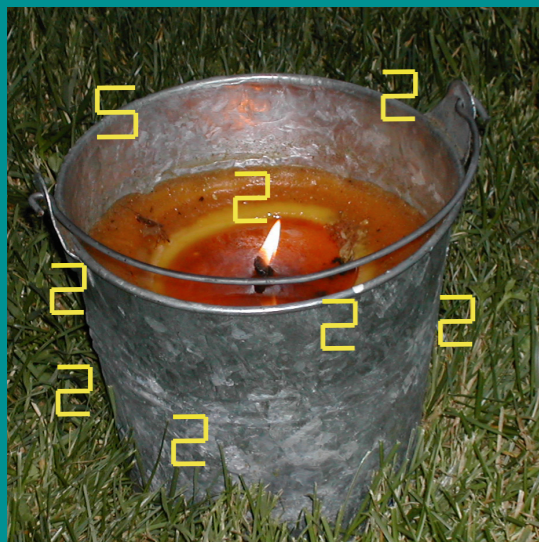
boundary extension
requires attention

withdrawing attention
will reduce boundary
extension

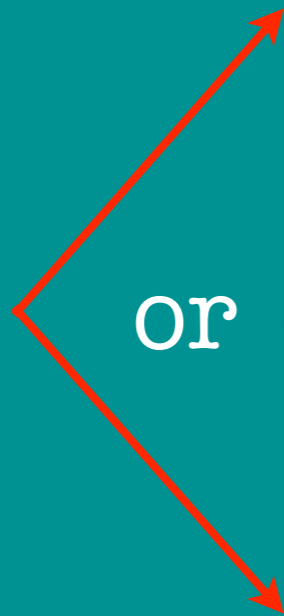
attention inhibits
boundary extension

withdrawing attention
will increase boundary
extension

procedure



750 ms



How many targets?
0, 1 or 2

How much did you like
the picture?
0, 1 or 2

<5000 ms

feedback

2000 ms

memory
test

memory test



compared to the picture you just saw, this picture is:
a lot closer-up (-2), a little closer-up (-1), same (0), a little farther away (1),
or a lot farther away (2)

memory test

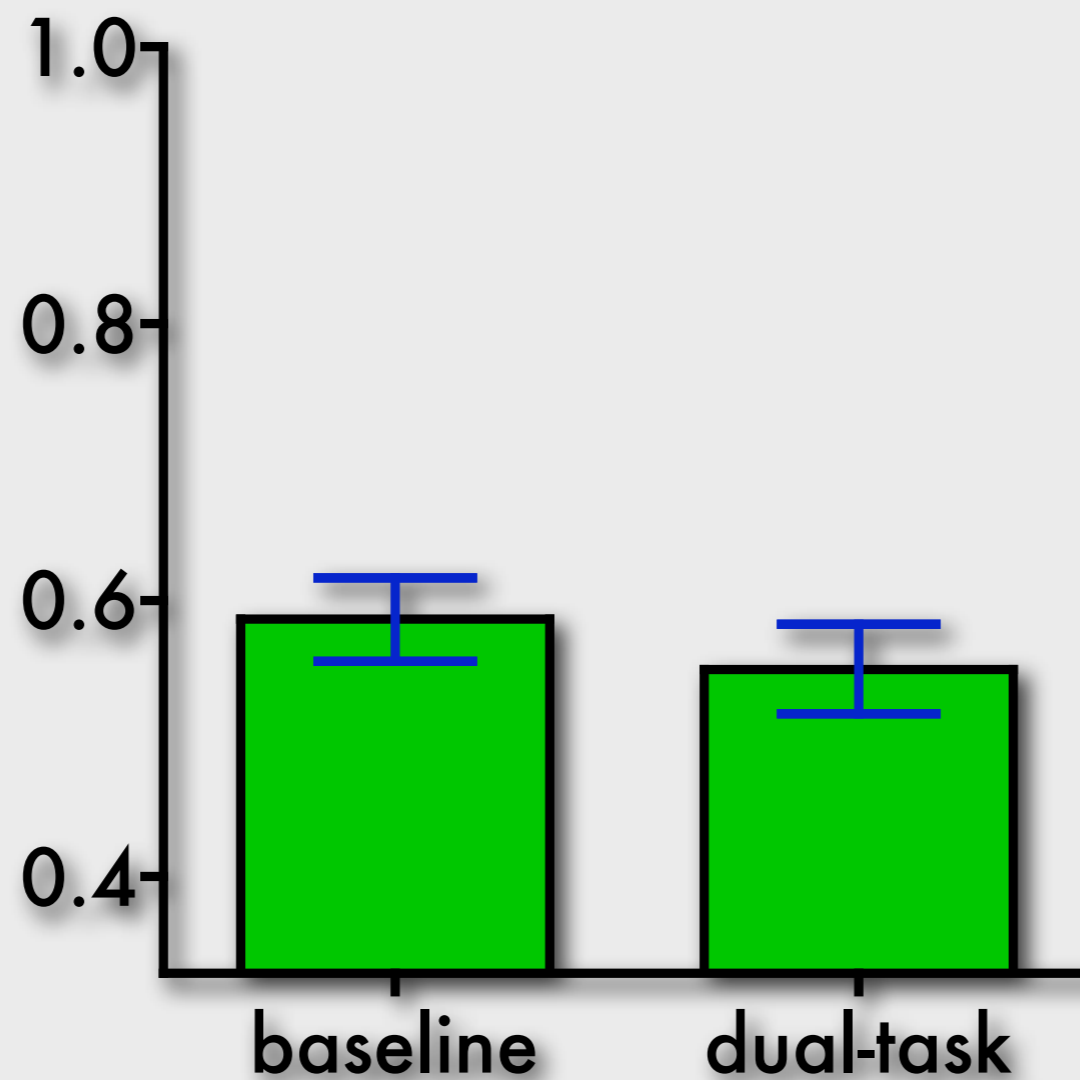


compared to the picture you just saw, this picture is:
a lot closer-up (-2), a little closer-up (-1), same (0), a little farther away (1),
or a lot farther away (2)

sure (3), pretty sure (2), or not sure (1)
[or did not see picture]

boundary extension

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.



search task
performance

chance = .33

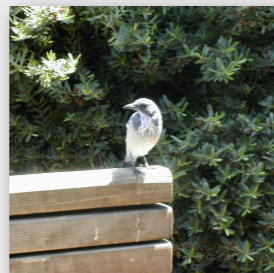
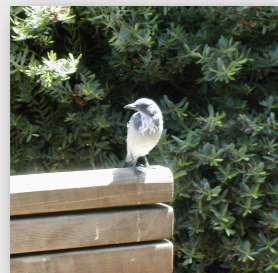
training-test pairs

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.



Close - Close

CC



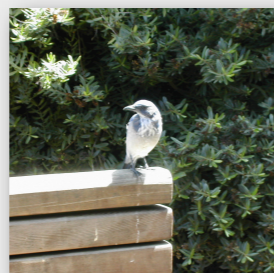
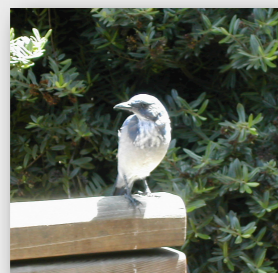
Wide - Wide

WW



Wide - Close

WC



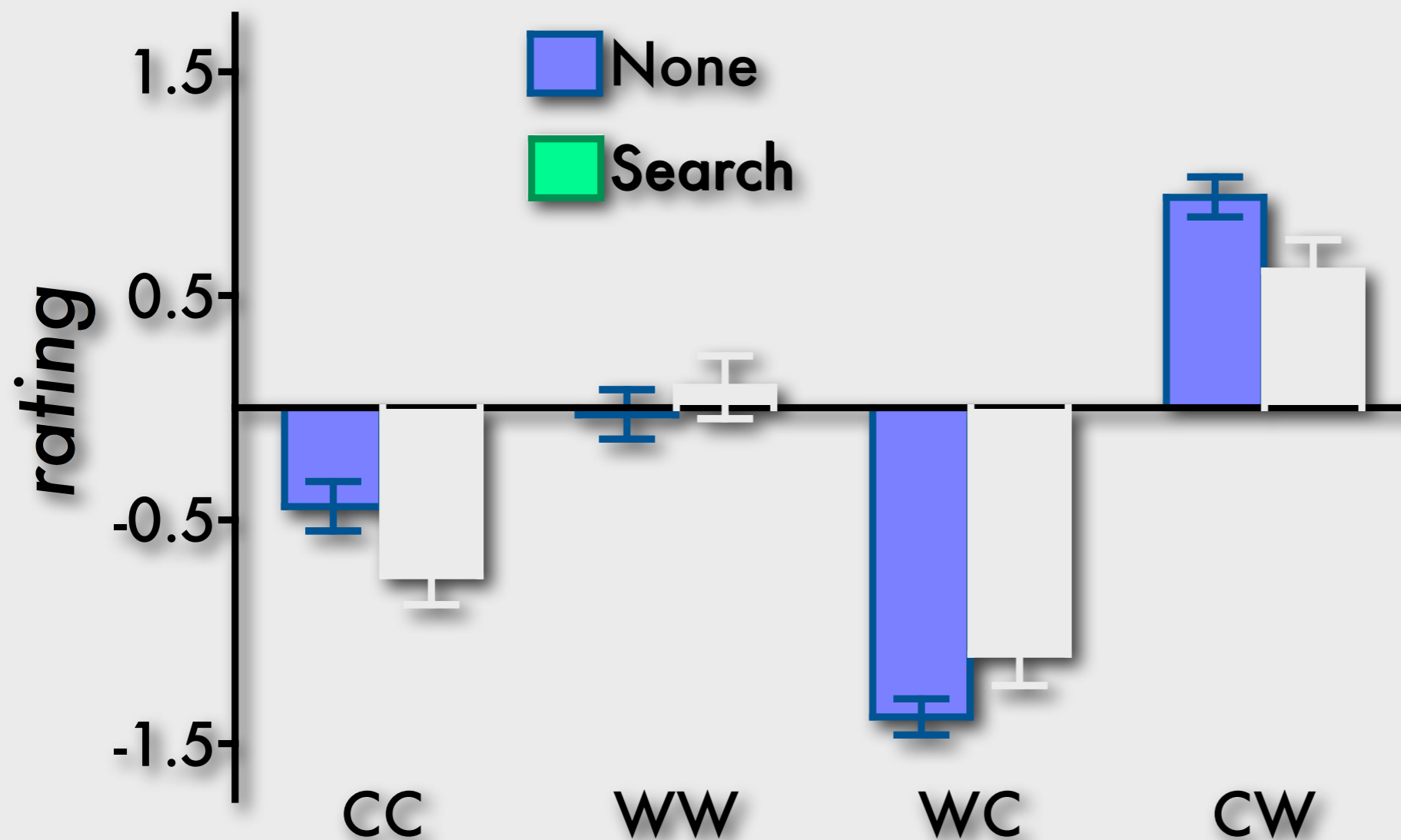
Close - Wide

CW

boundary ratings

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

too far



sure/pretty
sure
confidence
only

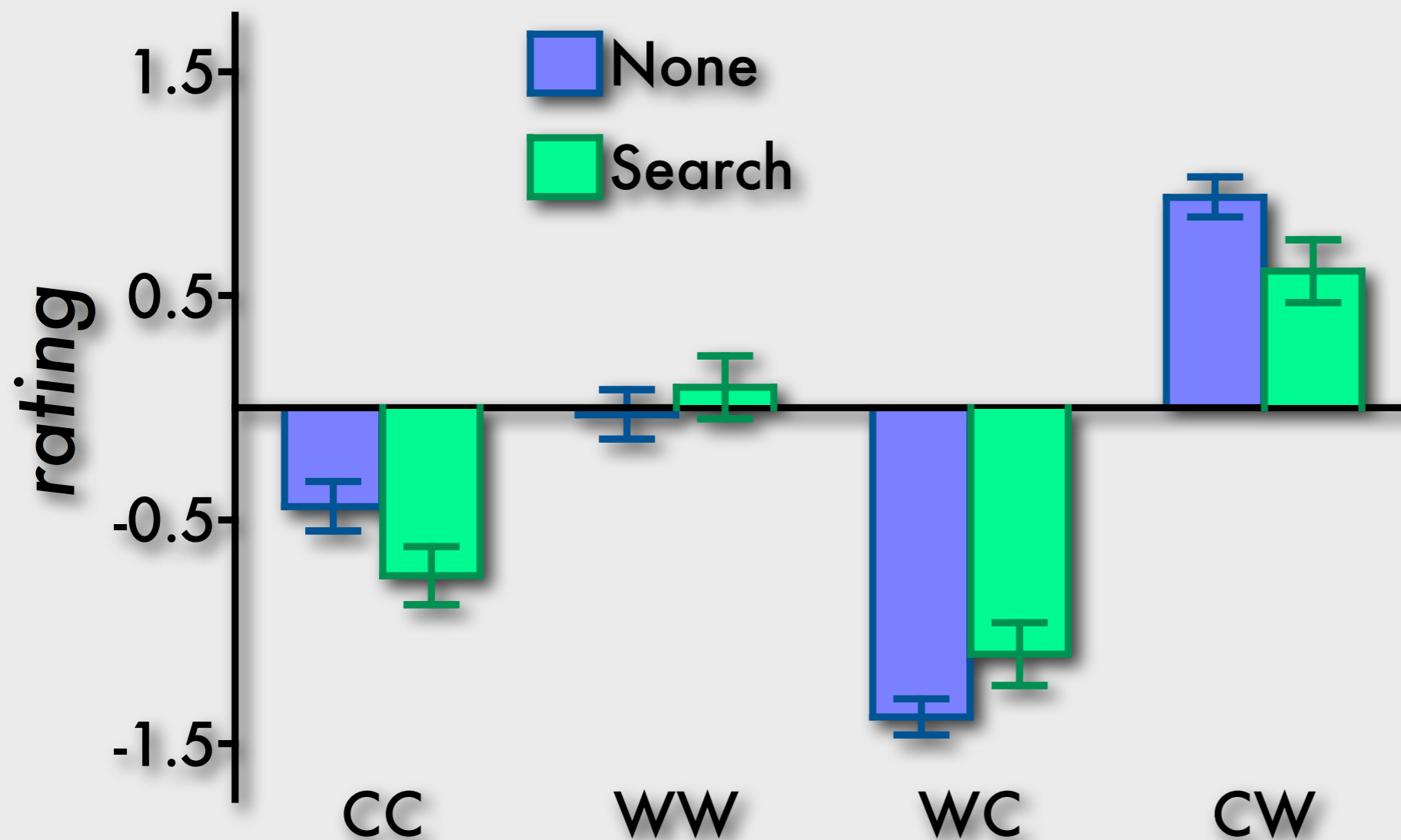
N = 36

too close

boundary ratings

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

too far



sure/pretty
sure
confidence
only

N = 36

too close

boundary extension & attention

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

~~boundary extension
requires attention~~

~~withdrawing attention
will reduce boundary
extension~~

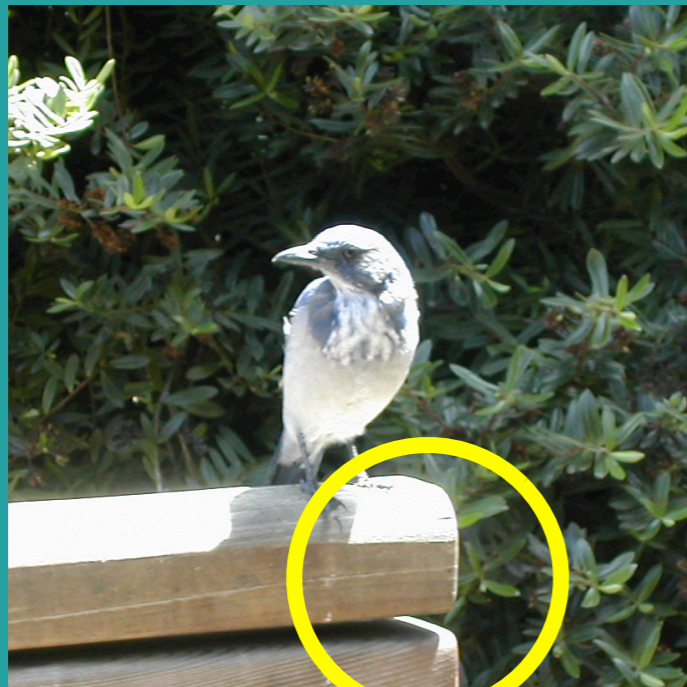
attention inhibits
boundary extension

withdrawing attention
will increase boundary
extension

why does withdrawing attention increase boundary extension?

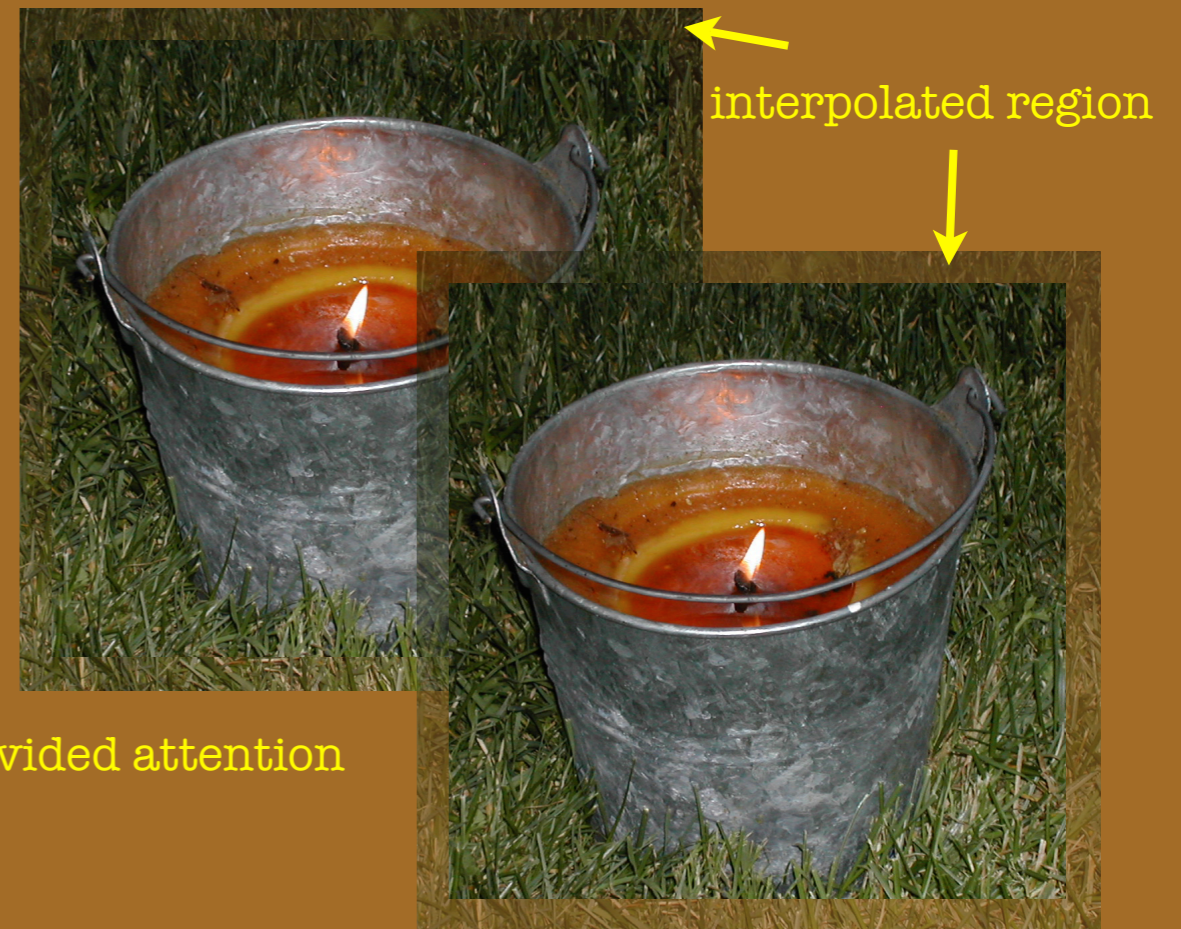
Intraub, Daniels, Horowitz, & Wolfe (under revision). Perception & Psychophysics.

Observers learn explicit strategies which require attention



“2 bars visible”

Attention improves source monitoring



divided attention

full attention

incidental boundary extension

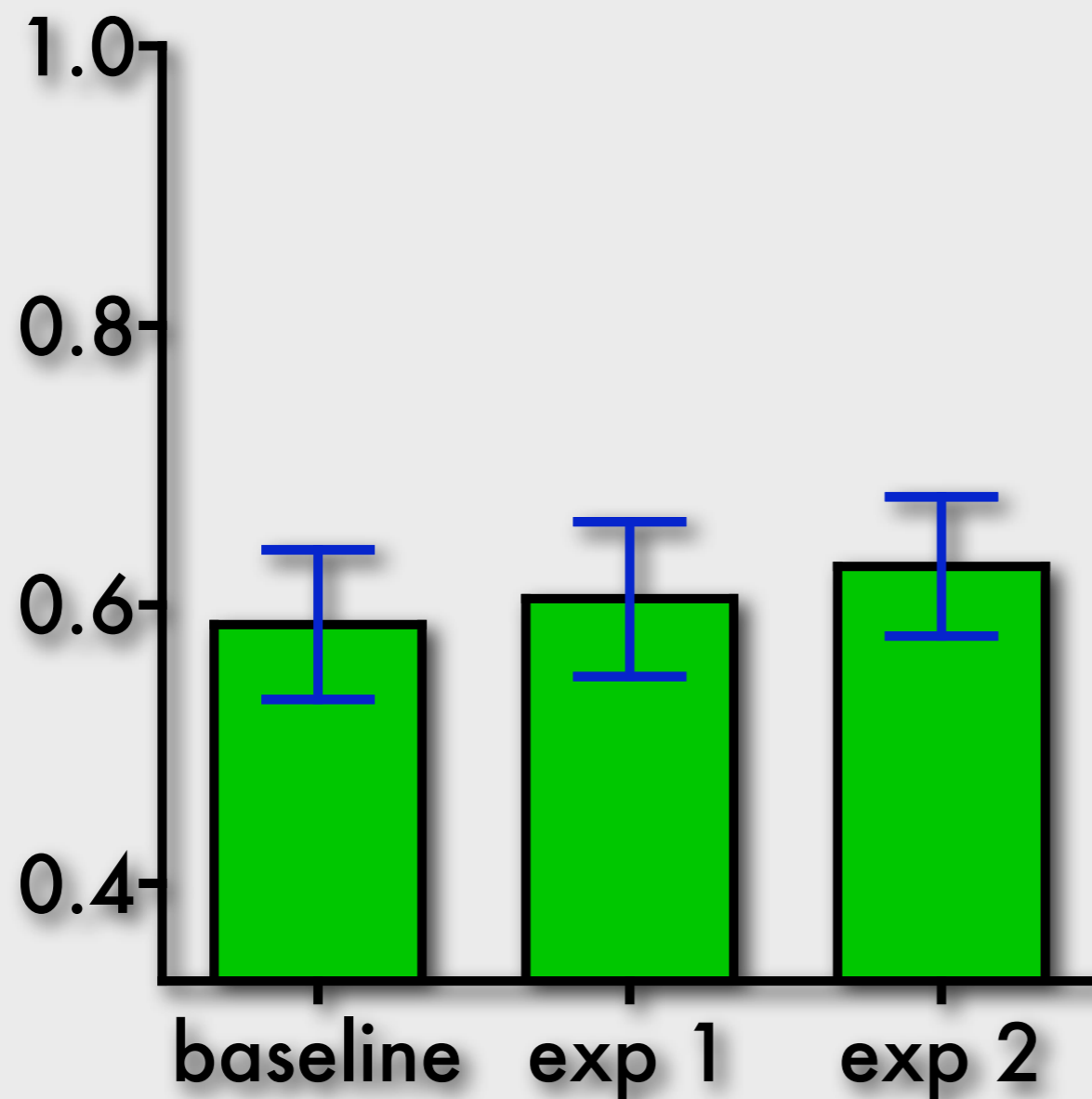
Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

CC & WW
trials

- 12 presentation trials in a row
- memory instructions deferred
- 12 boundary extension tests

incidental boundary extension

Intraub, Daniels, Horowitz, & Wolfe (under revision). Perception & Psychophysics.



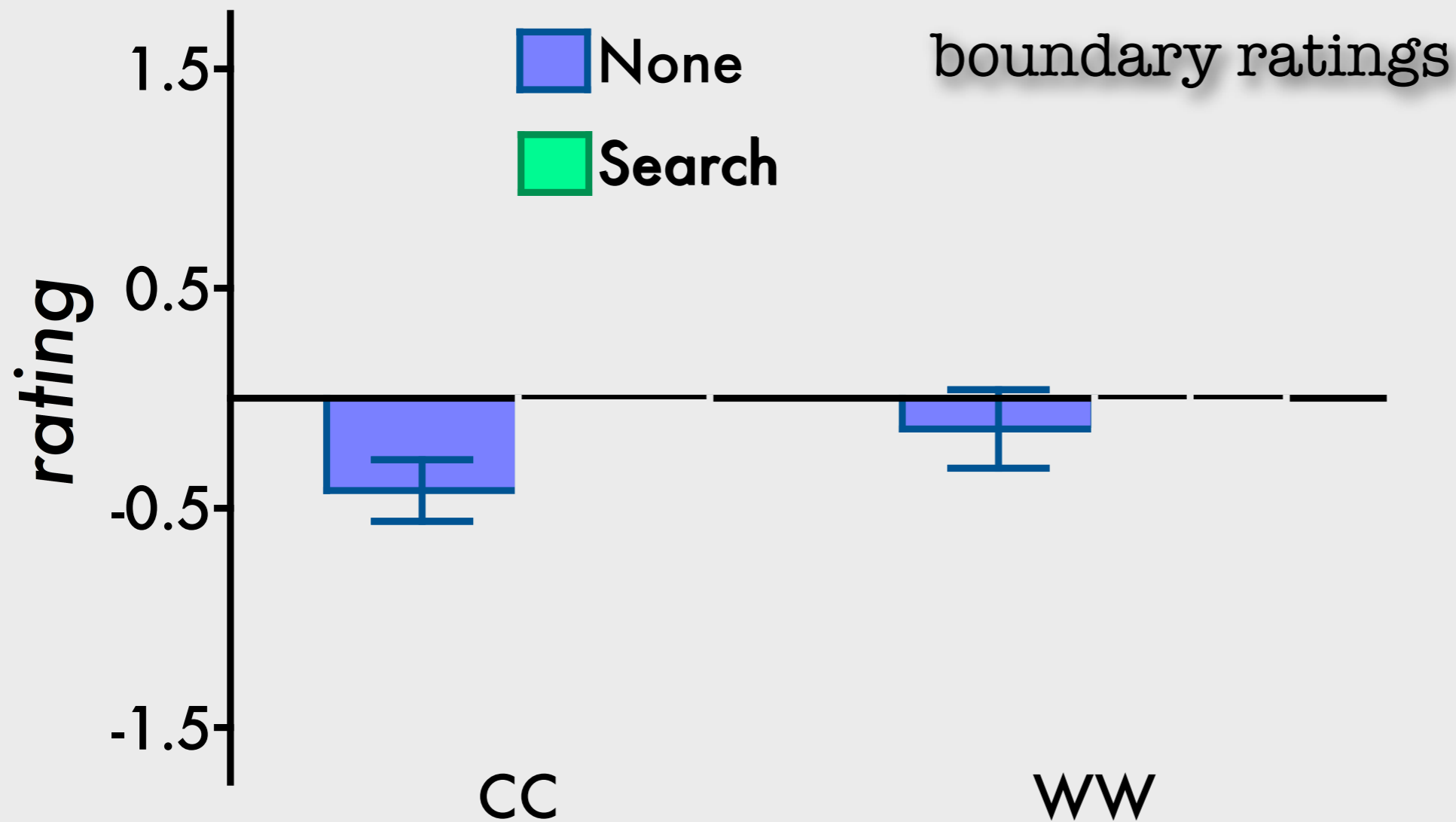
search task performance

chance = .33

incidental boundary extension

Intraub, Daniels, Horowitz, & Wolfe (under revision). Perception & Psychophysics.

too far



boundary ratings

all
confidence
ratings

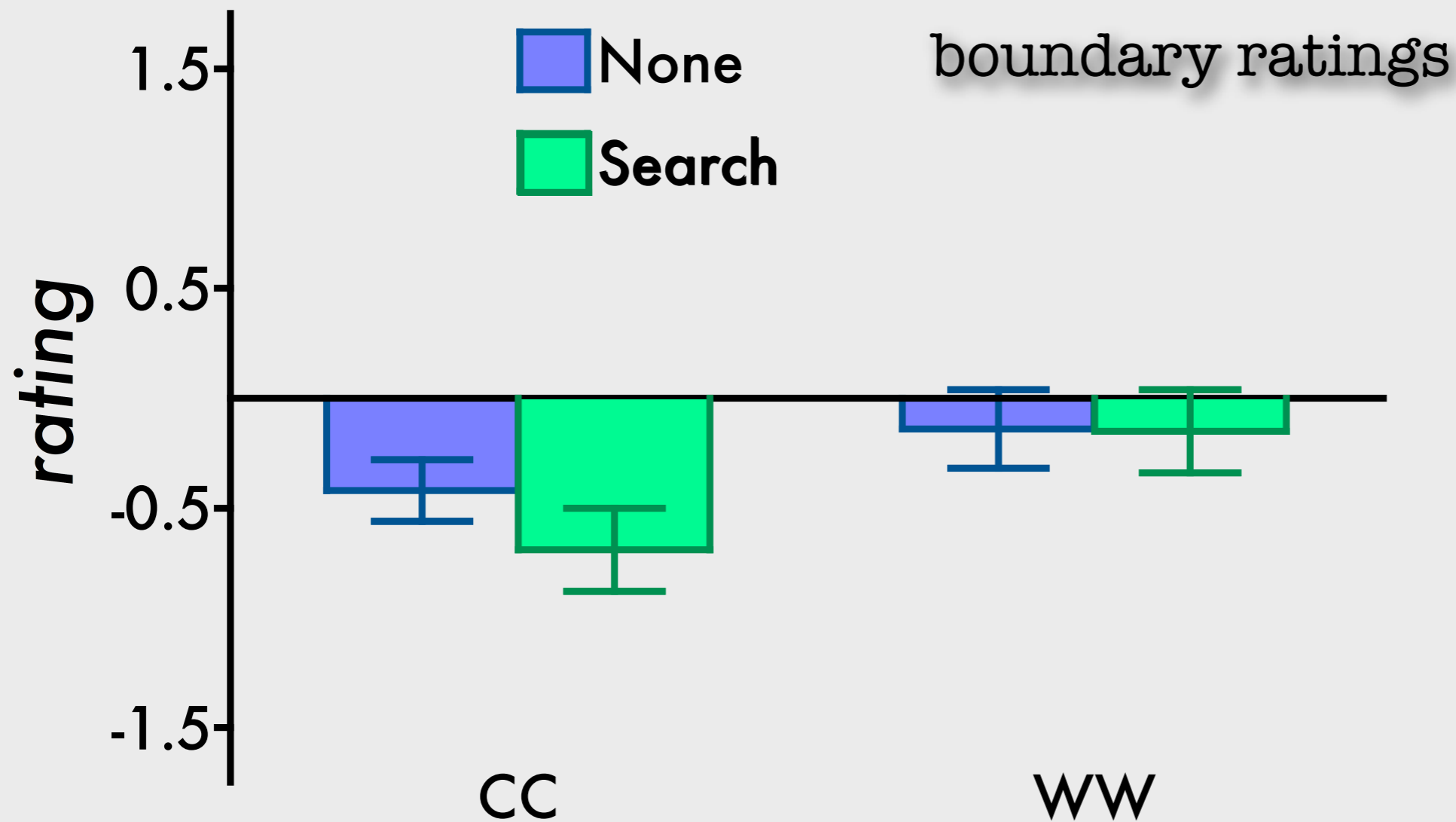
N = 36

too close

incidental boundary extension

Intraub, Daniels, Horowitz, & Wolfe (under revision). Perception & Psychophysics.

too far



all confidence ratings

N = 36

incidental boundary extension

Intraub, Daniels,
Horowitz, & Wolfe
(under revision).
Perception &
Psychophysics.

CC, WC, &
CW trials

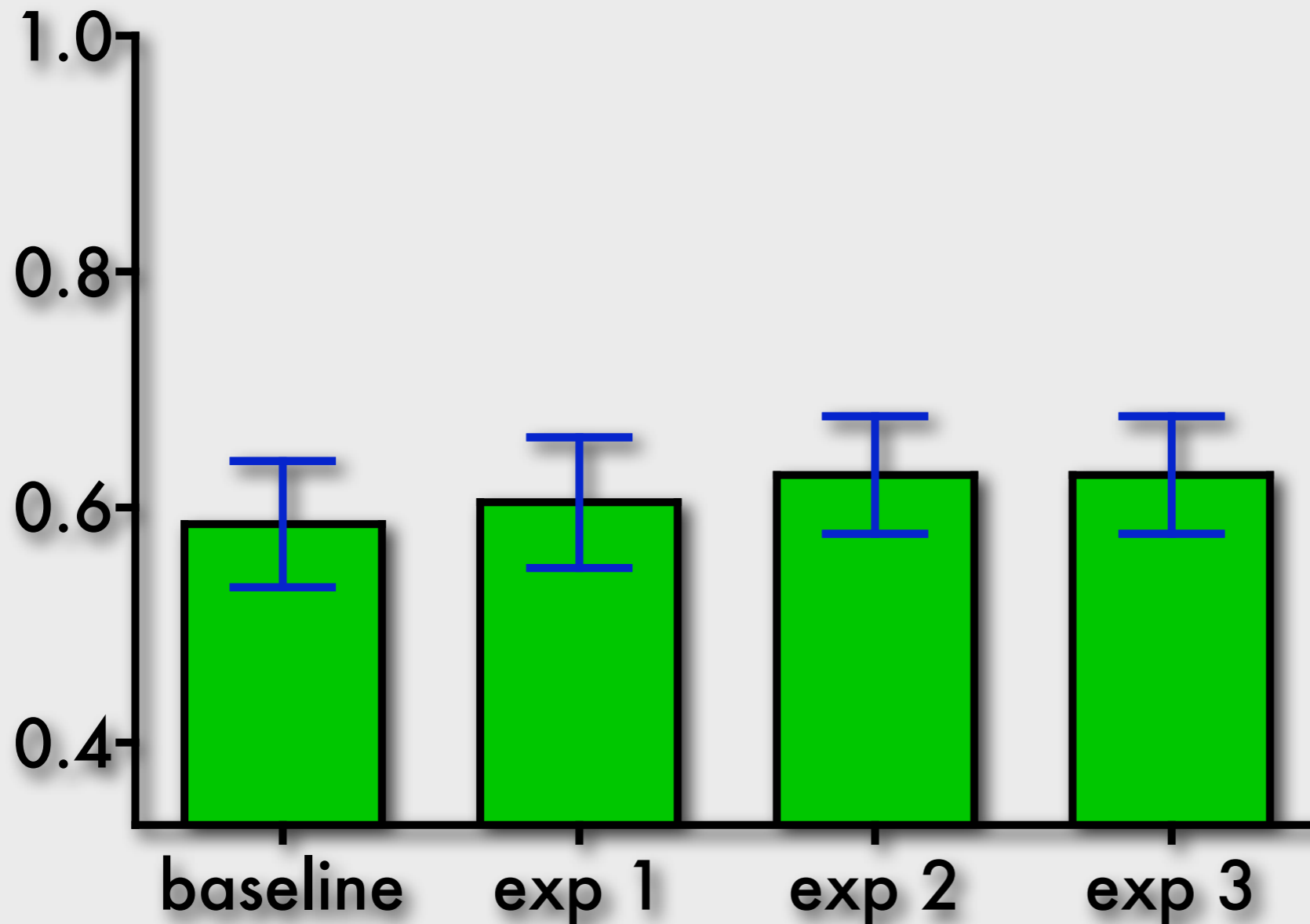
- 12 presentation trials in a row
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incidental boundary extension

Intraub, Daniels,
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Perception &
Psychophysics.

search task
performance

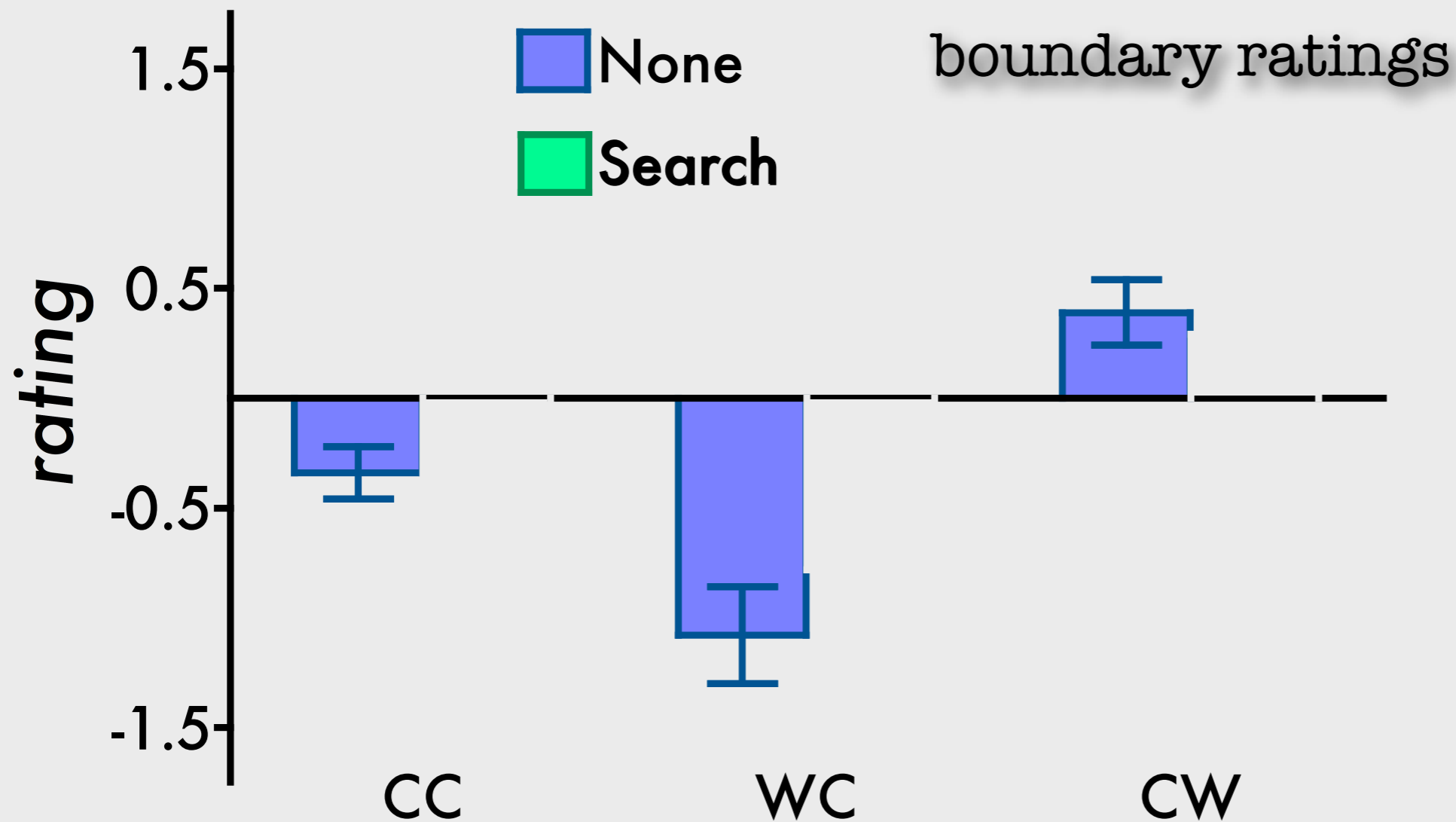
chance = .33



incidental boundary extension

Intraub, Daniels, Horowitz, & Wolfe (under revision). Perception & Psychophysics.

too far



all confidence ratings

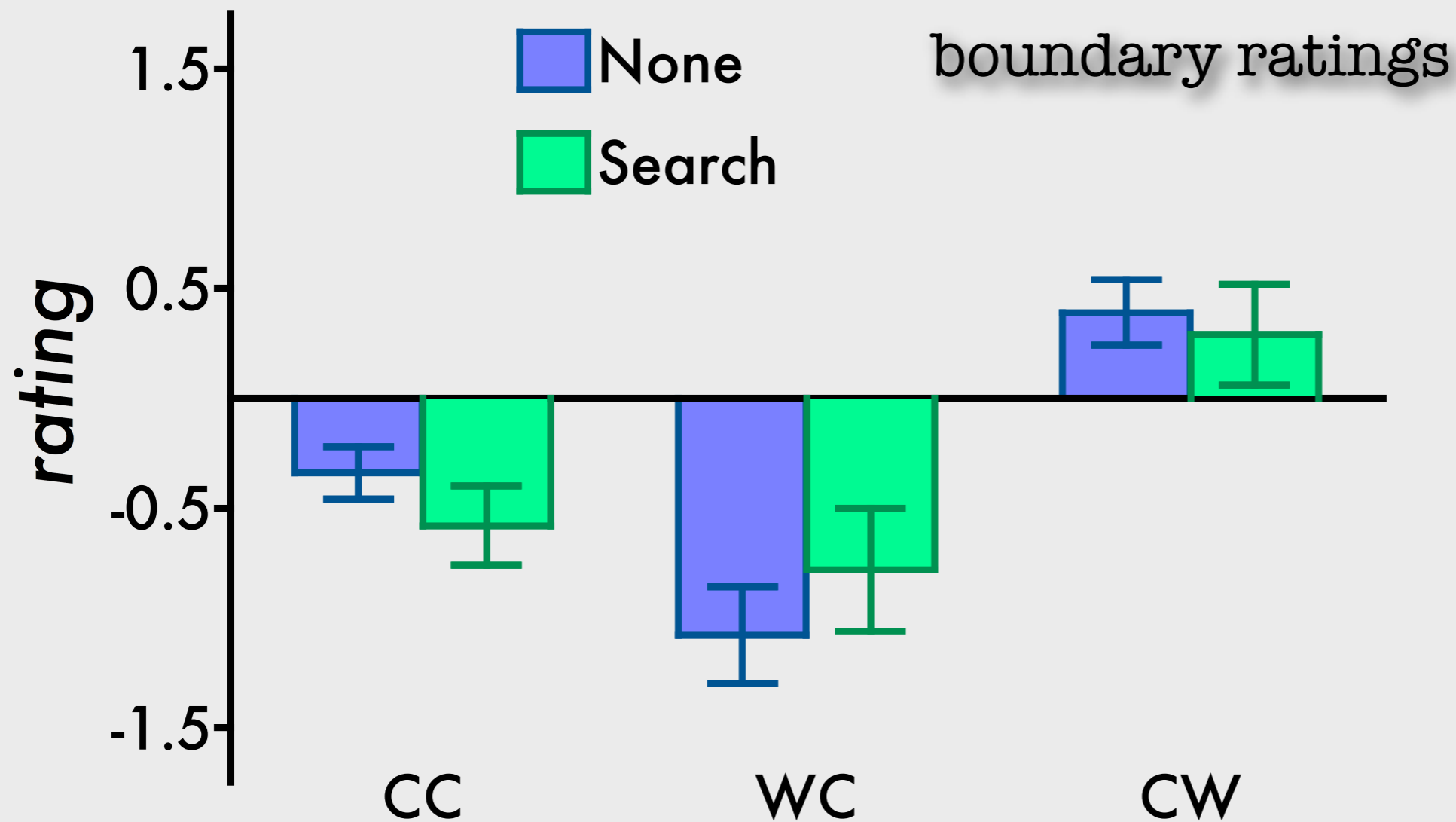
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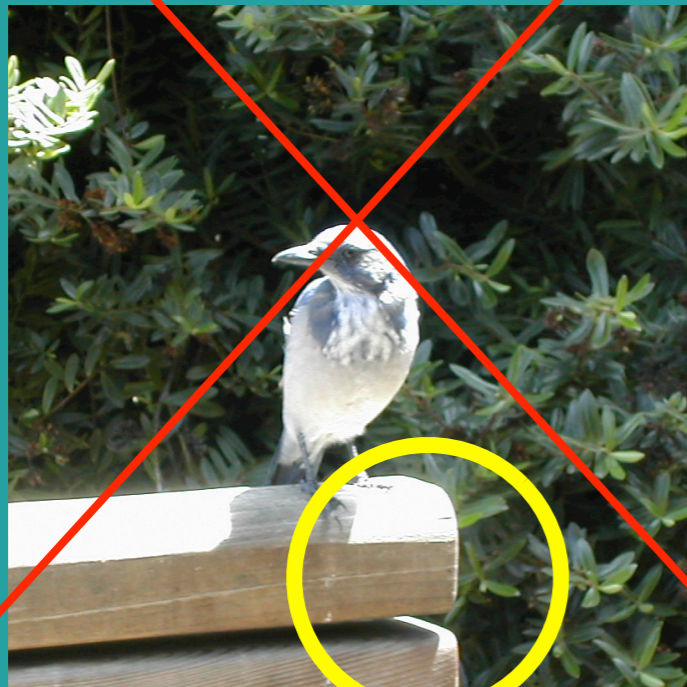
N = 36

too close

why does withdrawing attention increase boundary extension?

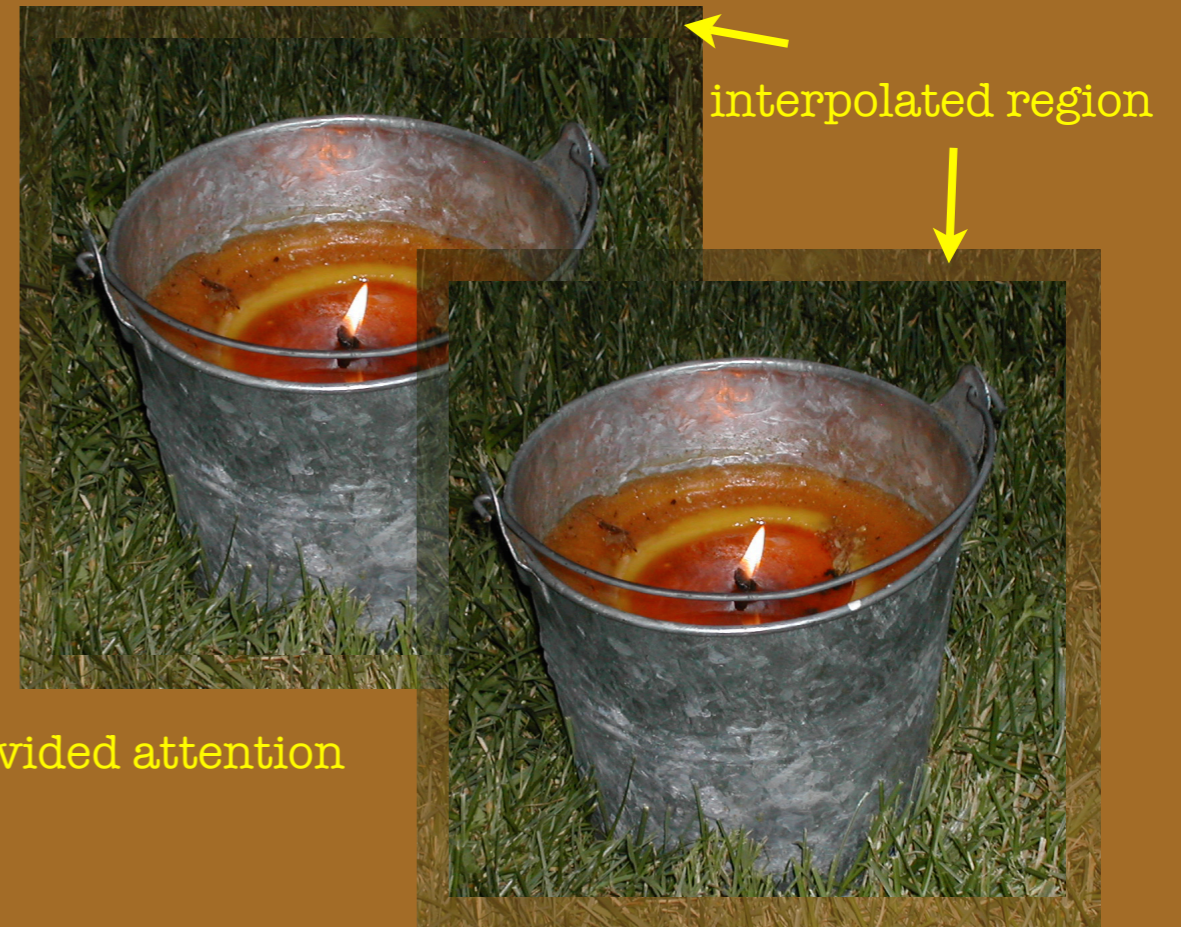
Intraub, Daniels, Horowitz, & Wolfe (under revision). Perception & Psychophysics.

Observers learn explicit strategies which require attention



“2 bars visible”

Attention improves source monitoring



divided attention

full attention

Attention and scene representations

- Encoding and consolidating gist information
- Discriminating between perceptual and amodal information
- Caveat: attention is not unitary!