



Representing Layout: What is the Time Course of Boundary Extension?

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Introduction

- Typically, viewers remember seeing beyond the boundaries of the current view (*Boundary Extension* [BE]; Intraub & Richardson, 1989)
- BE might facilitate integration of successive views, but ... to do so it would have to be available during the next fixation
- To date, the briefest retention interval tested is 1 s – Each trial consisted of an RSVP triad followed by 1 s mask and the test picture (Intraub, Gottesman, Willey, & Zuk, 1996)
- Is there a point earlier in visual processing at which a **veridical representation** of spatial layout might be maintained?

Experiment 1

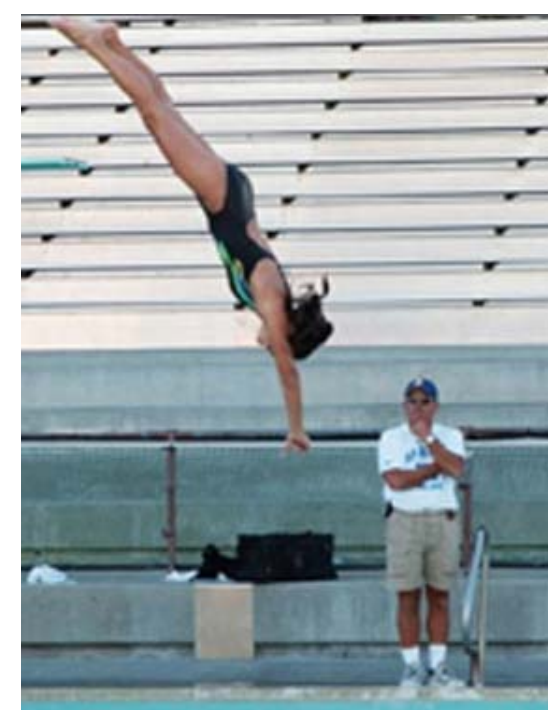
Purpose: Replicate the Intraub et al. (1996) experiment with new pictures and test briefer retention intervals (1 sec, 625 ms, 250 ms, 100 ms) to determine if there is a point at which viewers correctly recognize the same view (i.e., no BE)

Rationale: Close-ups were used in target trials because they elicit the greatest degree of BE; they would provide the most sensitive test for the presence of BE. Distractor trials in which close-ups were tested with a more wide-angle view (or vice versa) were included to direct attention to pictures' details and increase test's sensitivity. Spatial position of test picture was varied to test the hypothesis that an early visual buffer might contain a veridical retinotopic representation that is not maintained across a saccade.

Participants: N = 144 undergraduates (36/retention interval)

Stimuli: 32 pictures of scenes depicting various activities (+ 64 non-targets for RSVP sequences). Each tested picture had 2 versions: a close-up and a wide-angle version (as shown below).

Close-Up Views



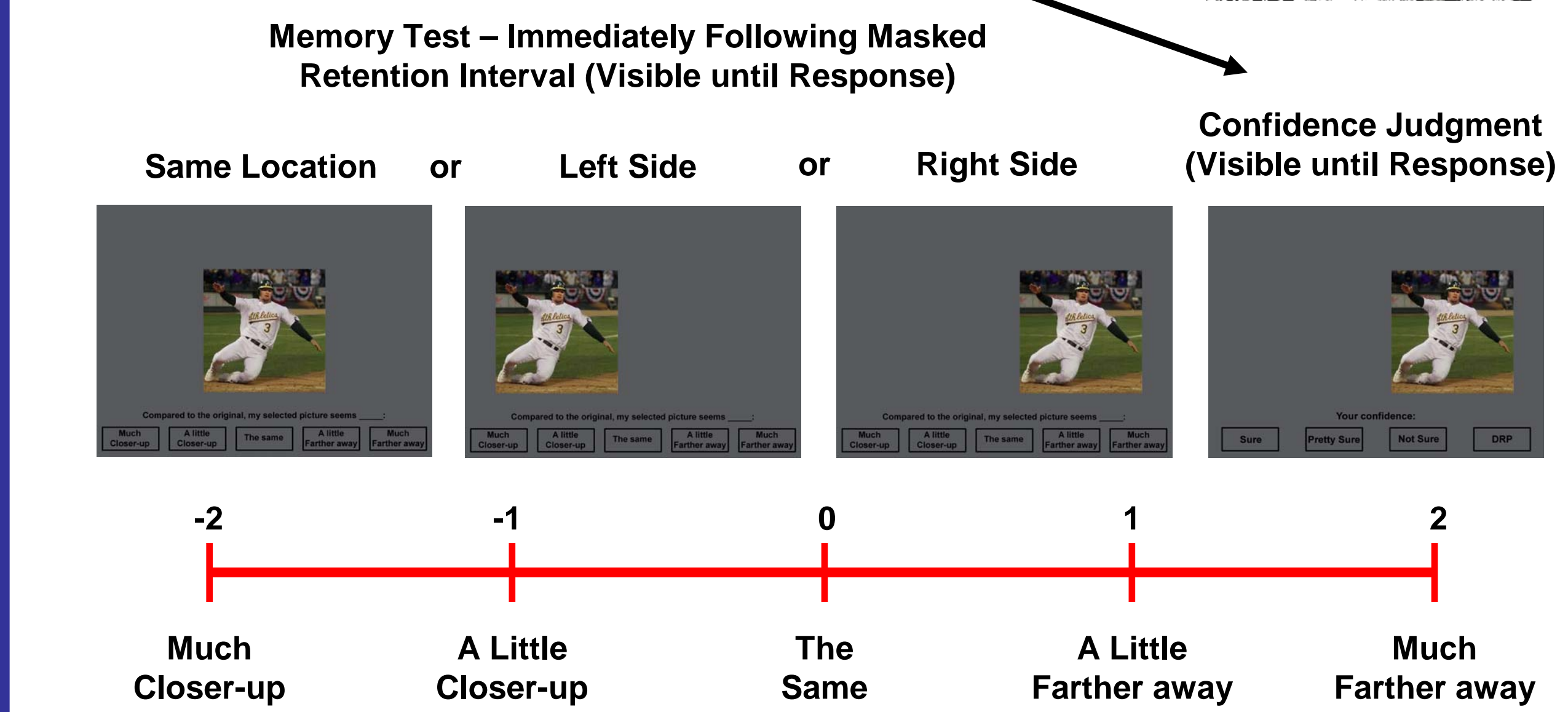
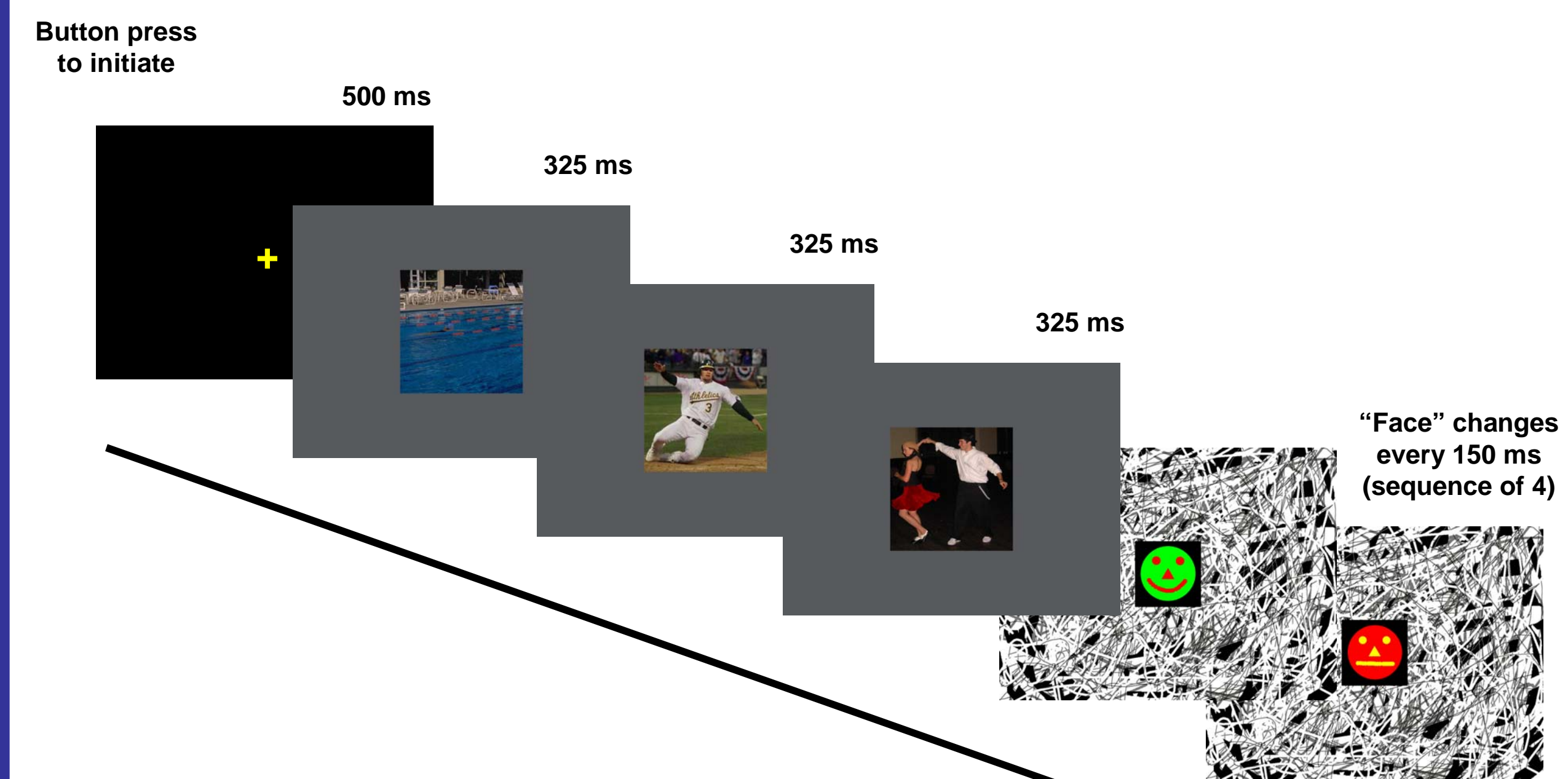
Wide-Angle Views



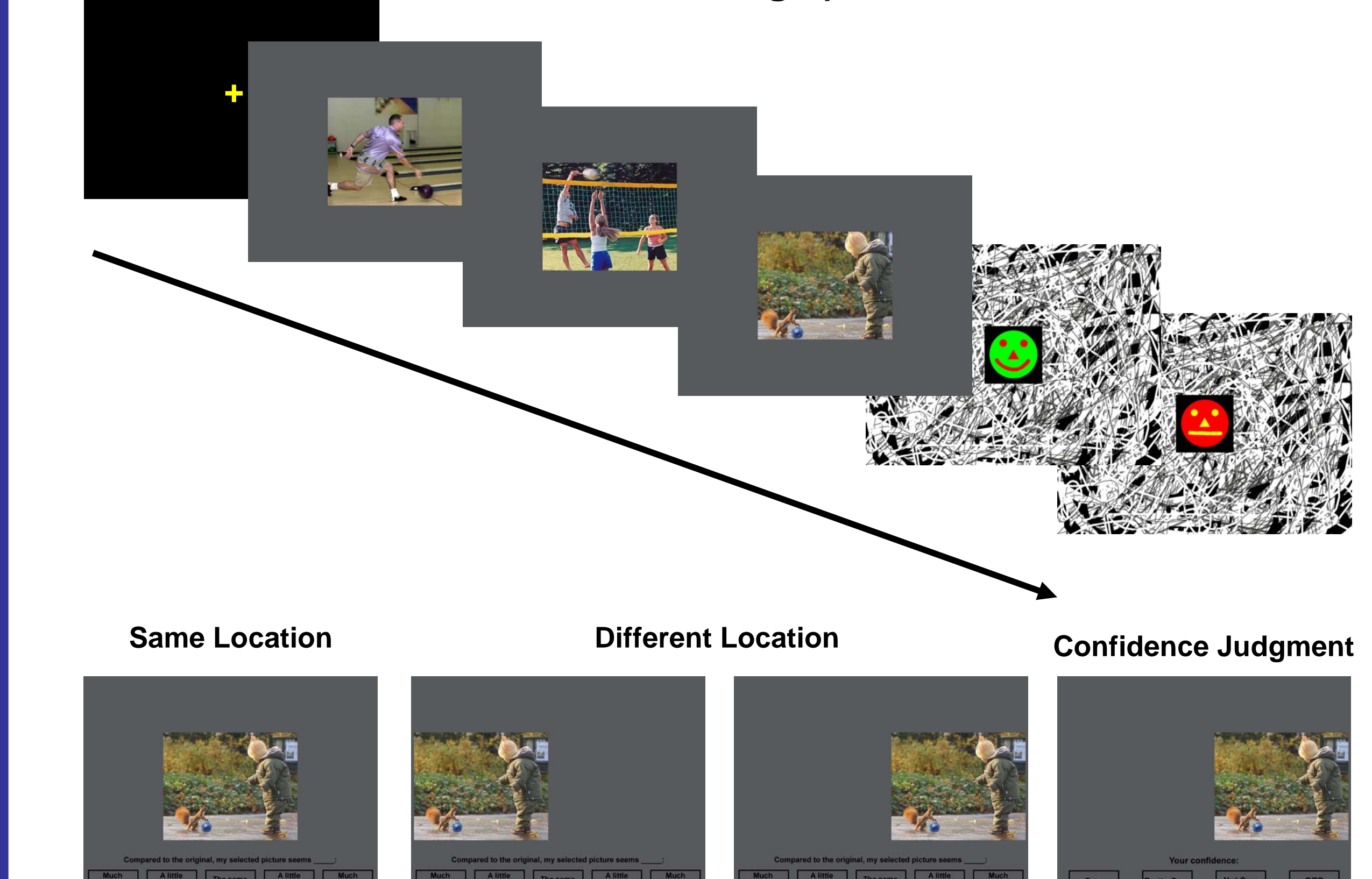
Task: Rate whether test picture was the same view, more close-up, or more wide-angle than initial stimulus on a 5-point scale (and rate confidence)

Design: 30 trials (+ 2 practice): 16 target trials, 14 distractors; each used separate groups of pictures. Tested items were shown at each serial position equally often; each tested picture appeared at each serial position (across participants). Each spatial position in which the test item could appear (center, left, right) was tested equally often. (Serial position and spatial position were not fully crossed). Stimuli were presented in 3-picture RSVP sequences; trials were self-initiated. Serial position was manipulated to prevent strategy use. Dynamic mask (with central cartoon "face" onset) was used to prevent verbalization and assure reliance on visual memory.

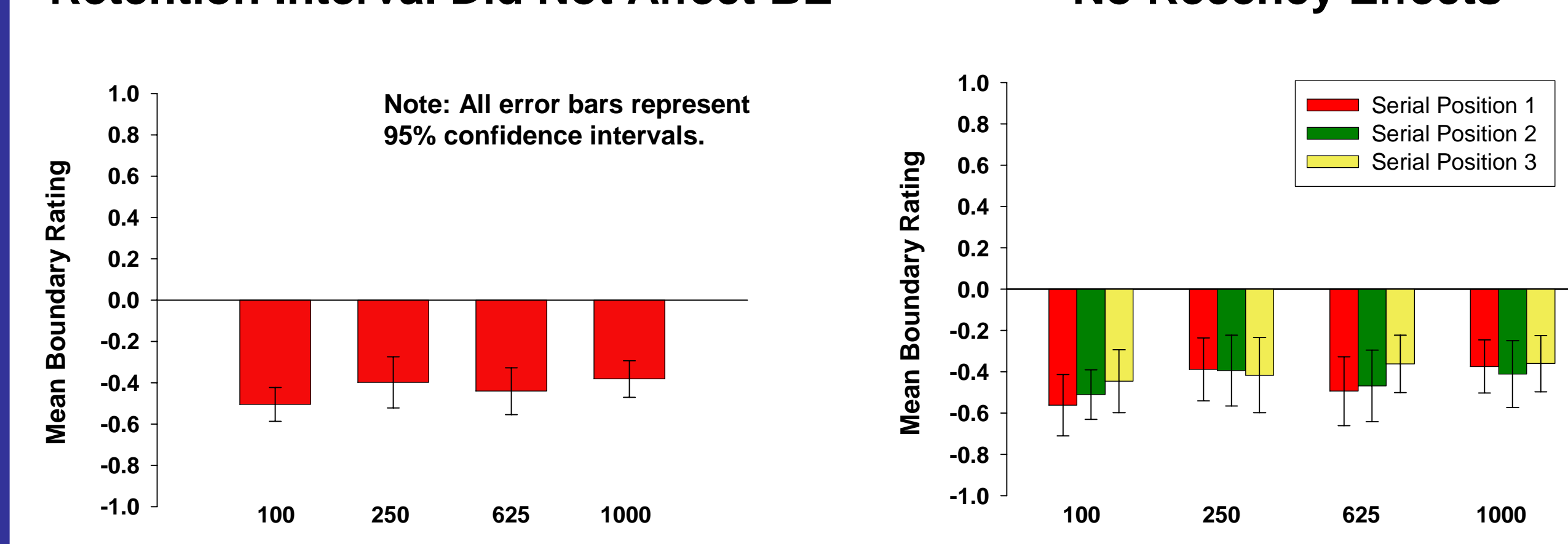
Sample Trial Sequence: Target Trial (CC: Close-up tested with Close-up)



Sample Trial Sequence – Distractor Trial (CW: Close-up tested with Wide-angle)

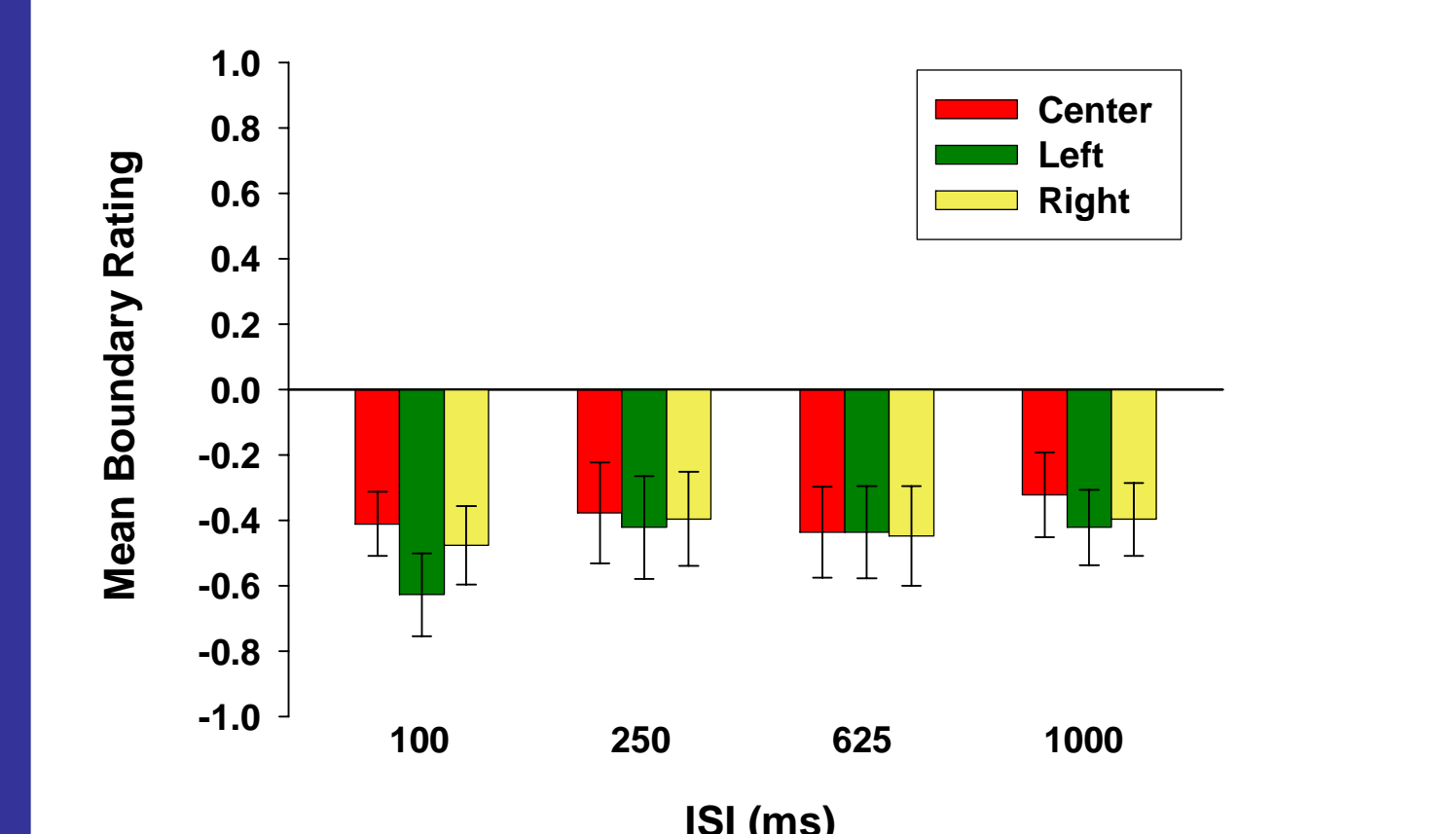


Retention Interval Did Not Affect BE



- Significant BE found at every retention interval
- No main effect of retention interval
- BE showed no evidence of a recency effect—it occurred after 100 ms (at serial position 3)
- No evidence for temporal limits of BE

BE Was Not Disrupted Across Saccades



- Significant spatial position effects at 100 ms retention interval only
- This ISI is closest to saccade durations – possible implications for BE across saccades
- BE for test items appearing in the center of the screen was comparable across retention intervals

Results

- Evidence for BE was found at all retention intervals, and at all serial positions
- BE occurred after a 100 ms masked retention interval
- BE was not disrupted by a mismatch between stimulus location and test item location
 - This suggests that BE survives across saccades
- Temporal limits of BE were not found

Experiment 2

Purpose: Surprisingly, in Experiment 1, BE was found at all retention intervals. In Experiment 2, we further explored the temporal limits of BE by testing a briefer retention interval (42 ms).

Rationale: We used a fully counterbalanced set of stimulus–test pairs to see if typical effects would occur at each retention interval. Test items always appeared center screen to separate spatial effects from temporal effects. We also tested the two shortest intervals from Experiment 1 (100 ms, 250 ms) to see if effects would replicate under conditions that might be more favorable to correct identification of same views.

Participants: N = 108 (36/retention interval)

Stimuli: 38 pictures total (+ 76 non-targets for RSVP sequences). Each tested picture had 2 versions: a close-up and a wide-angle version.

Design: 36 trials total (+ 2 practice); pictures were tested by the same view on 50% of trials. Stimulus view could be either close-up or wide-angle; test picture could also be either close-up or wide-angle, yielding 4 test types. Serial position and test type were fully crossed; every picture was tested in every condition across participants. Rating scale used at test was the same as in Experiment 1.

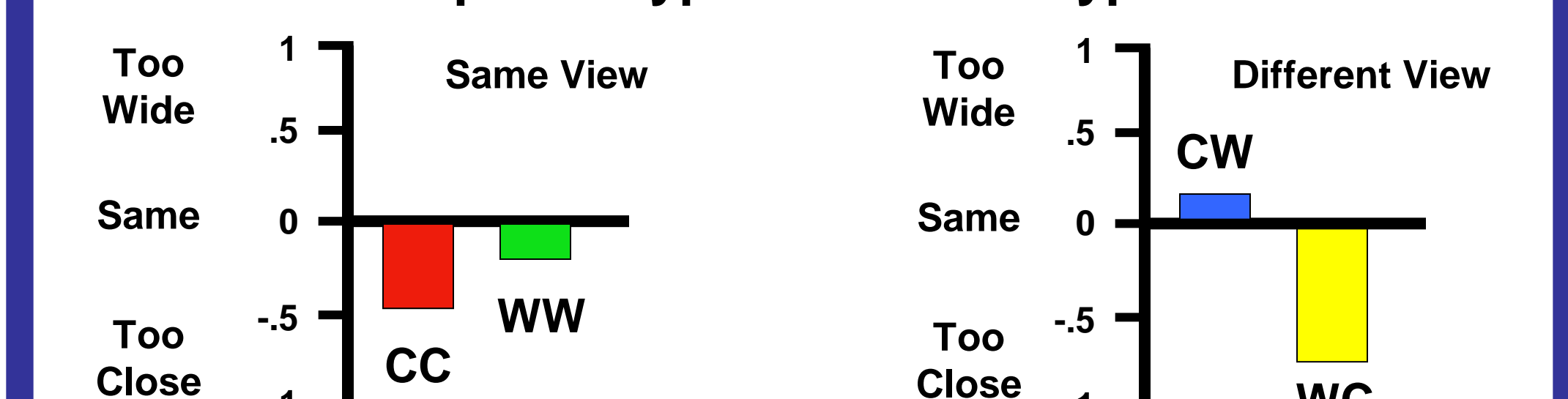
Test Types:

- Same view:
 - CC (close-up tested by a close-up)
 - WW (wide-angle tested by a wide-angle)
- Different view:
 - CW (close-up tested by a wide-angle)
 - WC (wide-angle tested by a close-up)

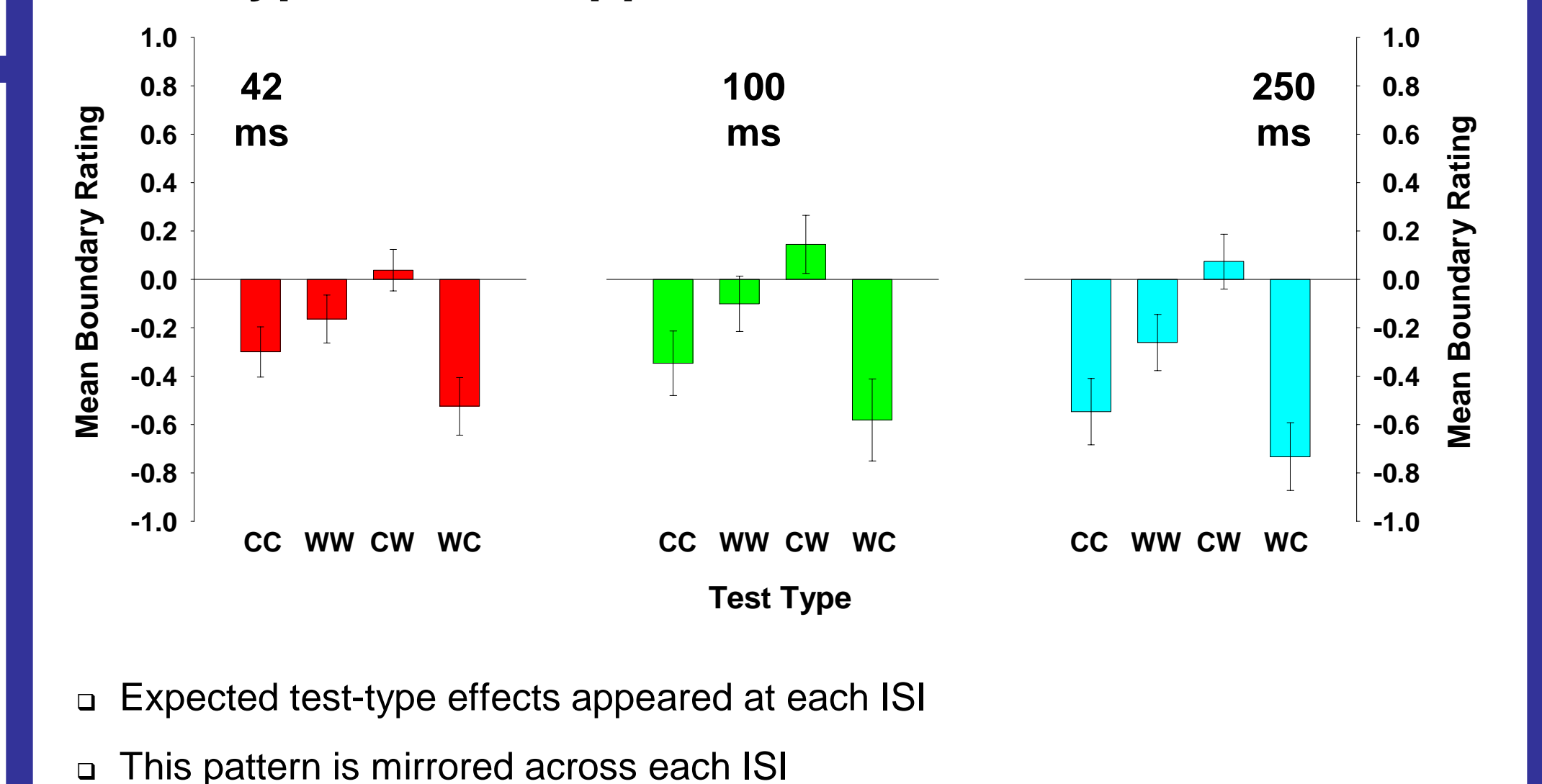
Expected Test-Type Effects in BE

- Test is the same view as stimulus:
 - CC vs. WW: More BE for CCs
 - Why? A close-up view contains less information that would be expected to appear beyond the current view than a wide-angle view
 - More extrapolation = more BE
- Test is a different view than stimulus:
 - CW: Test item is rated "about the same view"
 - Why? The close-up view yields BE – the memory representation includes information that will be included in the wide-angle version of the picture, making the two similar
 - WC: Test item is rated "much too close"
 - Why? Wide-angle generates some BE (less than close-up) – memory includes information not included in the close-up
 - Perceived disparity > actual physical disparity

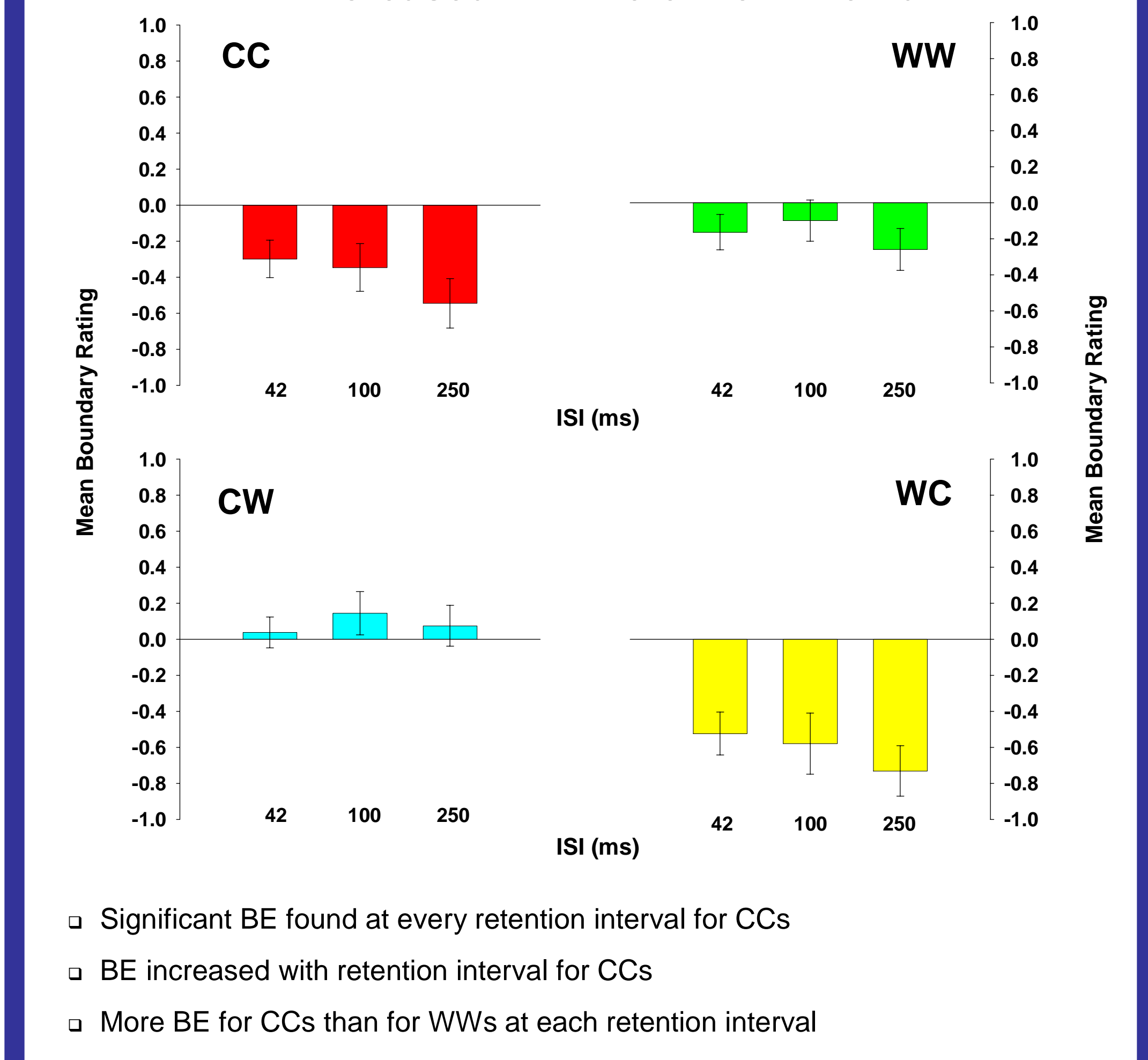
An Example of Typical BE Test-Type Effects



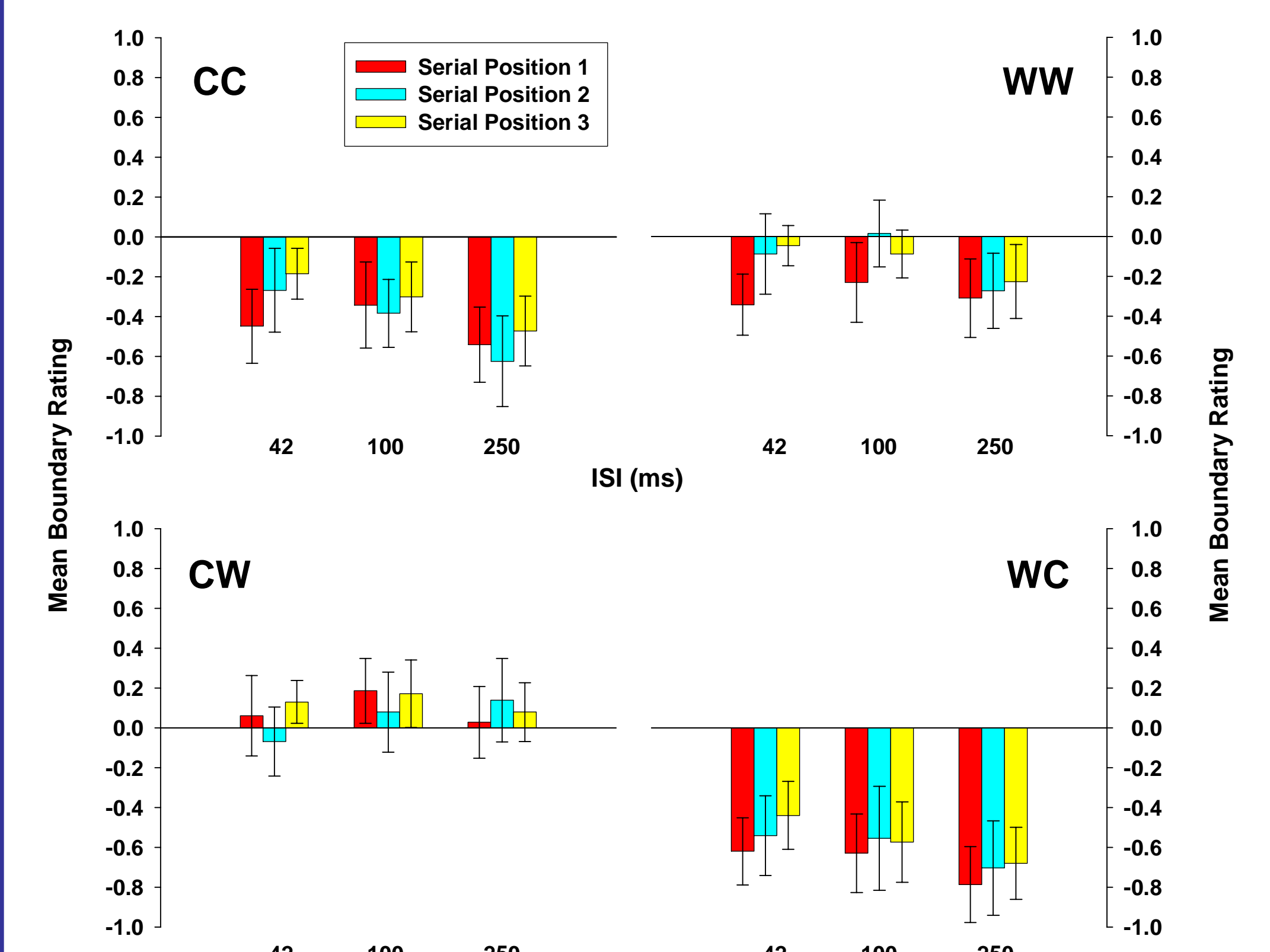
Test-Type Effects Appeared at Each Retention Interval



BE Increased with Retention Interval



Recency Effects, But No Temporal Limits of BE



- Significant BE found at every serial position for CCs – even after a 42-ms gap between stimulus and test
- CC: Less BE at serial position 3 than at serial position 1 at 42-ms retention interval
- CC: BE increased from 42-ms retention interval to 250-ms retention interval at serial position 3
- No evidence for temporal limits of BE; possible evidence for BE developing over time

Results

- Evidence for BE was found at all retention intervals—as rapidly as 42 ms after stimulus offset
- Amount of BE appeared to increase with retention interval
- Expected patterns of test-type effects appeared at each retention interval
- Temporal limits of BE were still not found, but ...
- It appears that BE may develop over time

Conclusions

What is the time course of BE? Is there a point in time at which BE is not present in people's representations of views of scenes? In two experiments, we investigated these questions by testing memory for briefly presented scenes across retention intervals ranging from 1 second to 42 ms. We found evidence for BE at even the briefest of these retention intervals. What's more, we found that 1) BE was not disrupted across a saccade (Exp. 1), and 2) the amount of BE increased across retention intervals that ranged from 42 ms to 250 ms (Exp. 2). Although we did not find temporal limits of BE, we may have tapped into a window in time within which BE develops.

Could BE facilitate the integration of successive views during active visual scanning? For this to be the case, BE would need to occur across changes in gaze position. It would also need to be available during the next fixation. We have demonstrated that BE satisfies the first constraint. It also appears that BE may be available quickly enough to satisfy the second. Research using eye tracking is underway to further explore the role of eye movements in BE.

References

Intraub, H., & Richardson, M. (1989). Wide-angle memories of close-up scenes. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15(2), 179–187.

Intraub, H., Gottesman, C. V., Willey, E. V., & Zuk, I. J. (1996). Boundary extension for briefly glimpsed photographs: Do common perceptual processes result in unexpected memory distortions? *Journal of Memory and Language*, 35, 118–134.

Acknowledgments

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