Crowding across time

Yaffa Yeshurun, Einat Rashal & Shira Tkacz-Domb

Institute of Information Processing and Decision Making

Psychology Department

University Of Haifa

מעמק"ה - המכון
לעיבוד מידע
וקבלת החלטות
**IIPDM-Institute of
Information Processing
and Decision Making**

Minerva Stiftung Gesellschaft
für die Forschung m.b.H

אוניברסיטת חיפה
University of Haifa

Background - Spatial crowding

The identification of a peripheral target is harder when it is surrounded by flankers.

L   +   Z T H

Background - Spatial crowding

» Crowding is reduced as the distance between the target and flankers increases

E   L   N   **+**   Z T H

Background - Spatial crowding

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Critical distance: The distance at which the flankers no longer affect target identification

» The critical distance increases as target eccentricity increases

Z T H   **+**   Z T H

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Z T   **+**   Z T

Background - Spatial crowding

» Crowding is reduced as the distance between the target and flankers increases

Critical distance: The distance at which the flankers no longer affect target identification

» The critical distance increases as target eccentricity increases

» Spatial crowding is asymmetric: a more peripheral flanker has a larger effect on target identification than a more central flanker

» Spatial attention can affect spatial crowding

Background - Temporal crowding

The identification of a target is harder when it is surrounded in time by other stimuli

➡ Stimuli that appear before and after the target at the same spatial location

Classical masking:

✦ Both forward and backward masking are over by an SOA of 100-150 ms (e.g., Breitmeyer, 1984; Breitmeyer & Ogmen, 2000, 2006; Enns, 2004; Enns & Di Lollo, 2000; Gorea, 1987; Michaels & Turvey, 1979).

➡ Temporal crowding refers to performance impairment that goes beyond the limits of classical masking

Background - Temporal crowding

Bonneh, Sagi and Polat (2007):

✦ Amblyopic vs. normal vision observers

✦ **Foveal presentation**

➡ Temporal crowding with strabismic amblyopes, but **not** with normal observers

Will a reliable temporal crowding be found for normal observers with peripheral presentation?

Stimuli: 3 letter displays

Eccentricity: 9° (left or right)

Target: The letter **T**

Task: Indicate target orientation (0, 90, 180, 270°)

Temporal order: 1st display, 2nd display

SOA: 130, 155, 180, 205, 230, 255, 280, 330, 380, 430 ms
Baseline - a single letter

Fixation
1000 ms

1st display
30 ms

ISI
100-400 ms

2nd display
30 ms

ISI
100-400 ms

3rd display
30 ms
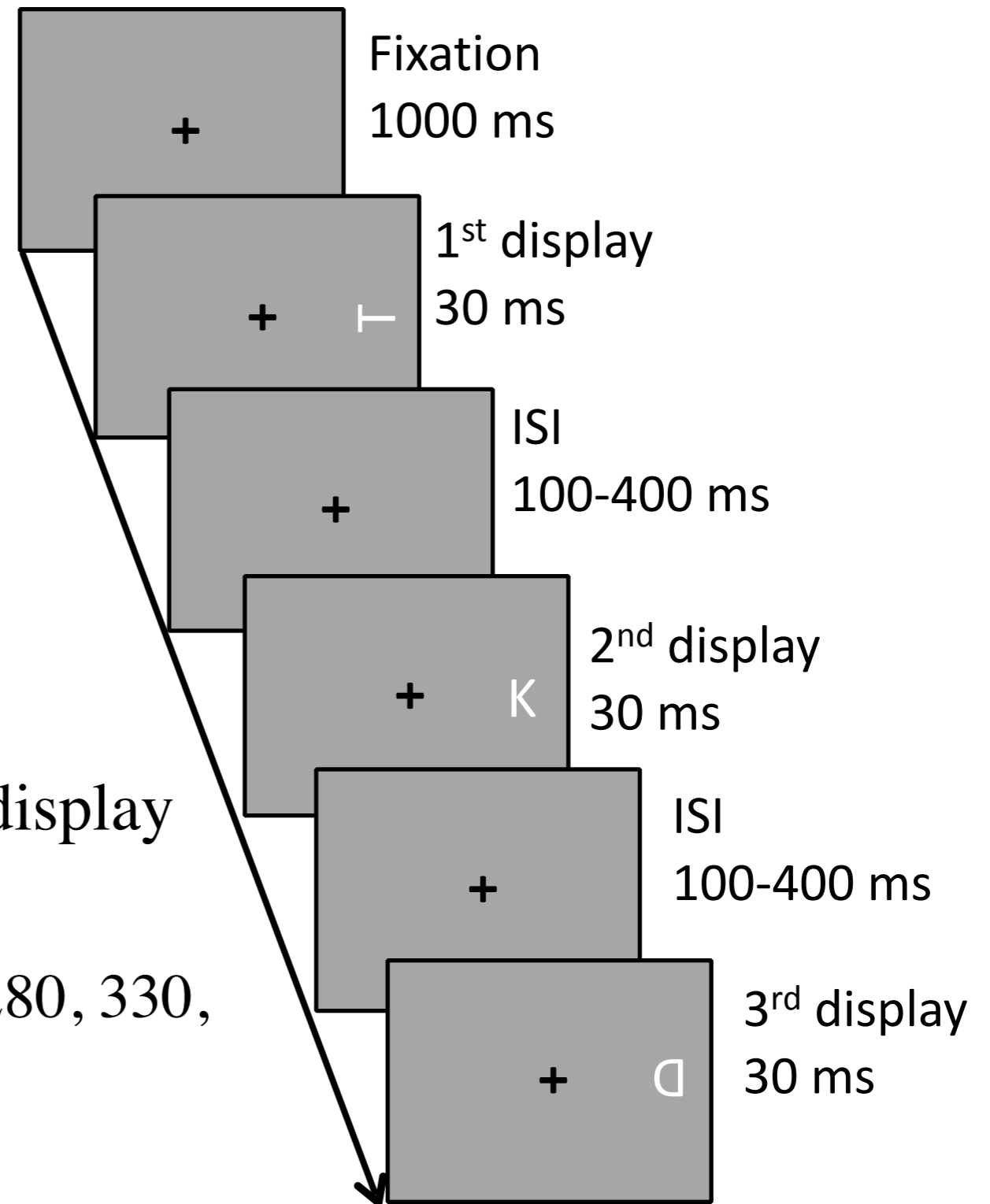
Predictions:

If temporal crowding occurs with normal observers

➡ Performance in the baseline condition (i.e., single letter) should be better than when the 3 letters condition

➡ Performance with short SOAs should be worse than with long SOAs

Will a reliable temporal crowding be found for normal observers with peripheral presentation?
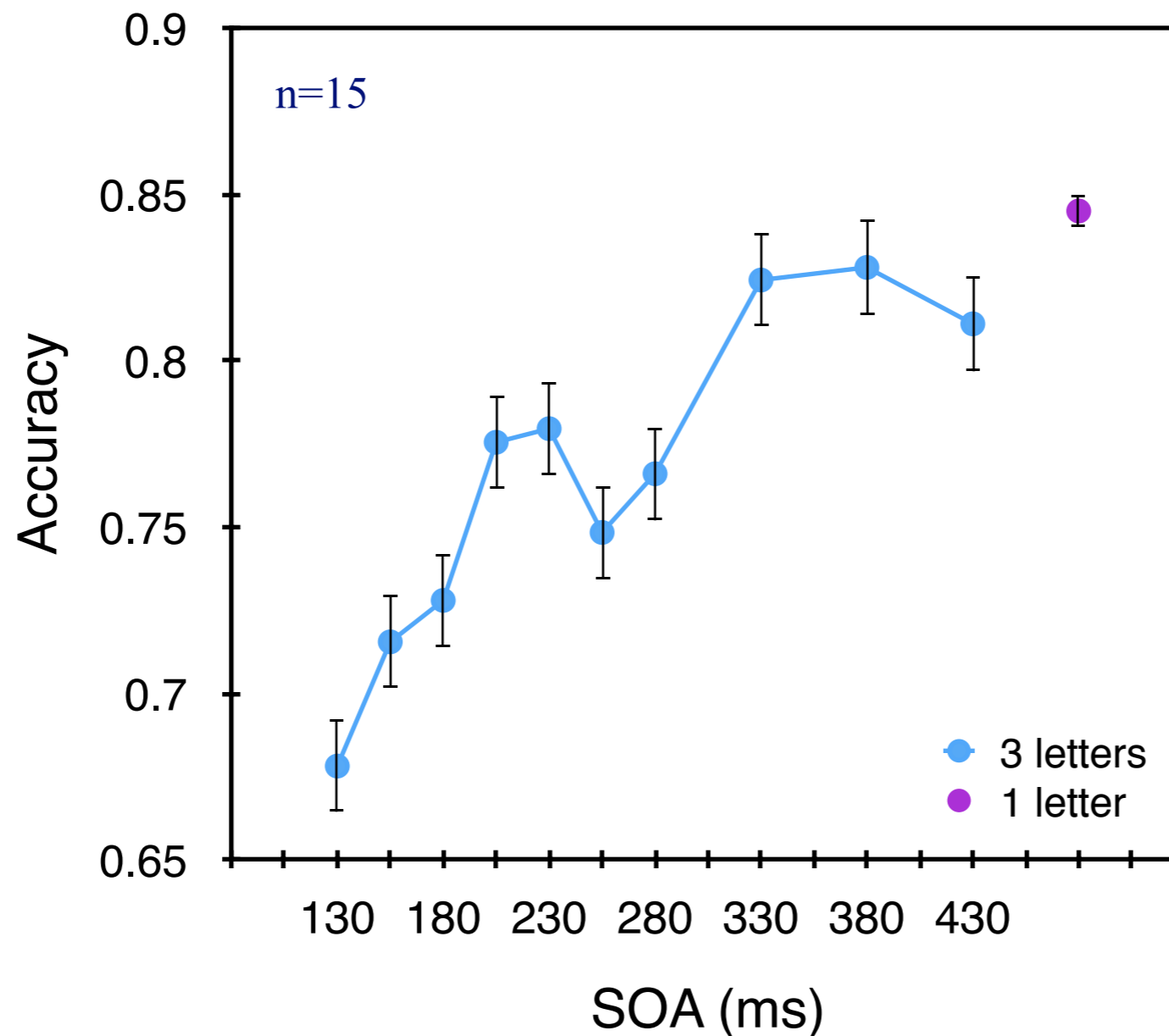
✦A significant effect of SOA

Will a reliable temporal crowding be found for normal observers with peripheral presentation?

Stimuli:

Eccentricity:

Target:

Task:
(0, 90, 180, 270°

Temporal order:

ISI: 100, 125, 150, 175, 200, 225, 250, 300, 350, 400 ms

150, 175, 200, 225, 250, 300, 350, 400 ms

Fixation
1000 ms

1st display
30 ms

SOA

ISI
100-400 ms

ISI

2nd display
30 ms

ISI
100-400 ms

3rd display
30 ms
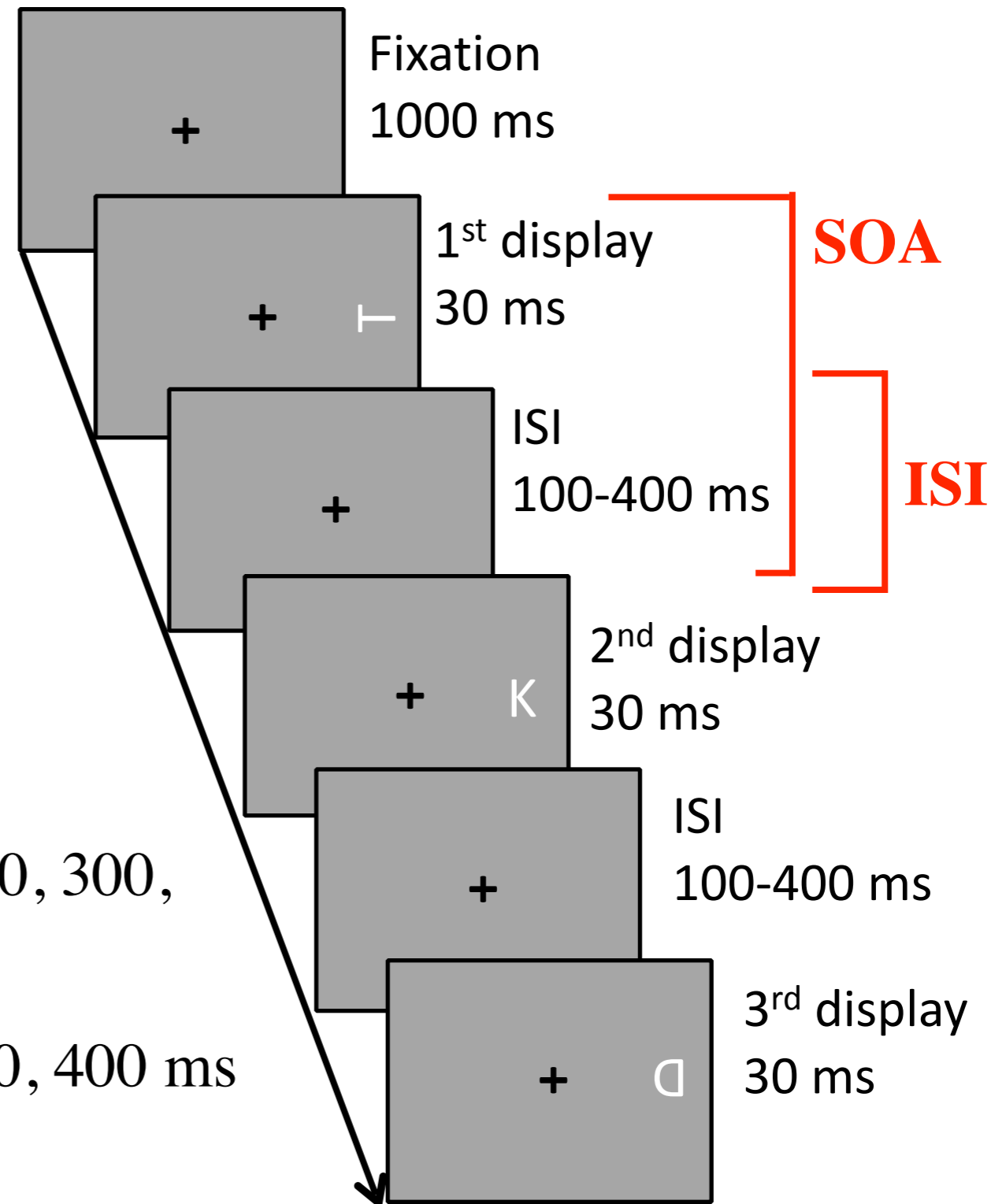
A consistent significant effect of ISI
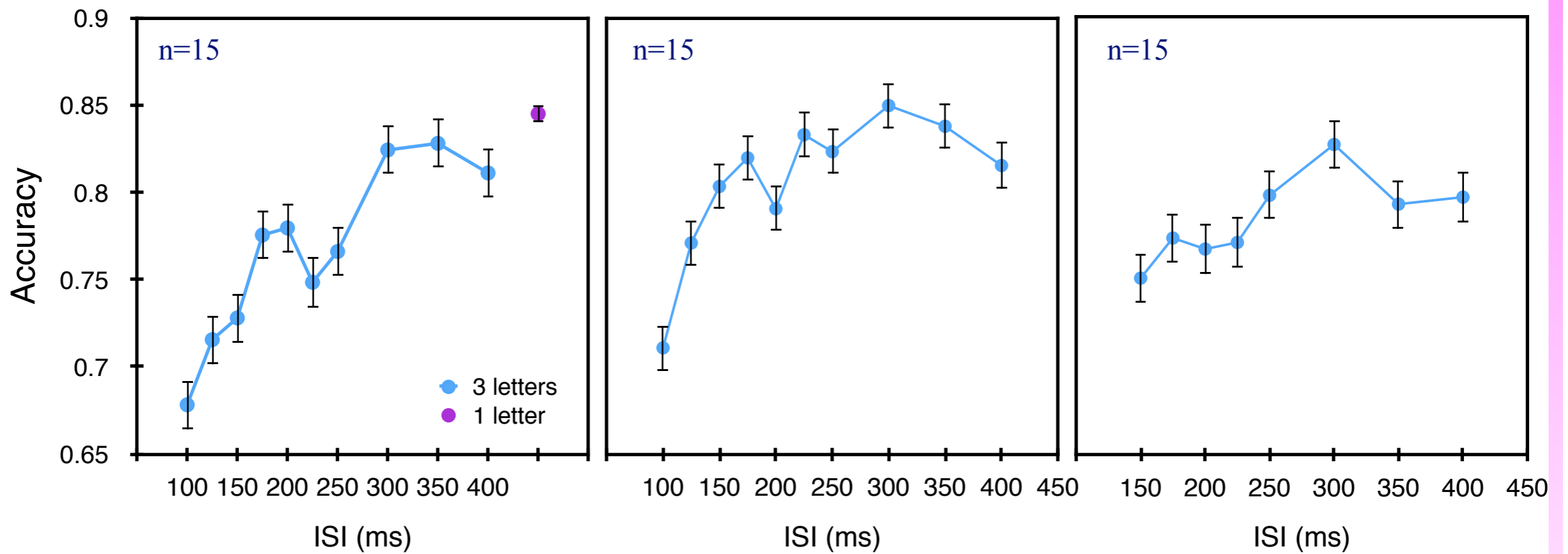
✦A consistent significant effect of ISI
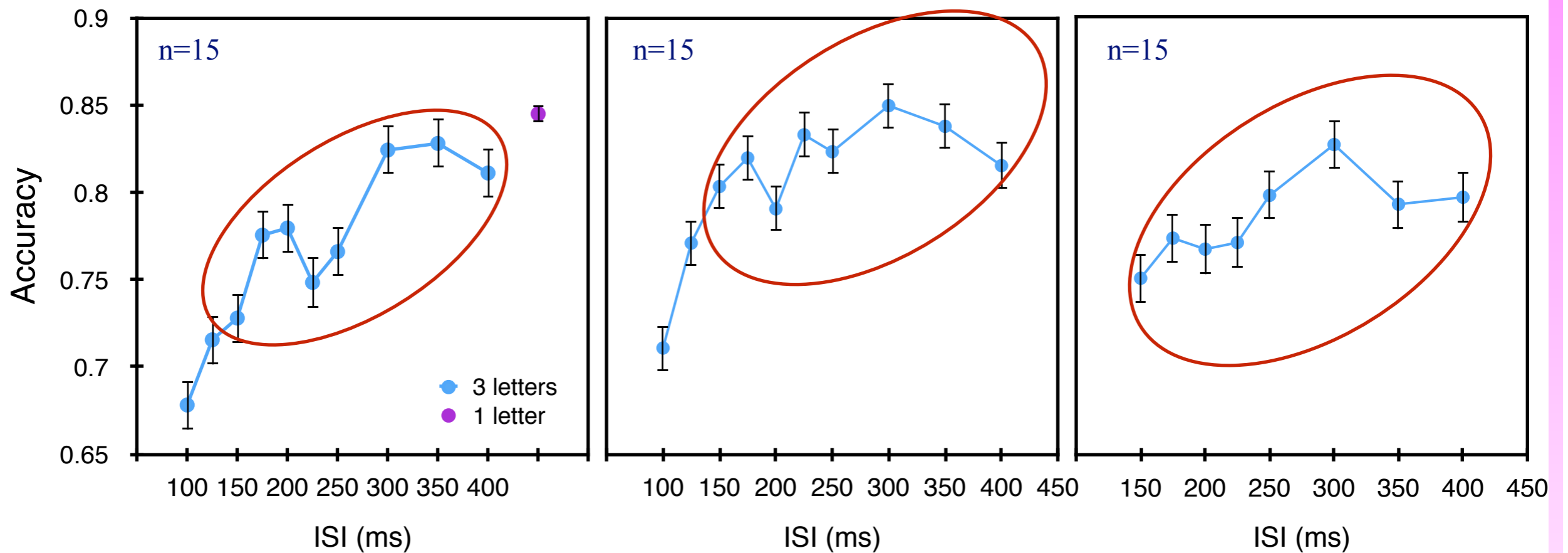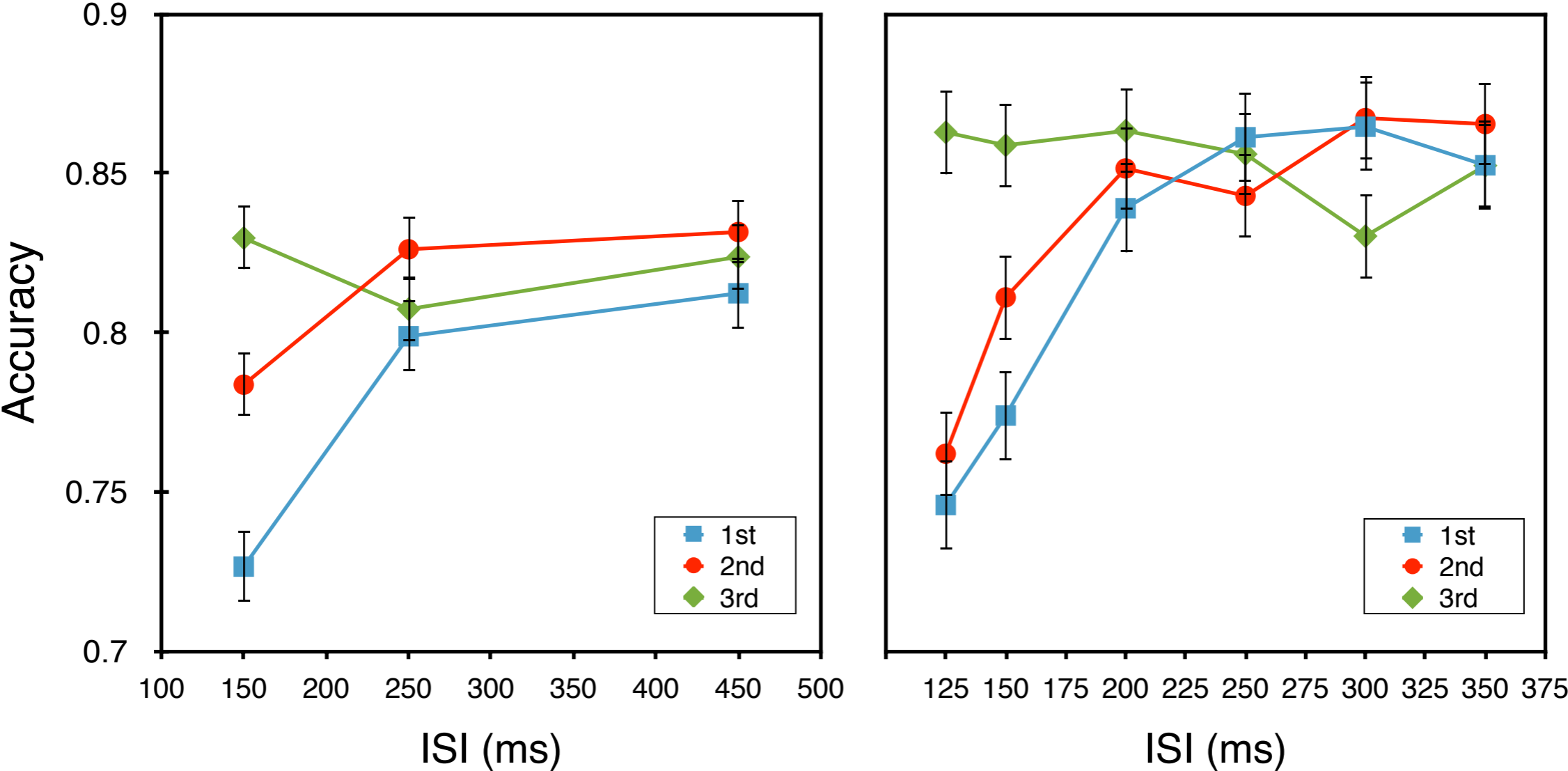

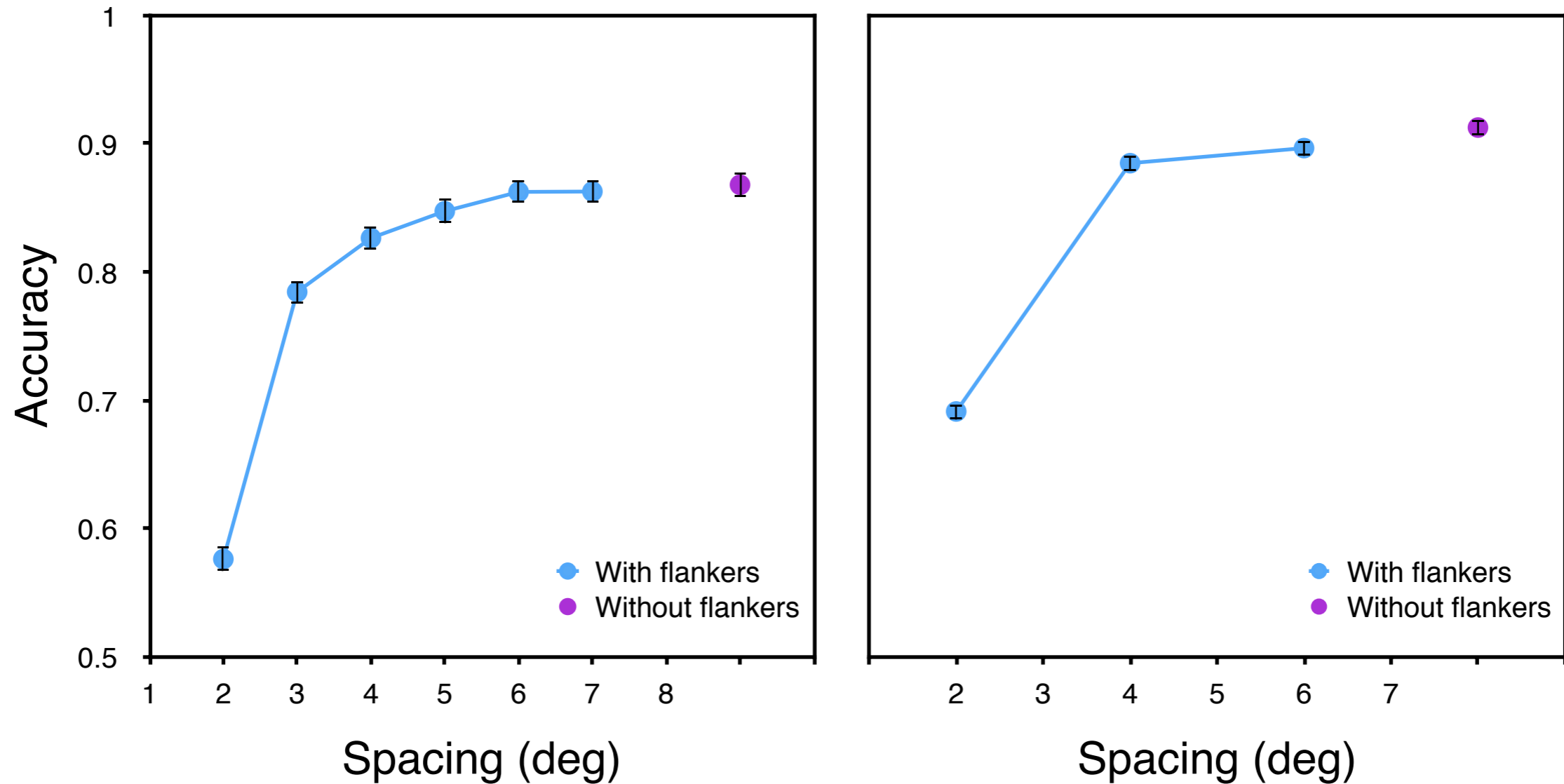**Temporal crowding can be found for normal observers with peripheral presentation**

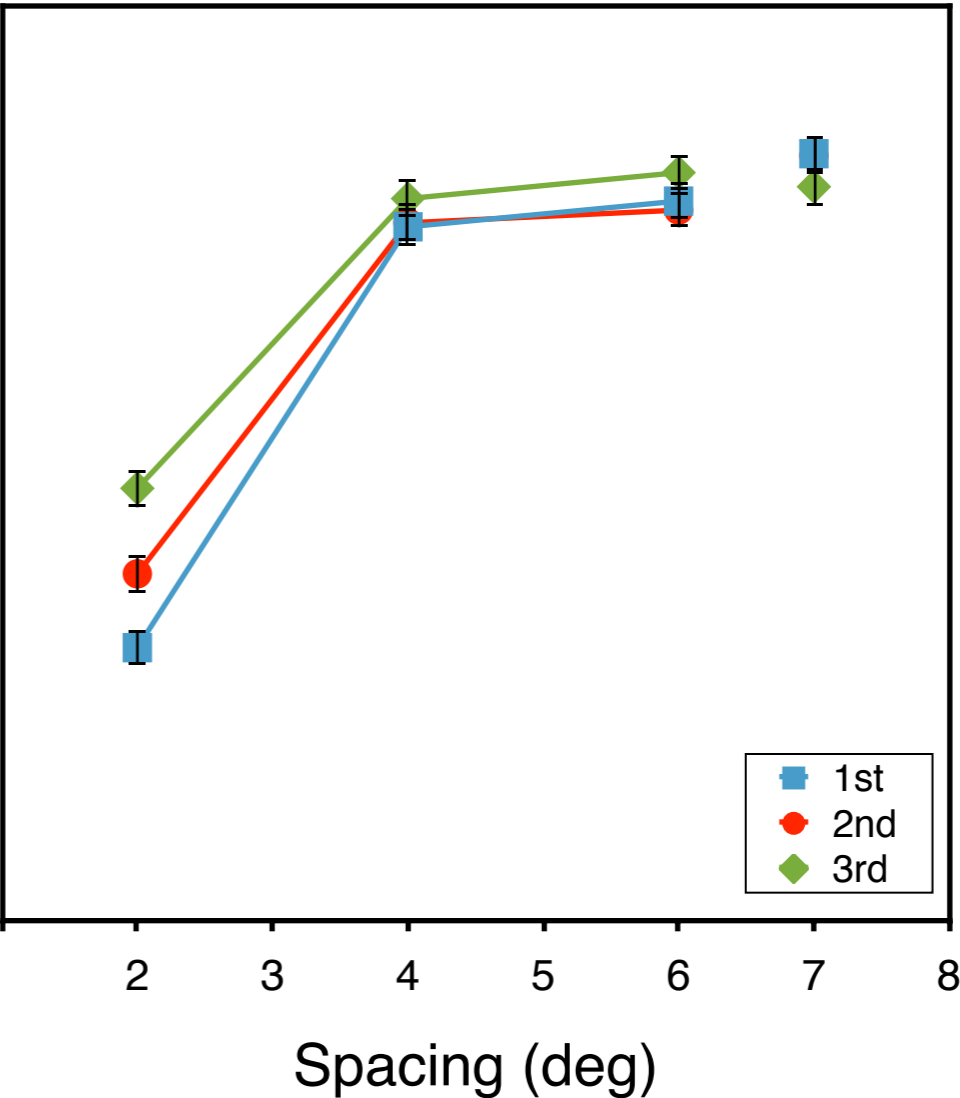# ISI x Target temporal order interaction
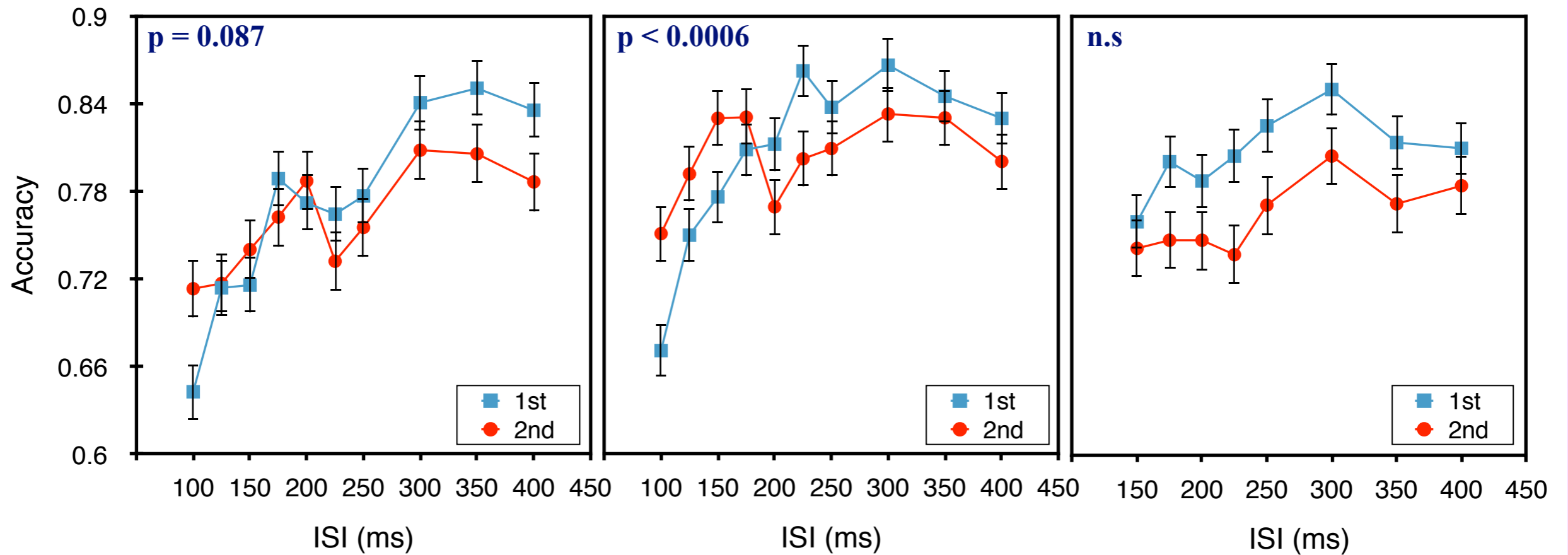
Temporal crowding can be found with normal observers.

=> What processes underlie temporal crowding?

Masking:

✦ Integration

✦ Interruption

➡ Object substitution (e.g., Enns & Di Lollo, 2000)

Bonneh et al. (2007) found strong relations between temporal and spatial crowding for strabismic amblyopes with foveal presentation.

=> Can similar relations between temporal and spatial crowding be found with normal observers and peripheral presentation?

When both temporal and spatial crowding are measured will they interact?

Stimuli: 3 letter displays

Eccentricity: 9º (left or right)

Target: The letter **T** (middle)

Task: Indicate target orientation
(0, 90, 180, 270°)

Temporal order: 1st, 2nd, 3rd display

ISI: (150, 250, 450 ms);
(125, 150, 200, 250, 300, 350 ms)

Target-flankers spacing:
(2, 3, 4, 5, 6, 7º);
(2, 4, 6º)
No Flankers
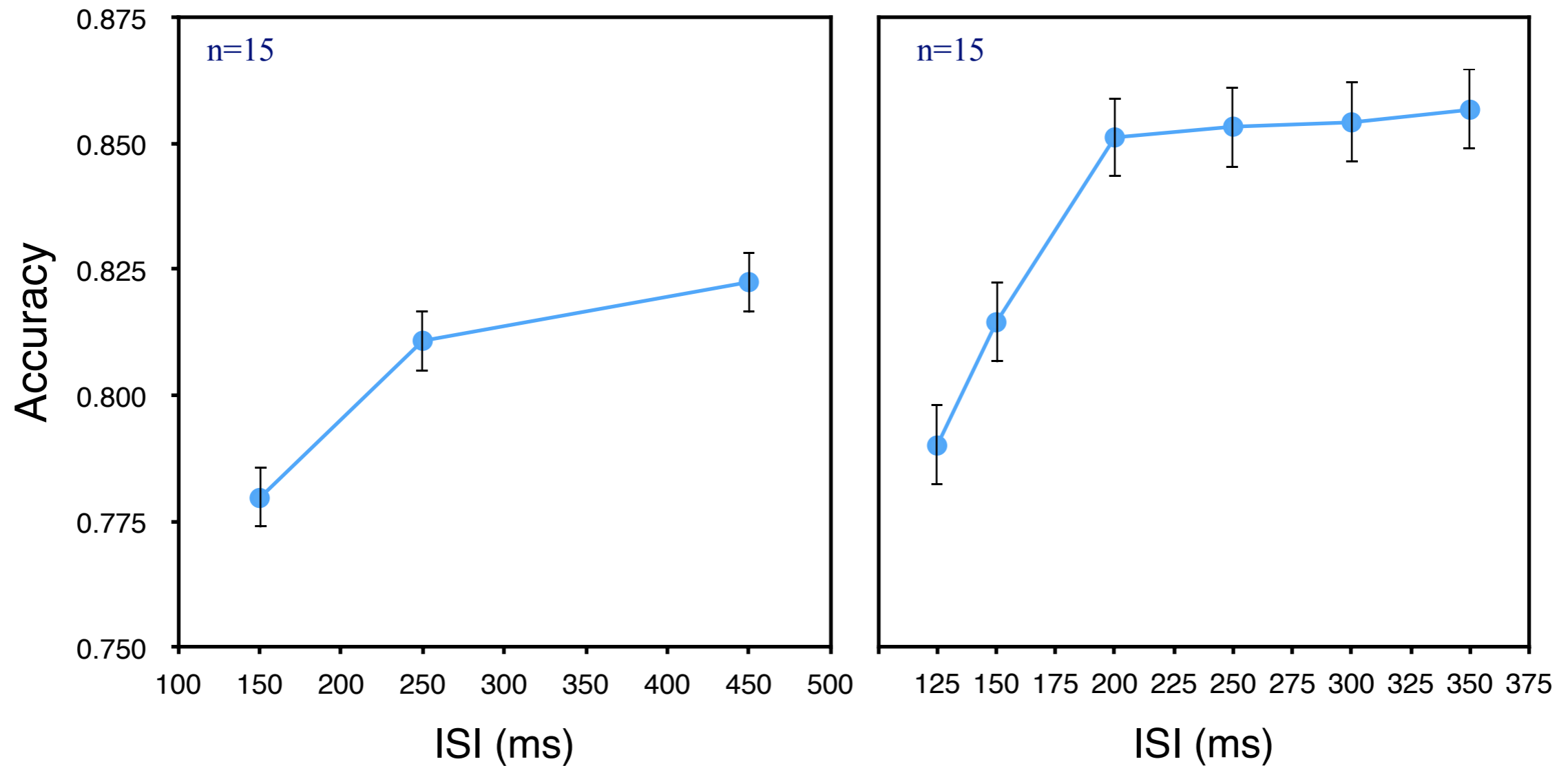
Fixation
1000 ms

1st display
30 ms

ISI
100-400 ms

2nd display
30 ms

ISI
100-400 ms

3rd display
30 ms

✦A reliable effect of **ISI**

Temporal crowding can be found for normal observers with peripheral presentation
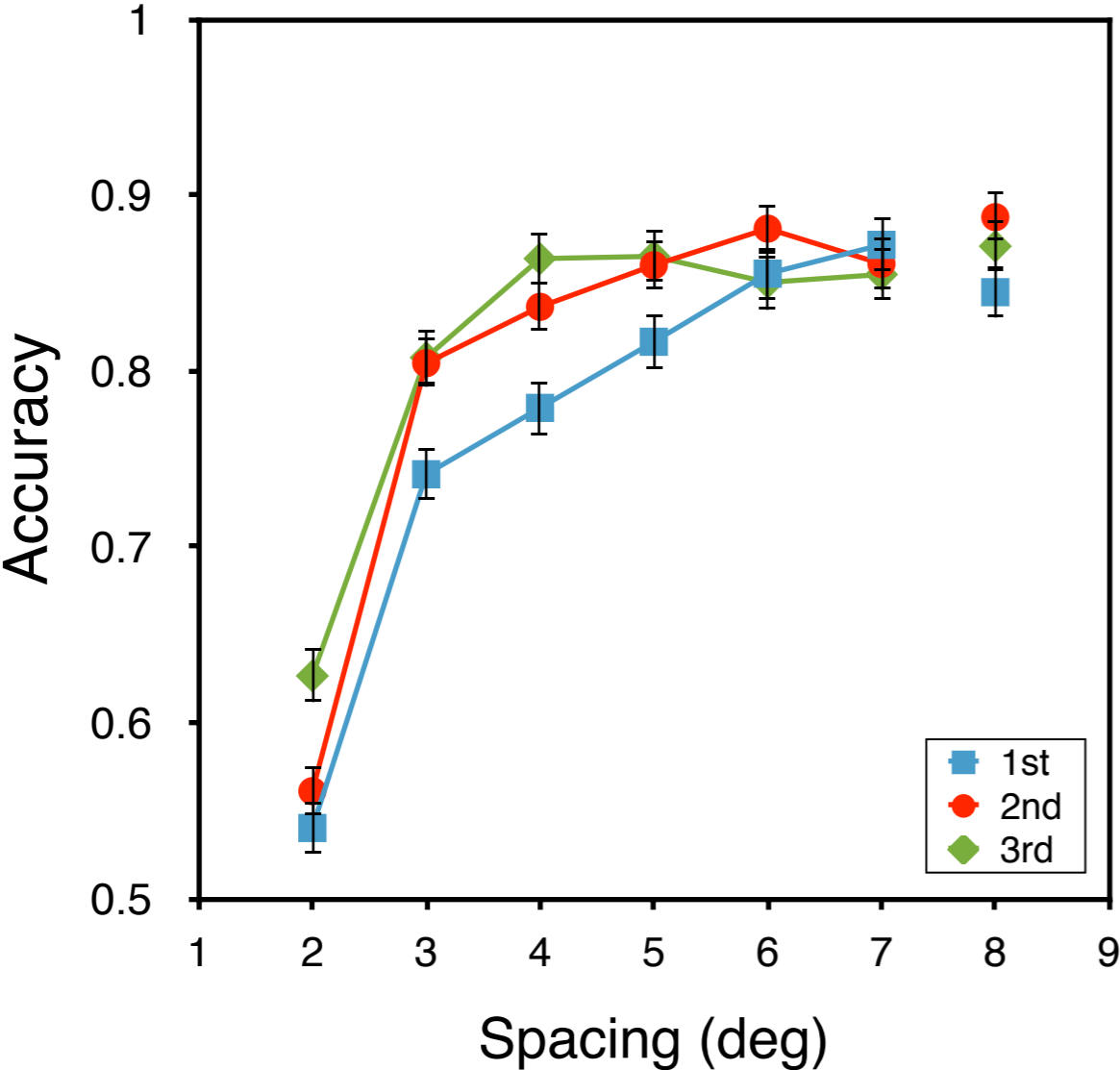
Significant ISI x Target temporal order interaction
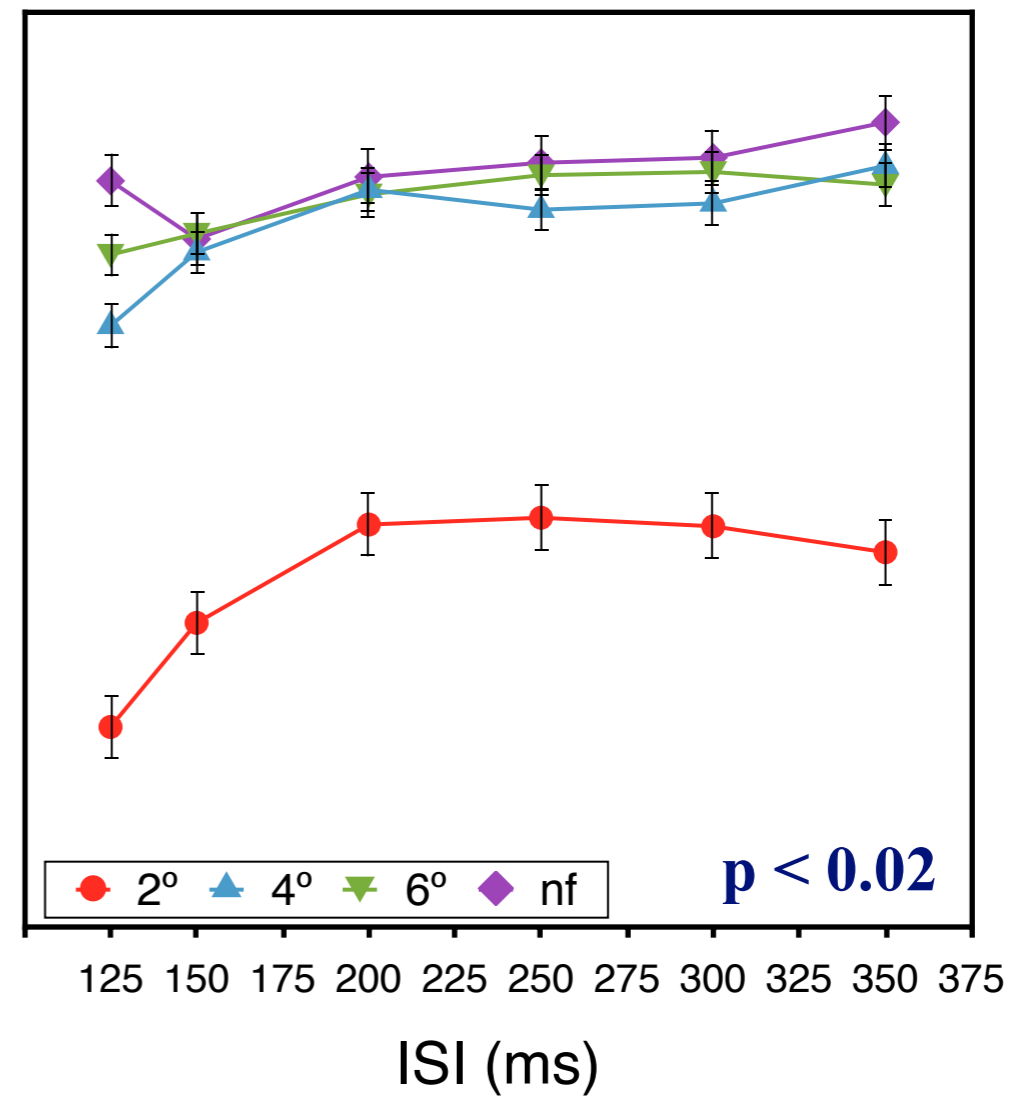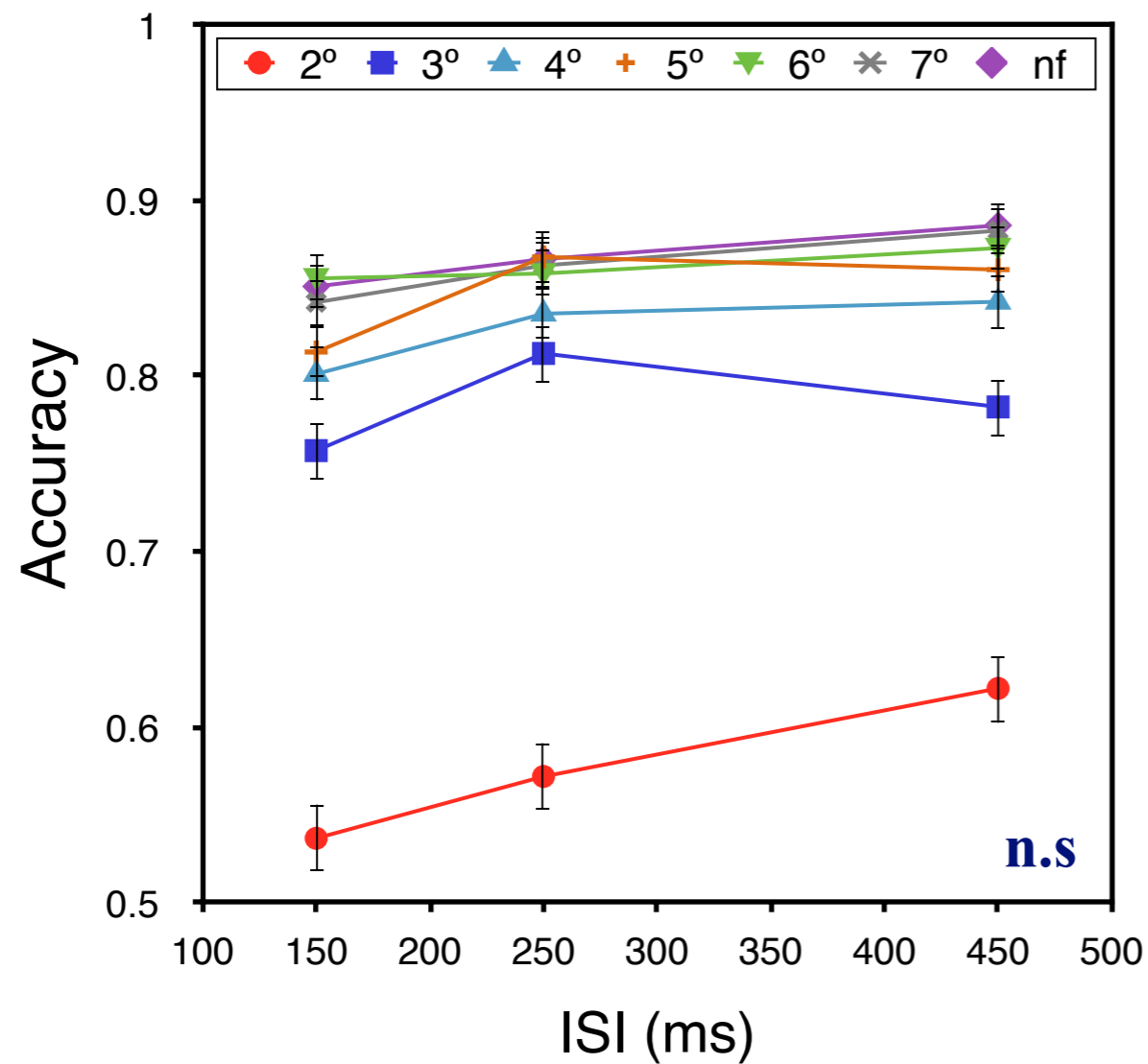
✦A reliable effect of target-flankers **spacing**

Spatial crowding can be found for normal observers with peripheral presentation

Significant Spacing x Target temporal order interaction

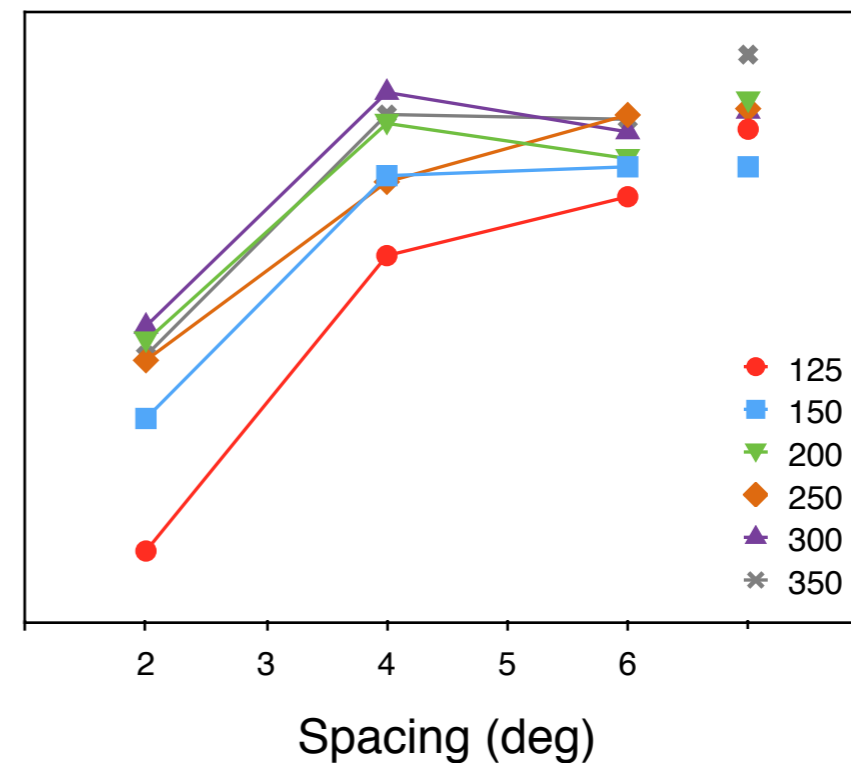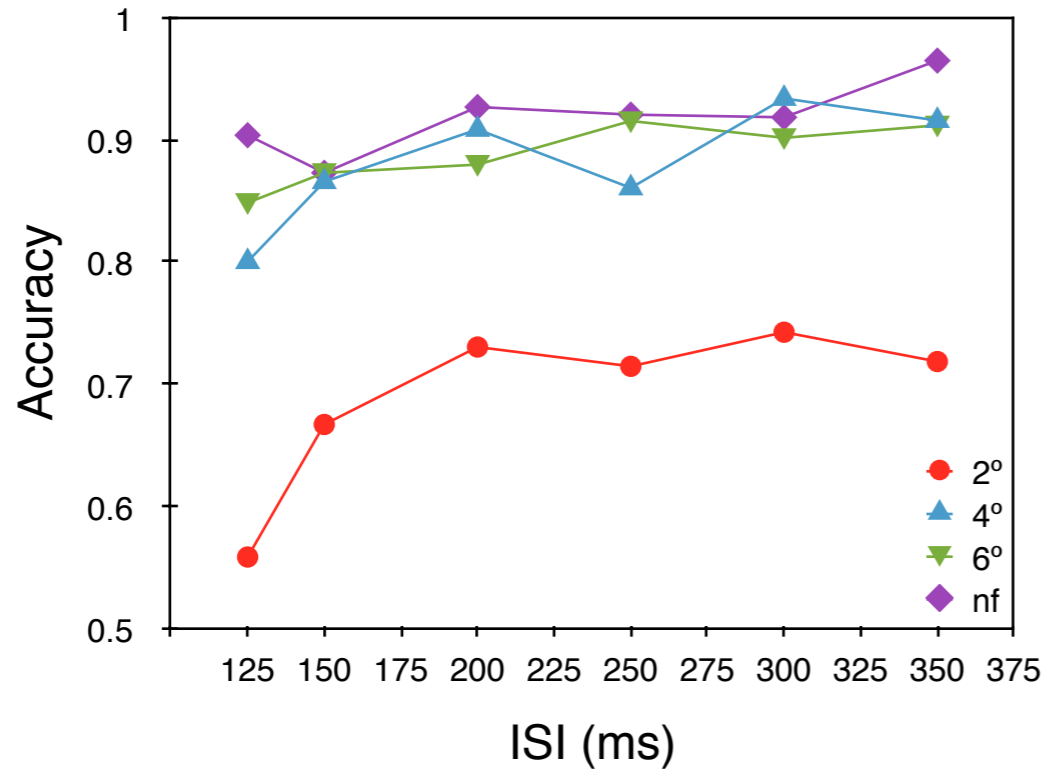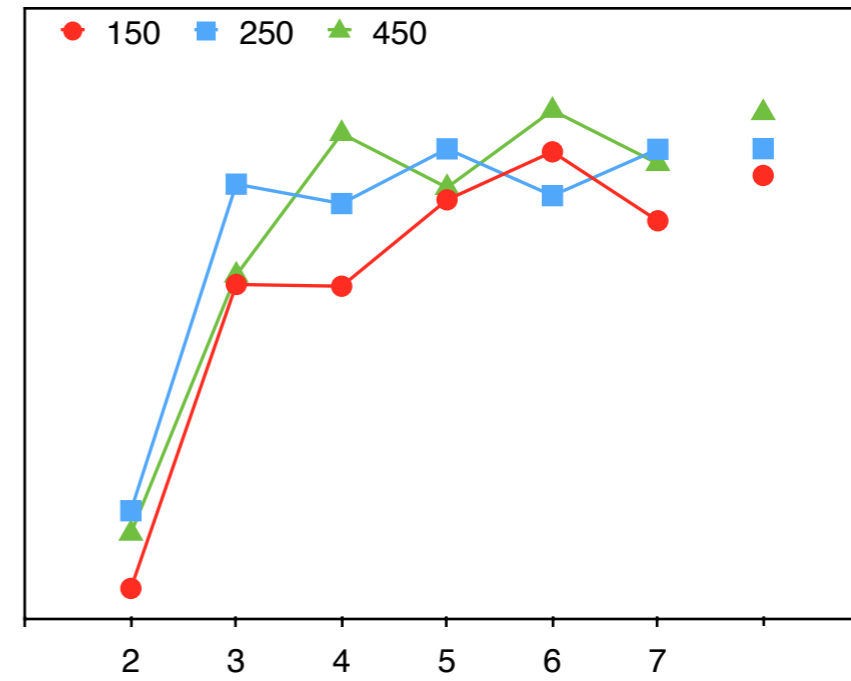# Do temporal and spatial crowding interact?

➡ Spacing x ISI interaction

Do temporal and spatial crowding interact?

➡ Spacing x ISI x Temporal order interaction $(p<0.03, p=0.1)$

Do temporal and spatial crowding interact?
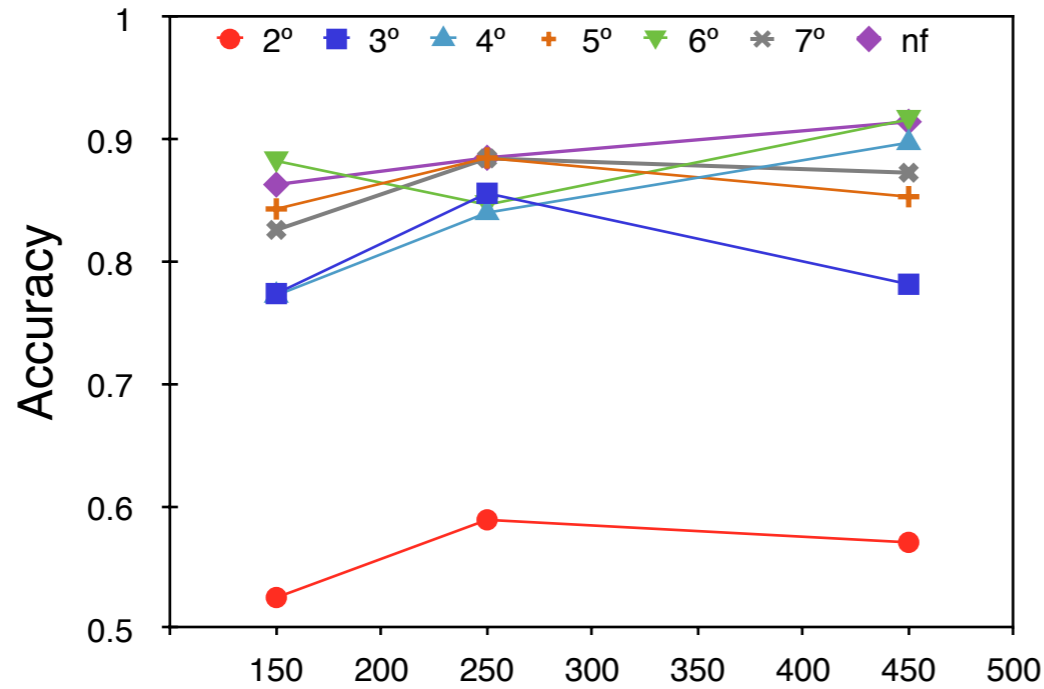
➡ Spacing x ISI interaction: **2nd display** (p=0.066, p<0.02)

Summary

- We found robust long-lasting effects of ISI with normal observers and peripheral presentation.

  ➡ Temporal crowding can occur with normal observers

- Only a weak interaction between spatial and temporal crowding was found.