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# A new twist to the grid illusions

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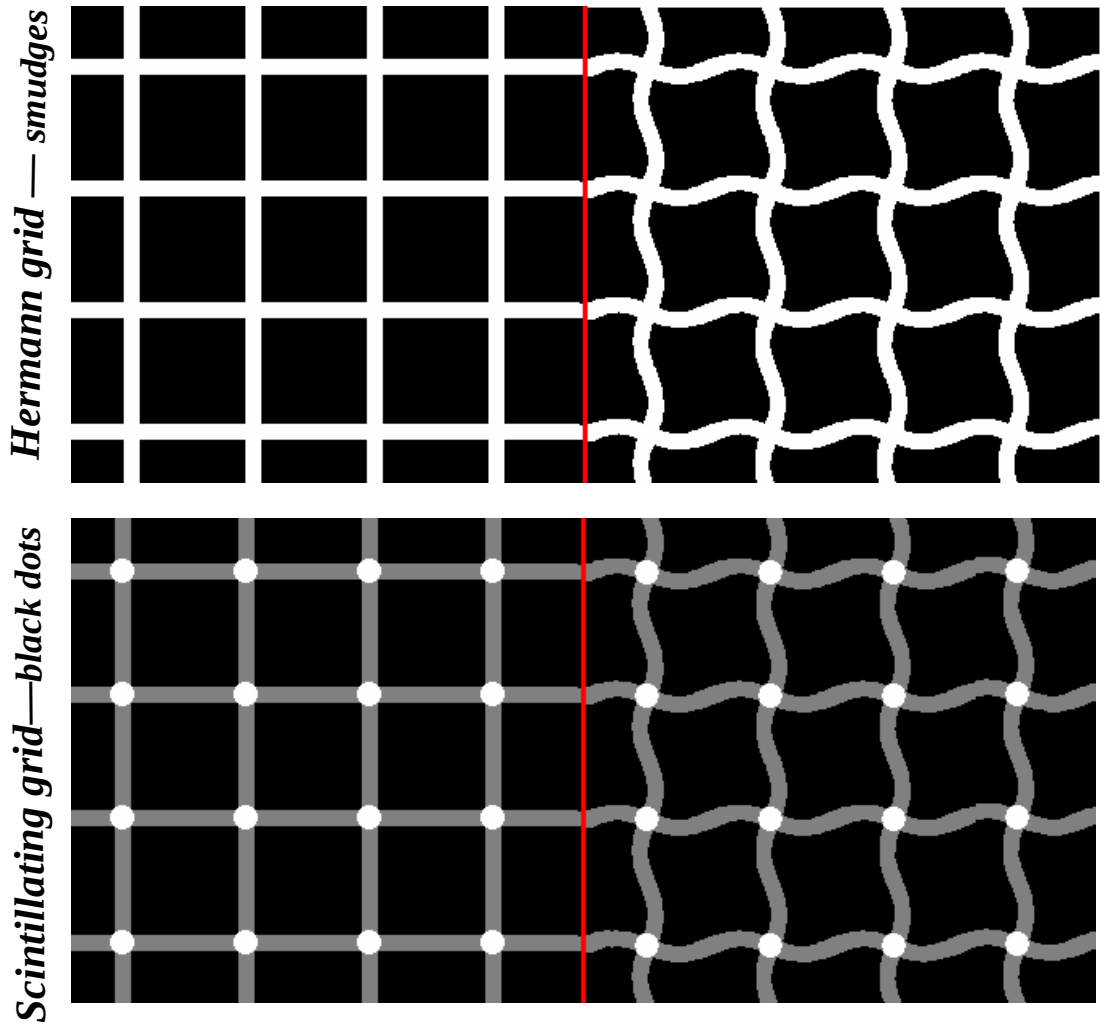
# Curving alleys defeat grid illusions

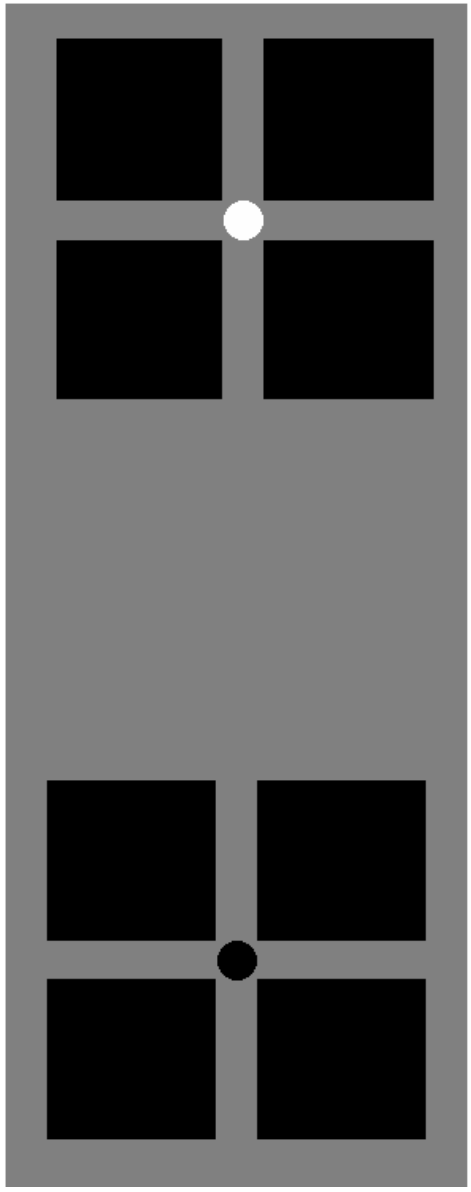
- Shown by Geier, Sera, & Bernath (2004) *(EVCP 2004 abstract)*
- They suggest this eliminates lateral antagonism as the explanation for these effects




*Note illusion on left side of each panel is absent on right…*

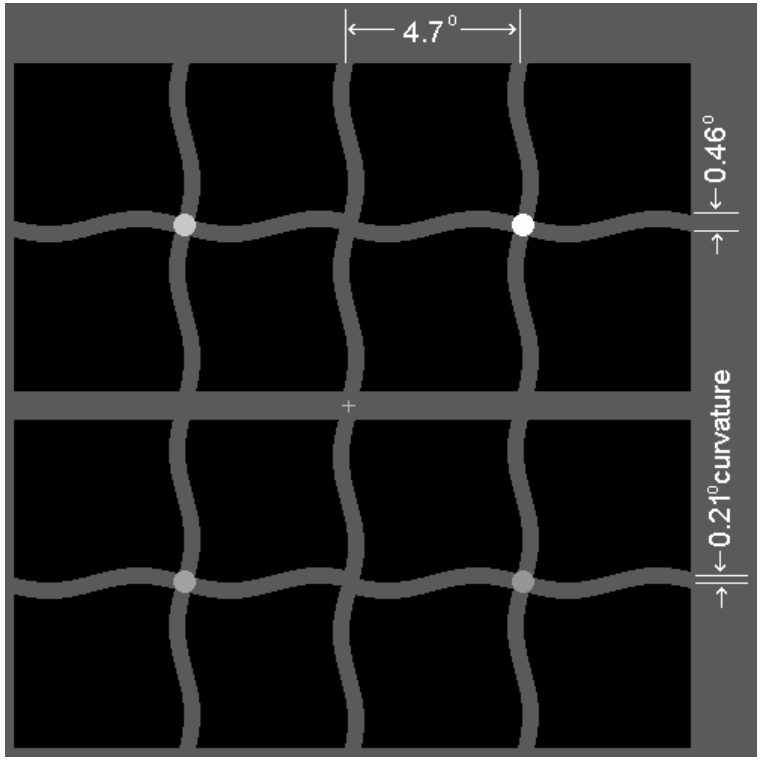
# Question:

- If curving the alleys affects the Herman grid and scintillating grid, would it also affect the vanishing disk to the same extent?
- **<u>Vanishing disk</u>***:* a single bright disk in an intersection (a reduced scintillating grid) is invisible when the grid is fixated at a distant position *(fixate the black disk at the right and note that the white disk vanishes)*
- Previous work showed the vanishing disk depended both on a peripheral process (before binocular interaction) and a higher process after fusion (McAnany & Levine, 2005, *Vision Research* **45**: 193-203)
- **Would curvature negate this illusion also, or have no effect – or make it stronger?**



# Methods

- Subjects: 4 males, ages 22-62, vision corrected to normal. Subjects 1 & 2 (authors) completed all conditions with repeats; subjects 3 & 4 confirm with one or two runs.
- Stimuli: Presented on 19" monitor. Array of 8 "squares" above fixation, and another 8 below fixation. "Squares" separated by alleys that could be straight or curved; intersections were usually "twist". Amount of curvature is given in degrees of visual angle of the sinusoidal amplitude of the deflection. Vertical separation of the two grids could be varied to suit the subject's capabilities. Gray of the alleys and surrounding screen was set to various levels. Disks could be in one of four locations (or all four, as shown)
- Presentation: A uniform gray screen with fixation cross was present between trials. The pattern appeared for 280 ms, replaced by the response pattern. After each response, the gray with fixation reappeared; the next stimulus followed 500 ms later

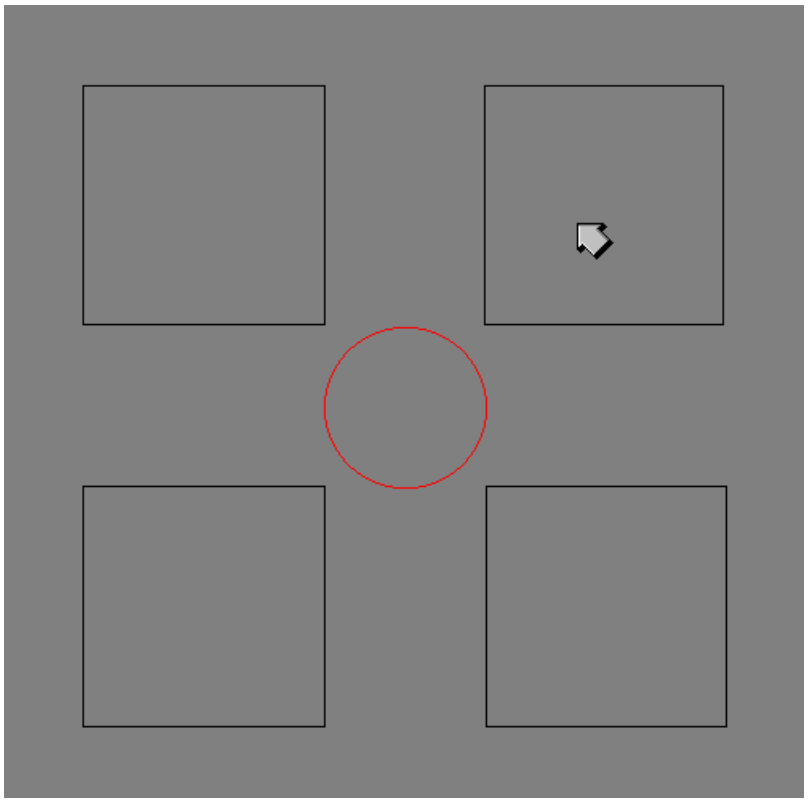



# Staircase methods

- Simultaneous method: Since a forced choice is not suitable for detecting scintillation (the correct choice is wherever there is a disk), all four disks were always present (as in the illustration on the previous panel).
  - ✓ The subject responded by indicating which disk was most salient *or* which had the strongest scintillation. There was also an option of "didn't see any"
  - ✓ The luminance of the selected disk was decreased 8 units; the other three were increased one unit. If "didn't see any" was selected, all disks increased two units on the next trial
  - ✓ Runs were terminated when all 4 disk thresholds stabilized (after at least 100 trials)
- Four independent staircases: Only one (random) disk was present on each trial.
  - ✓ The subject responded by indicating which disk was present. The "didn't see any" option was not used (4AFC)
  - ✓ An incorrect response increased the displayed disk two units on its next presentation; two correct responses in a row decreased it one unit
  - ✓ Runs were terminated when all 4 disk thresholds stabilized (after at least 8 reversals of each staircase)
- Upper/lower staircases: Appeared identical to the four staircases to the subject.
  - ✓ The subject responded by indicating which disk was present. The "didn't see any" option was not used
  - ✓ The luminances of the two upper disks and the two lower disks were linked. Thus, this was 4AFC, but for only two interlaced staircases.
  - ✓ Luminances changed in both linked disks at each response, according to the same rules as for the four independent stairs

# Responses

- Following each stimulus presentation, the subject made his response using a “pen” on a graphic pad that controlled a cursor on the response screen (shown here)
- The subject clicked on the square corresponding to the position of the disk or scintillation. (Upper right indicated here)
- In the simultaneous method, clicking the red circle in the center indicated “didn’t see any”
- The red circle was present for all methods (for consistency), but not used except in the simultaneous method



# Curvature affects both scintillation and visibility

- As curvature (degrees amplitude) increases, scintillation is harder to see (Figs. 1 & 2, blue); this was as noted by Geier *et al*.
- As curvature increases, the disk itself also becomes harder to see (Figs. 1 & 2, red)
- Scintillation seems more susceptible to curvature
- Note that “pinch” restores visibility at high curvatures, but does **not** restore scintillation

Fig 1. Subject 1: **Scintillation and visibility** (±95%)

Scintillation and visibility data collected in the same sessions (Simultaneous method)

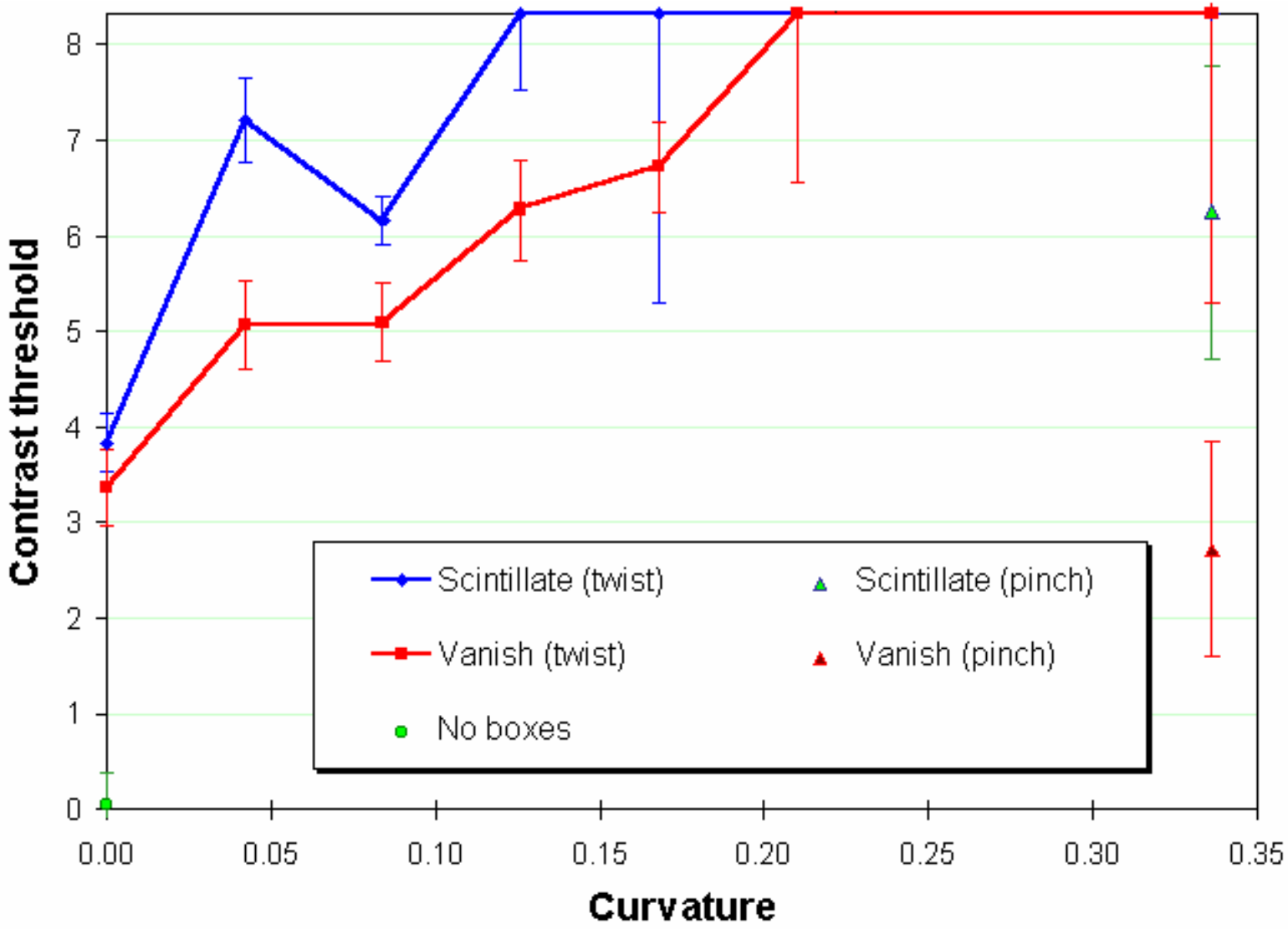
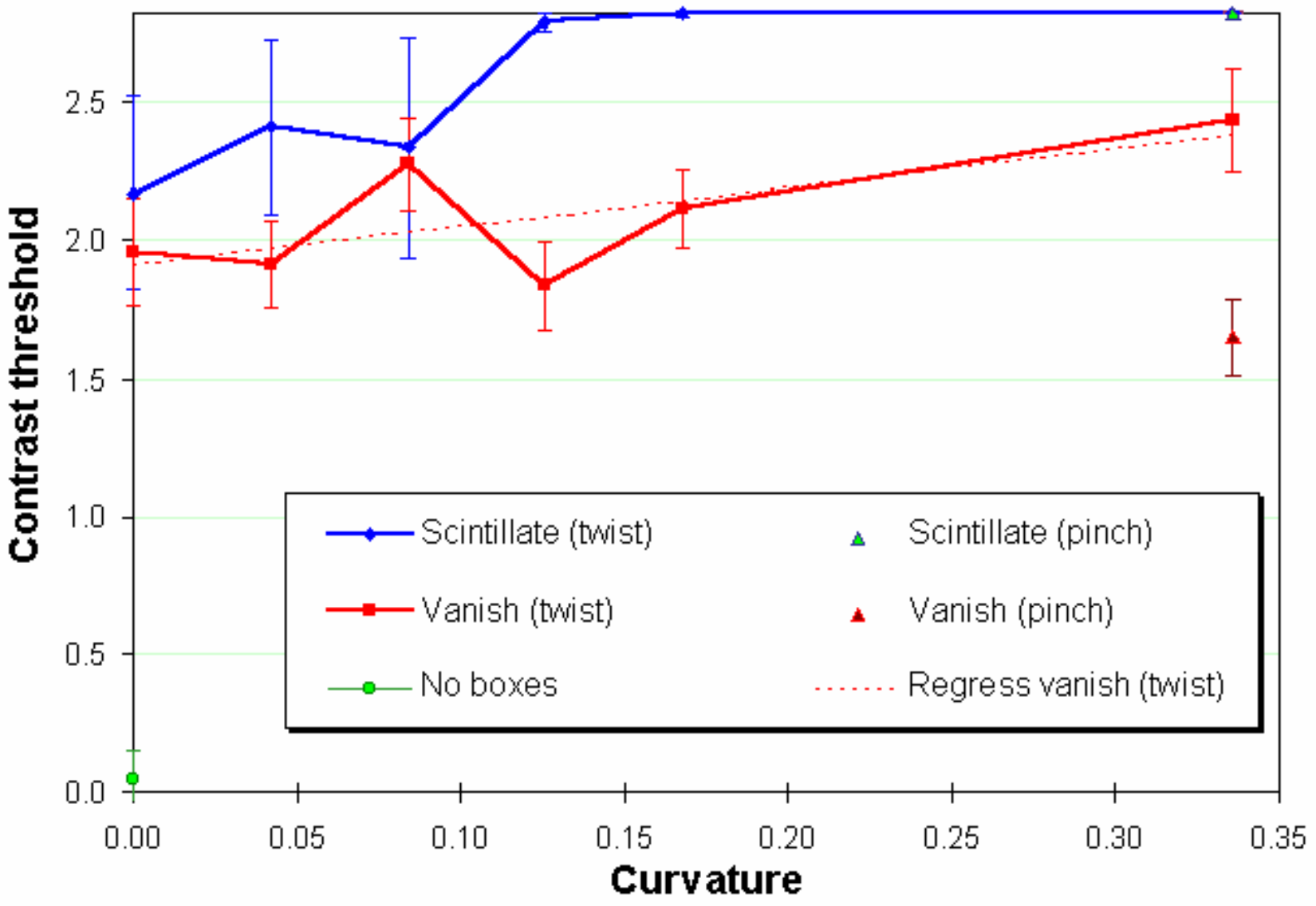


Fig 2. Subject 2: **Scintillation and visibility** (± 95%)

Scintillation and visibility data collected in the same sessions (Simultaneous method)

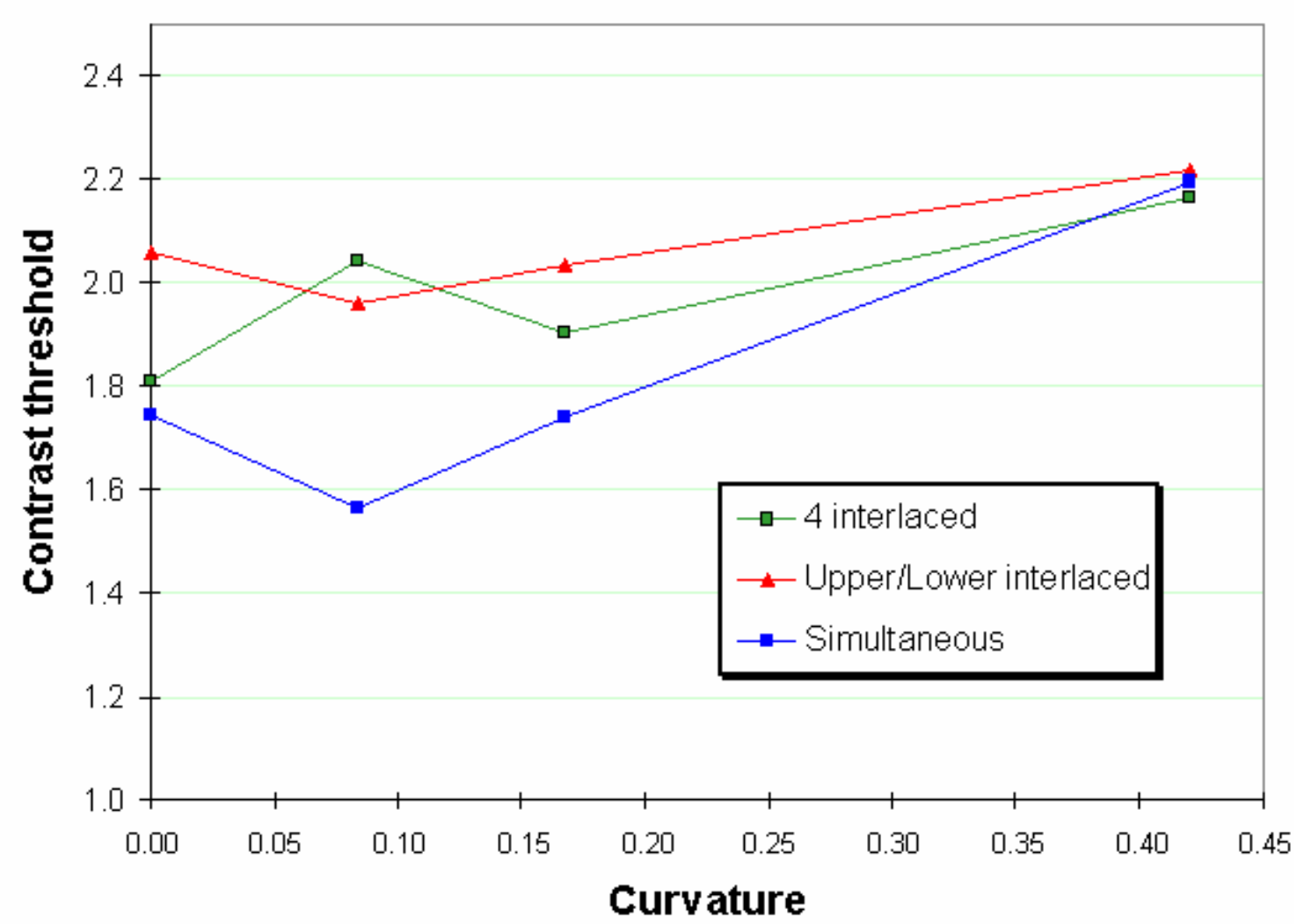


# Method test

- Simultaneous *vs* 4 separate interlaced staircases or upper/lower interlaced staircases (for visibility)
- Simultaneous allows “didn’t see” response, is therefore subjective
- Four separate stairs could be subjective if one position is favored for all “not sure” (we never observed this happening)
- Upper/Lower removes criterion and subjectivity
- All give similar responses (Figs. 3 & 4), but
  - ✓ Simultaneous tends to be steeper slope

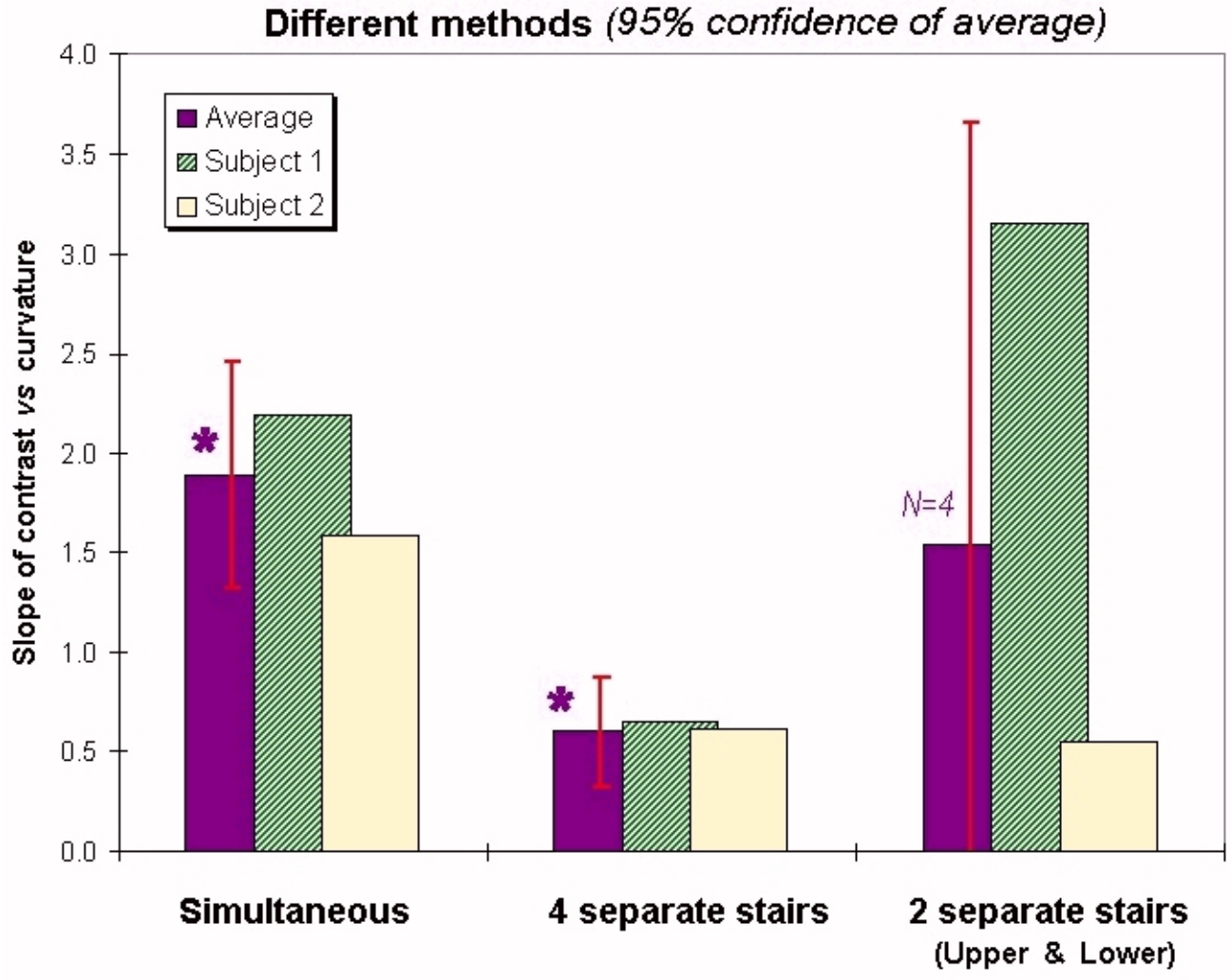
Fig 3. Subject 2: **Compare three methods for testing visibility**

*Simultaneous most curvature sensitive — all methods at the same session*



# Fig 4. Comparison of methods for visibility (slope *vs* curvature)

Asterisks indicate all-subject means different from 0 ($p<0.01$)




**Notes:**

- Subject 3 was included in the *simultaneous* and *2 separate (upper/lower)* averages
- Subject 4 was included in the *simultaneous* average only

# Decreased visibility with curvature found for non-blanked (or non-scintillating) disks

- Dark disks with black “squares” also show higher threshold with curvature (much lower contrast threshold than light disks, but higher than with no “squares”) (see Fig. 5)
- Disks out of intersections (much lower threshold than centered) also have increased threshold with curvature (out of intersection means disks were displaced one radius along the centerline of a horizontal alley) (see Figs. 6-8)

Fig 5. **Dark disks on black "squares"**

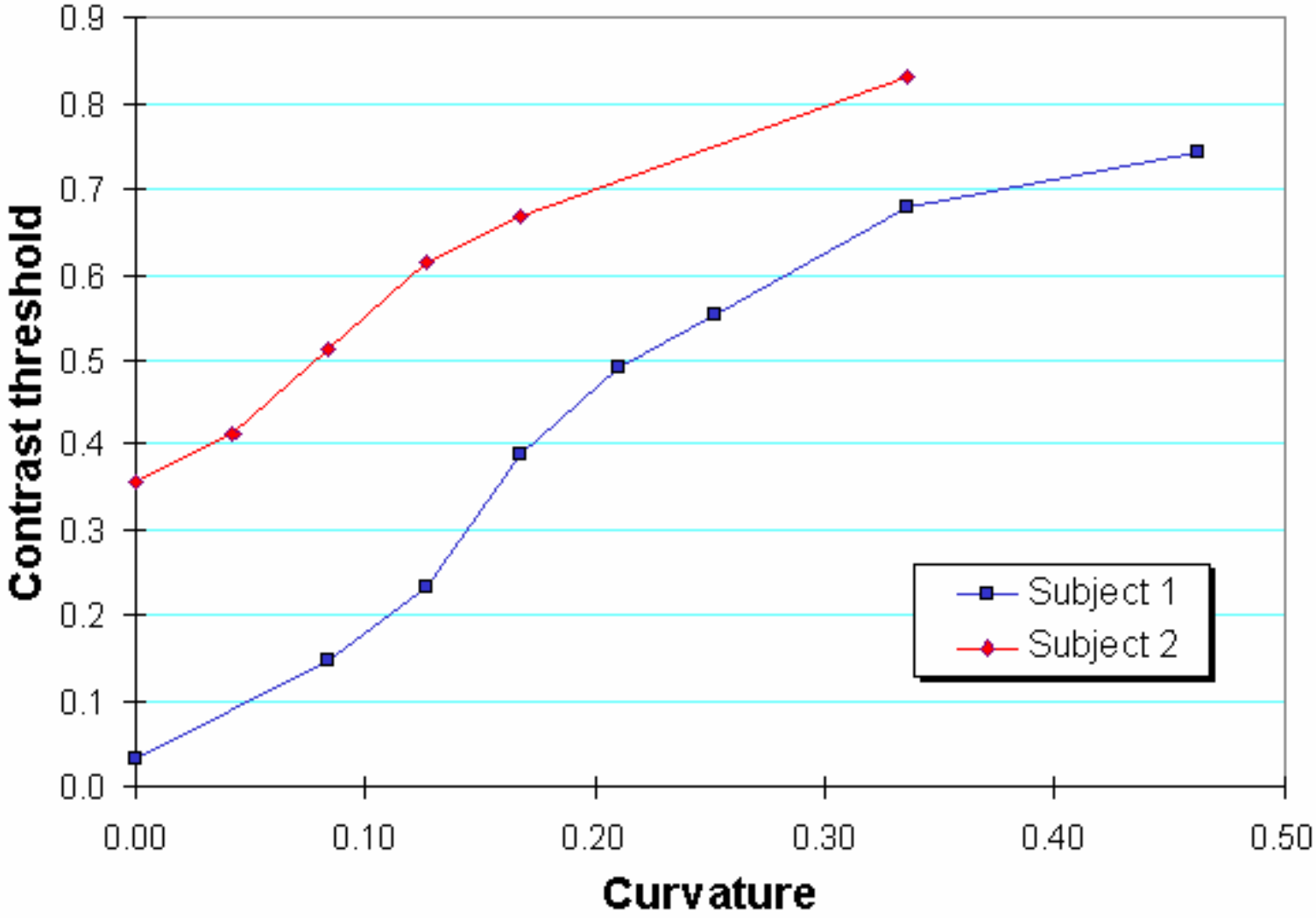
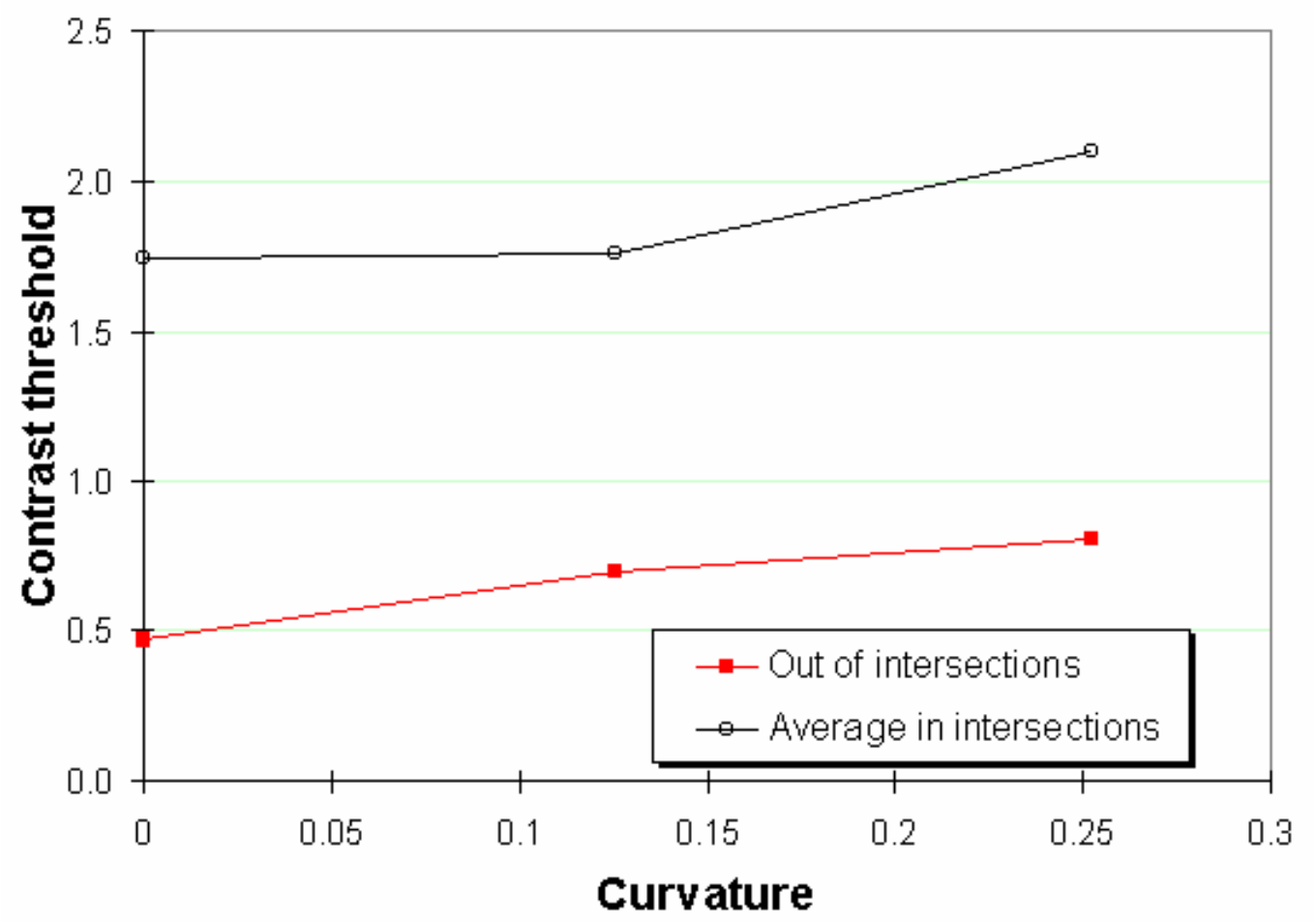


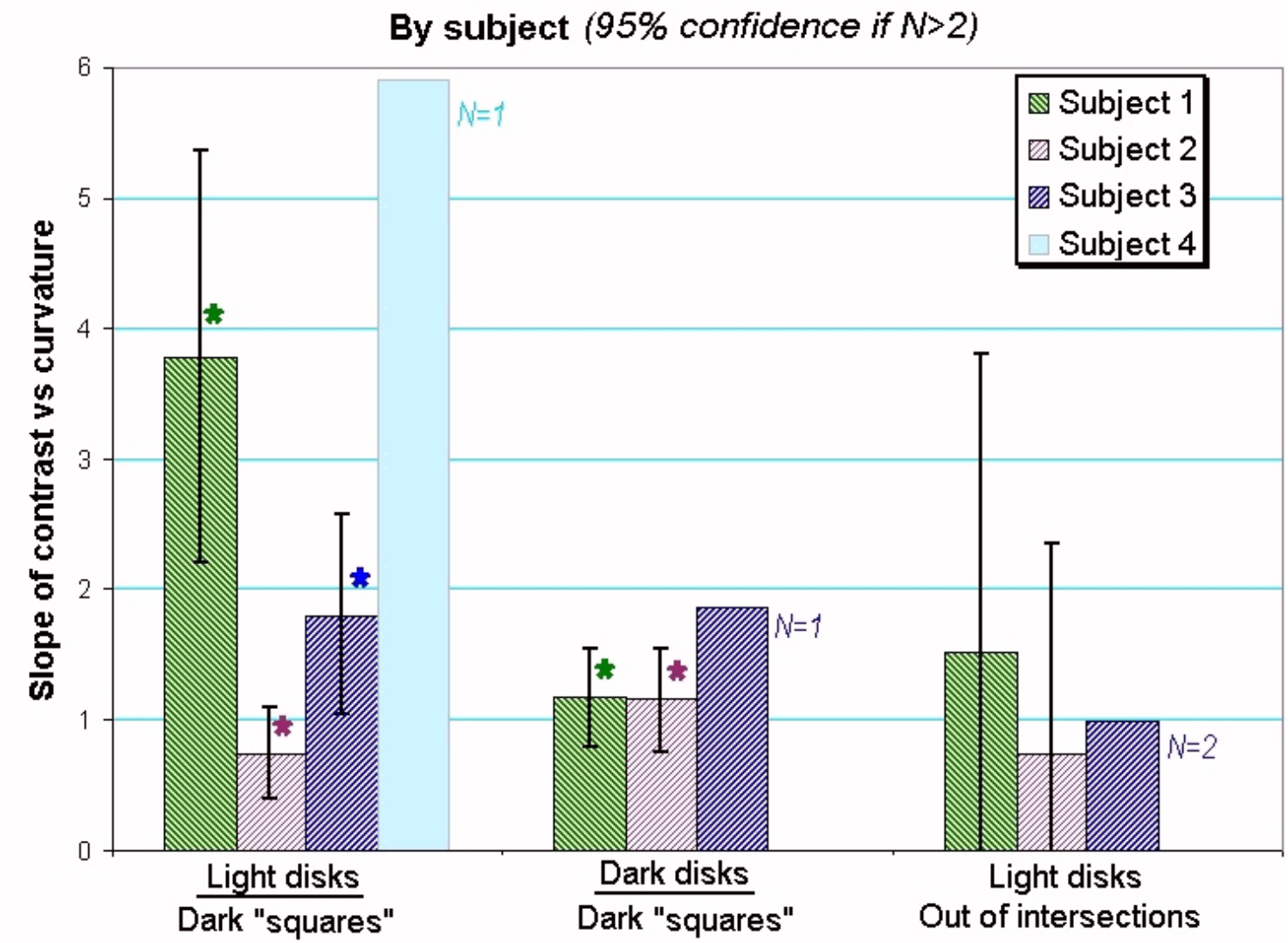
Fig 6. Subject 3: Comparison of light disk in intersection or out of intersection by 1 radius

(data collected in the same session)



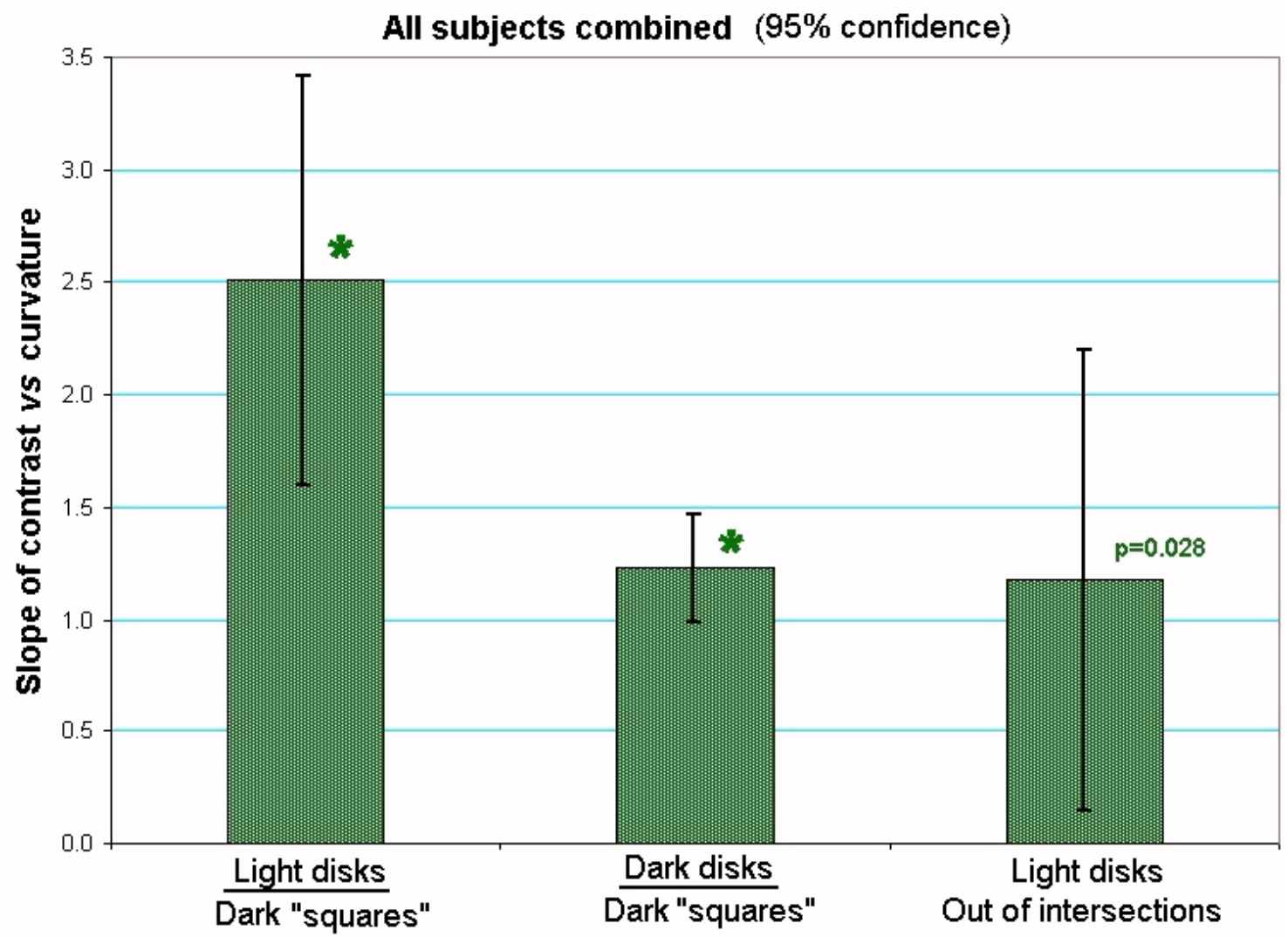
# Fig 7. Compare disk conditions *by subject*

Asterisks indicate means different from 0 ($p<0.01$)



# Fig 8. Compare disk conditions for *all subjects*

Asterisks indicate means different from 0 ($p<0.001$)



# Other factors apparently not important:

- Random change in polarity of curves from trial to trial
- Random left-right misalignment of grids above and below fixation

- Neither has a significant effect, although they tend to slightly decrease thresholds at the same curvature
  - ✓ Note again that out of intersection has lower threshold, but shows curvature effect
  - ✓ Data from two subjects shown in Figs. 9 and 10; a bar graph (Fig. 11) summarizes all subjects

Fig 9. Subject 1: **Effects of other manipulations**

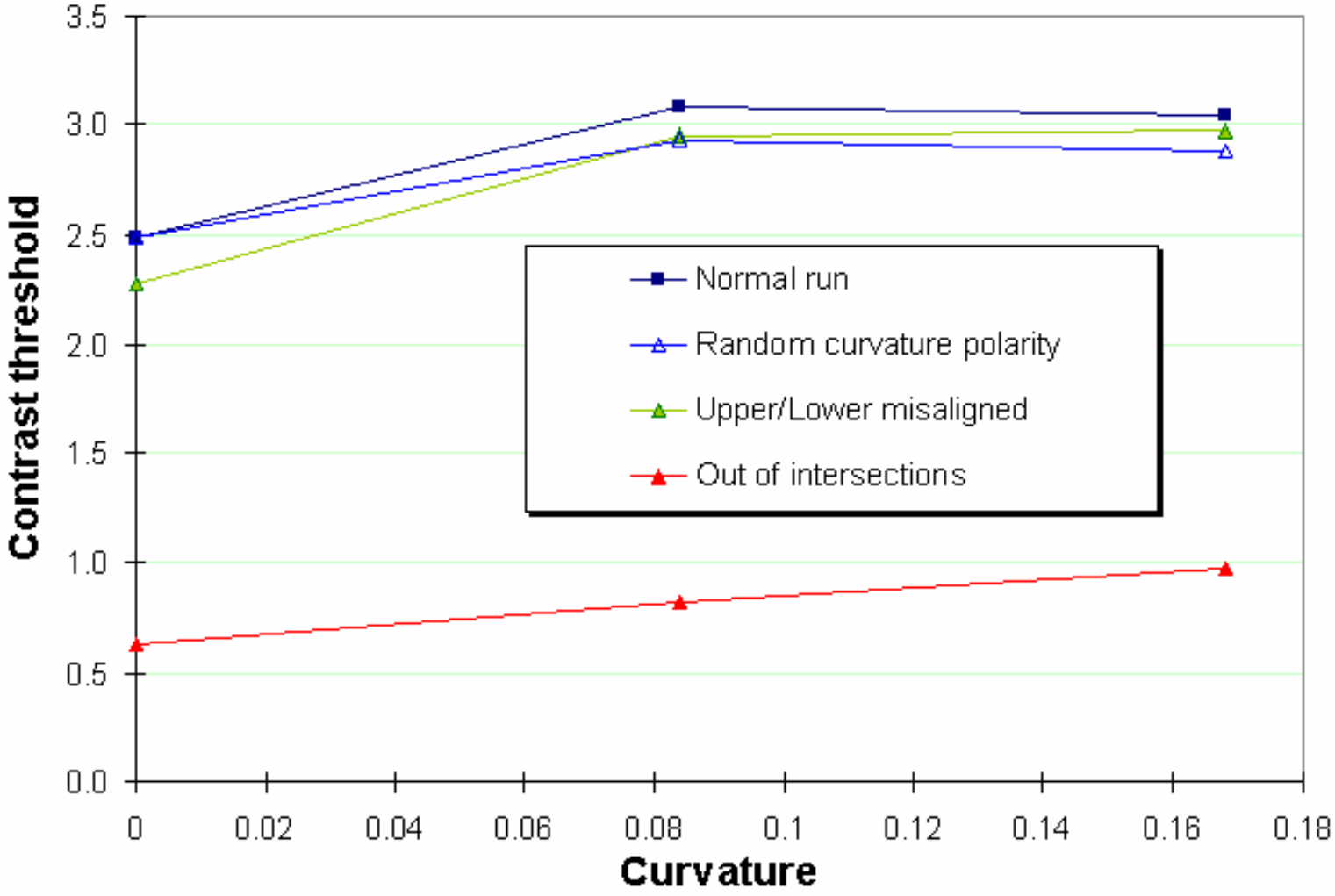


Fig 10. Subject 2: **Effects of other manipulations**

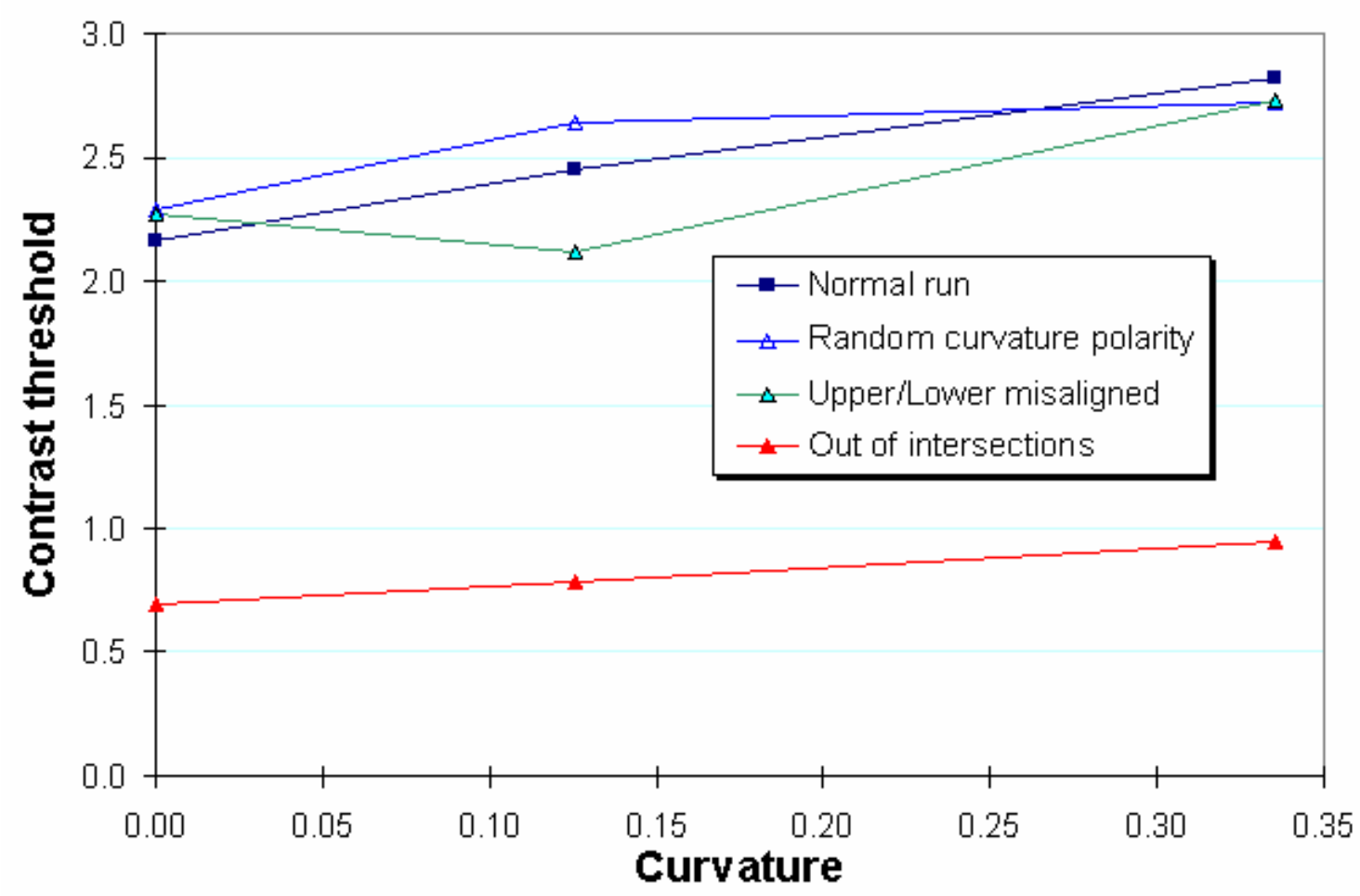
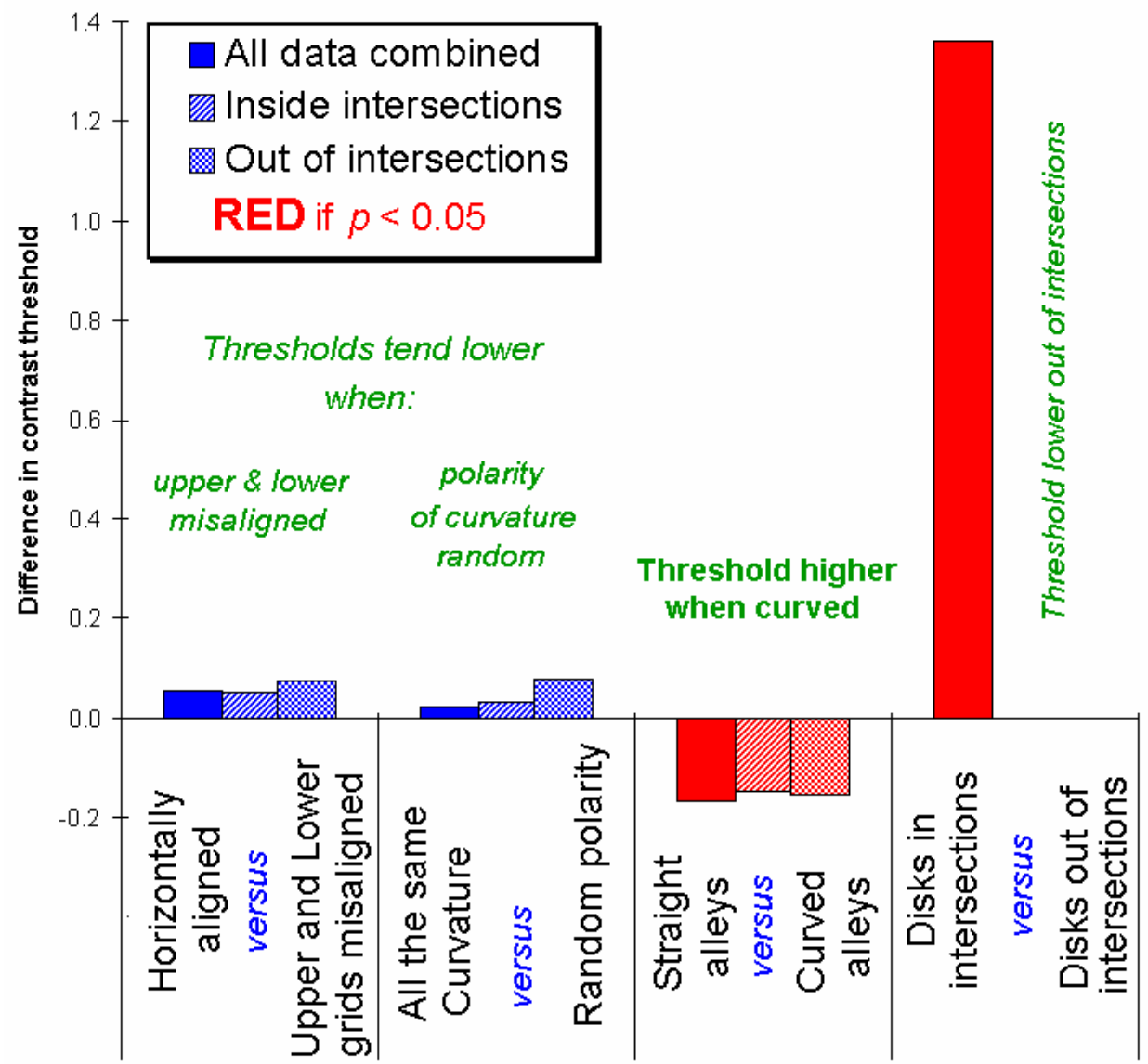


Fig 11. All subjects, contrast differences in matched conditions



# Summary

- We verify that curvature defeats scintillation (informally, we agree for the Hermann grid)
- Curvature also raises threshold for vanishing disks
- Curvature raises threshold for non-vanishing disks (dark or out of intersection), implying a general visibility effect
- “Pinching” restores visibility of a disk, because “intersections” are straighter – but does not restore scintillation, probably because inhibition is also not present with straighter “intersections”
- Possible learning of curvature: later runs on the same subject seem to have a less dramatic effect *(compare Fig 9 to Fig 1; Fig. 10 to Fig. 2)*

# Conclusions

- Curvature must affect a higher-level process than lateral antagonism
- Lateral antagonism is not ruled out to explain the Hermann grid or scintillation (curvature decreases visibility, so it would override illusory effects)
- Note that this challenges our "contrast" explanation of dark disks*– contrast is the same, so increased thresholds of dark disks must be a complexity effect
- Similar higher-order processes may account for the post-fusion part of the vanishing disk illusion

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*We suggested that dark disks are less visible because mean luminance is diminished by the presence of a grid; this would boost effective contrast for white disks, but other processes cause them to vanish (McAnany & Levine, 2004, *Vision Research* **44**: 993-1001)