TEMPORAL PROPERTIES OF CONTOUR INTEGRATION IN COLOUR VISION

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PURPOSE

Contour integration requires the spatial integration of co-oriented and collinear cues across the visual field. We previously showed that luminance, red-green, and blue-yellow can support contour integration with the same efficiency in terms of their spatial properties [1-3]. Here we extend these studies to the temporal domain by investigating the processing time required for contour integration for the two chromatic mechanisms and the achromatic mechanism.

METHODS

The task requires the linking of orientation across space to detect a 'path'. Stimuli were arrays of oriented Gabor patches (1.5 cpd, = 0.17 deg) pseudo-randomly positioned within a 14 degree square. Half the presented stimuli contain a 'path' made of 10 adjacent aligned elements, and the other half have no path. Curvature is defined as the angle difference between adjacent path elements. Paths with low curvatures are relatively straight, and paths with high curvatures are more snaky. Stimuli were represented within a 3D cone contrast space, and were generated in real-time on a Cambridge Research Systems VSG 2/4 with 15 bits of resolution.

EXPERIMENT:
Effects of contrast and curvature on processing time

Reaction times were obtained as a function of contrast and curvature:
1) for **simple detection** of the stimulus regardless of the presence of a path,
2) for **path detection** measured using a yes/no procedure with path and no-path stimuli randomly presented,
3) from these we calculated the **processing time** for contour integration as the difference between simple stimulus detection and path detection.

Processing Time

Thus processing time is the time required specifically for integration of the Gabor elements into a contour and excludes the times required for simple stimulus detection and response execution. To discard any bias due to differences between left and right hand responses in the yes/no procedure, we measured simple detection for each hand.

RESULTS

1) There are absolute differences in **reaction time** between the mechanisms, with blue-yellow slower than red-green and achromatic mechanisms.
2) All mechanisms at all curvatures show an initial decrease in **processing time** with increasing contrast, followed by constant processing time at suprathreshold contrasts.
3) Processing time is similar for the two chromatic mechanisms.
4) For straight paths, processing time is longer for chromatic paths (around 200 ms) than for achromatic ones (around 100ms).
5) Processing time increases for curved paths, by around 100 ms for ACH stimuli and around 50 ms for colour ones.
6) Detection of the absence of a path requires 50 to 100 ms of additional time independent of chromaticity, contrast and path curvature.

CONCLUSIONS

1) The ACH mechanism requires less processing time for contour integration than the chromatic mechanisms.
2) The RG and BY mechanisms show no difference in processing time, although they are different in reaction time.
3) Processing time for the ACH mechanism is, however, more dependent on path curvature than for chromatic mechanisms.

On the basis of their similar spatial responses, we have previously proposed that the three mechanisms share a common contour integration process [2-3]. We suggest that the temporal properties of this common process differ according to its chromatic inputs.

References

1. McIlhagga WH, Mullen KT (1996). Contour integration with colour and luminance contrast. Vision Res. 36(9), 1265-1279.
2. Beaudot WHA, Mullen KT (1998). Role of the blue-yellow mechanism in contour integration. ARVO 1998, IOVS 39(4), S848/3938.
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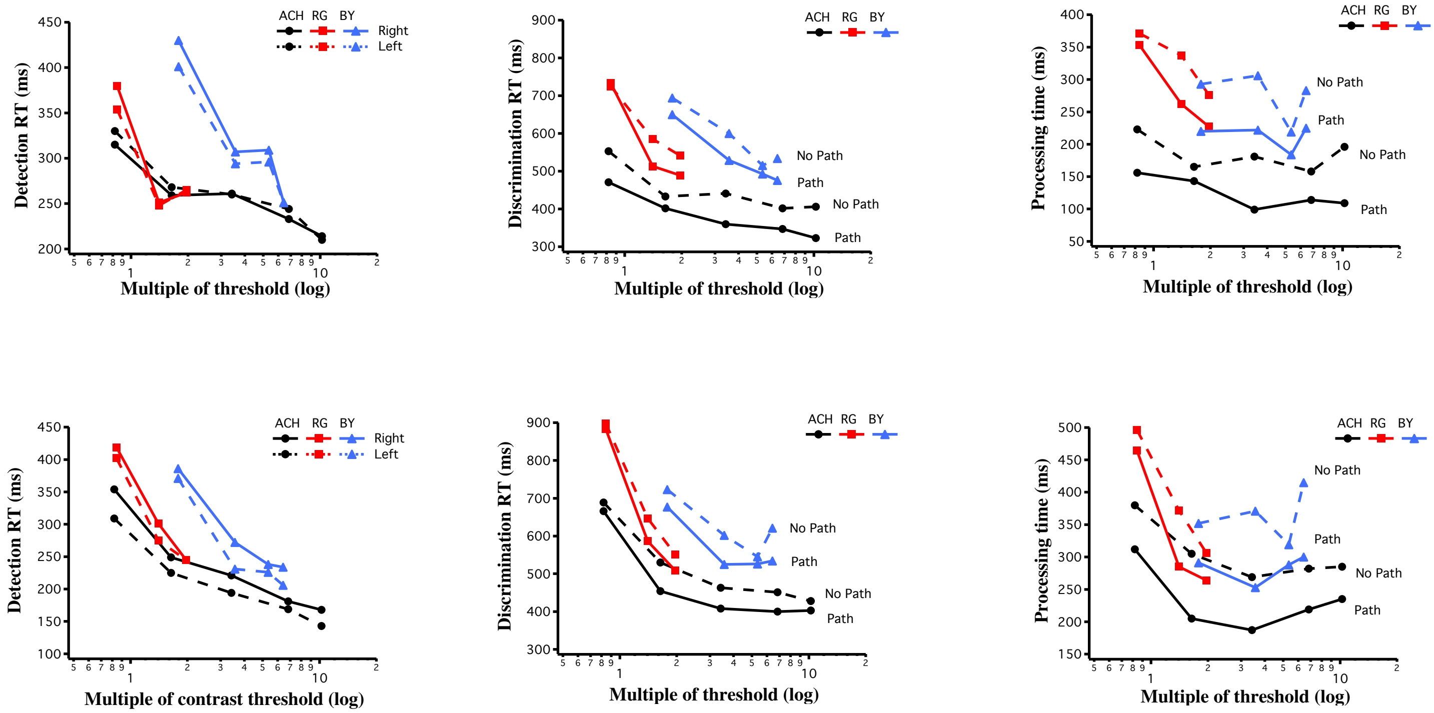
Path Detection | Path Discrimination | Processing Time

Straight Path

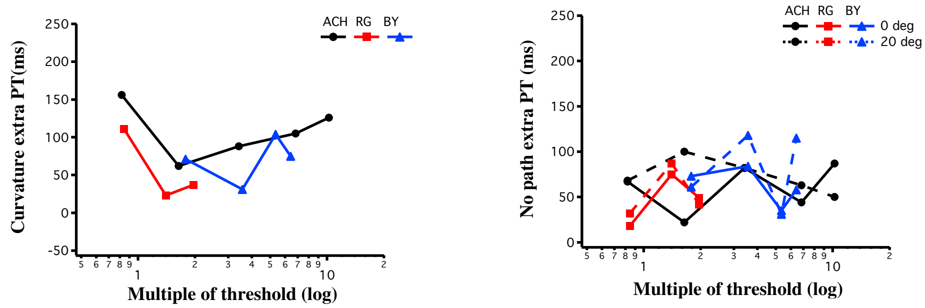
Curved Path (20 deg)



Extra Processing Time for Curvature

Extra Processing Time for No-Path Detection

Subject WHB



Subject KTM