Population receptive fields isolate or combine target and flankers in (un)crowding

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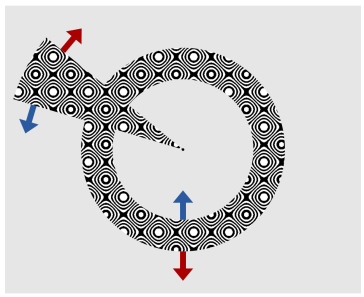
Introduction

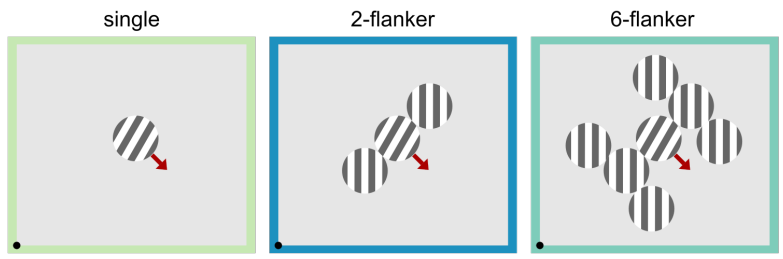
- Crowding leads to poorer target discrimination
- Traditional explanation based on feedforward, local models of vision: target and flankers fall within the same receptive field, leading to pooling of target and flanker features and irreversible loss of information as early as in V1
- Functional MRI (fMRI) studies[1] suggested that stronger crowding effect coincides with larger population receptive field (pRF) size estimates, in line with traditional explanation
- Here, we investigate the relation between the crowding performance and pRF size in crowding and uncrowding, where adding more flankers improves the performance
- Traditional explanation would predict that adding flankers leads to worse performance, with pRF size either the same or larger (through feedforward processing) as in the condition with fewer flankers

Methods

- 30 participants with normal vision
- Siemens 3T PRISMA MRI: 1-mm T1-weighted structural MRI, 3mm fMRI (TR = 2s)
- Experimental design:
  - Standard pRF mapping[2,3]: wedge-and-ring stimulus[4], central fixation task



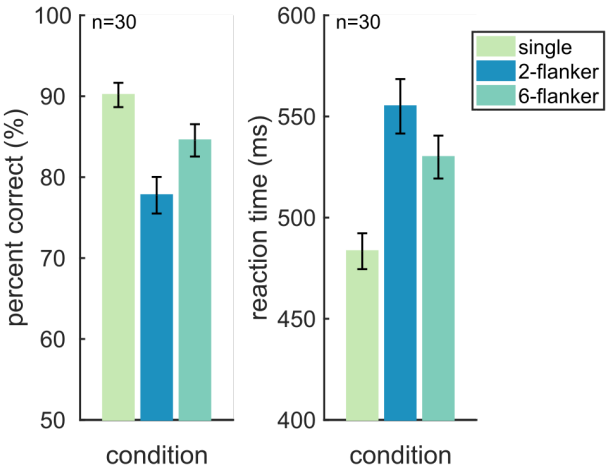
  - Task-relevant pRF mapping[3]: (un)crowding stimulus, target orientation task, 3 conditions (target diameter: 2°, target eccentricity: 7°)



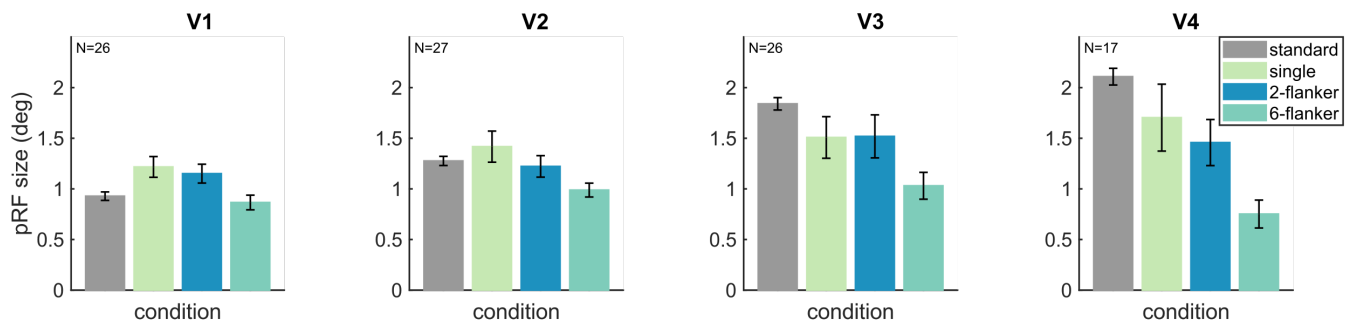
- Data analysis:
  - Behavior: reaction times, accuracy
  - Standard pRF mapping: manual delineations of visual areas V1 to V4, mask of target eccentricities (6° - 8°)
  - Task-relevant pRF mapping: extract average pRF size within target eccentricities across regions of interests (V1 to V4)

Results

- Behavioral results



- PRF size results:
  - Comparable pRf sizes in crowding (2-flanker) and no crowding (single)
  - *Decreased* pRF size in uncrowding (6-flanker)



Note: Error bars correspond to the standard error of the mean (SEM)

Conclusions

- Global stimulus configuration modulates pRF size
- We posit that in crowding, target and flanker features are *combined* within the same pRF because target and flankers group together, leading to a deterioration in performance as compared to the no crowding condition
- In uncrowding, target features are *isolated* from flanker features through a *decrease* in pRF size, likely due to top-down feedback caused by different target-flanker grouping; performance improves as compared to the crowding condition
- Recurrent processing plays a critical role in (un)crowding[5,6] and vision in general[7]

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