

Introduction

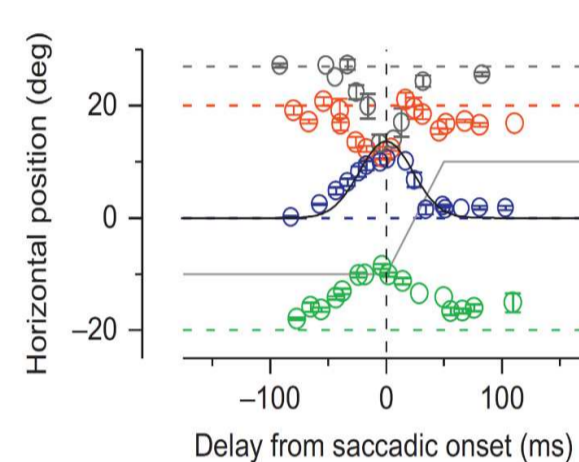
When coupled to saccades, visual attention enhances the perception of stimulus' physical properties such as orientation, contrast or spatial resolution^[1]. Can we observe such an improvement for size perception? It has been established that the size of an object presented in peripheral vision is generally underestimated due to the structural properties of our visual system^[2]. Moreover, Kirsh et al. (2020) have shown that visual attention can help lessen this size-eccentricity effect^[3]. Does action, namely saccade execution, take a substantial part in this mechanism?

Our goal was to assess the effect of saccade production on visual objects' size perception. In addition, we investigated whether movement parameters, in particular saccade amplitude, can modulate this effect.

In this study, participants were presented with a first disk in peripheral vision. They had then to make a saccade in the direction of the disk, towards a cross presented at different eccentricities. After a delay, a second disk was displayed in foveal vision, and participants had to perform a comparative judgment of the size of the stimuli. The introduction of a delay between both disks prevented any presaccadic compression of visual space.

What is presaccadic compression?

Compression of visual space is observed when stimuli are presented around saccade onset^[4]. We perceive these stimuli as being closer to the saccadic target than they actually are. Since spatial features as location are impacted, we hypothesized that size could also be affected.

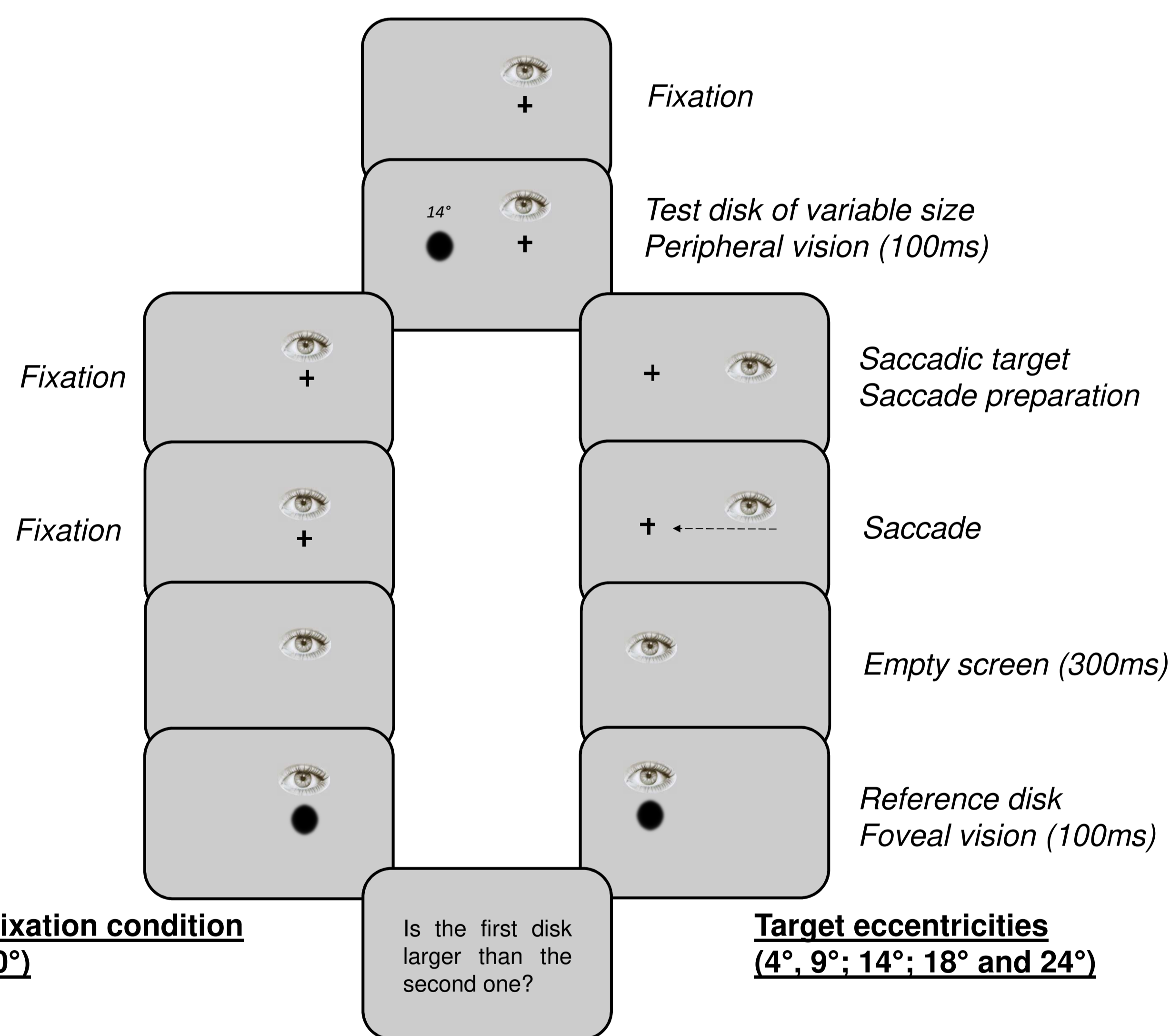


"Perceived spatial location of a bar flashed at four different locations as a function of the time of its presentation relative to the saccade onset.^[4] Around saccadic onset, a perceptual compression of all bars' location is observed. The spacing between the flashed bar and the saccadic target appears reduced."

(Burr et al., 2011)

Methods

Trial structure : Size comparative judgment task



Six visual target eccentricity conditions (0°, 4°, 9°, 14°, 18° or 24°, by reference to the fixation cross) of 276 trials were presented to each participant (N = 15. Four additional participants were removed, ±1.5*IQR)

Each eccentricity condition consisted in:

- Saccade phase: motor training at the specific target eccentricity (92 trials)
- Judgment phase: Constant stimuli procedure, with the peripheral test disk varying in size (184 trials)

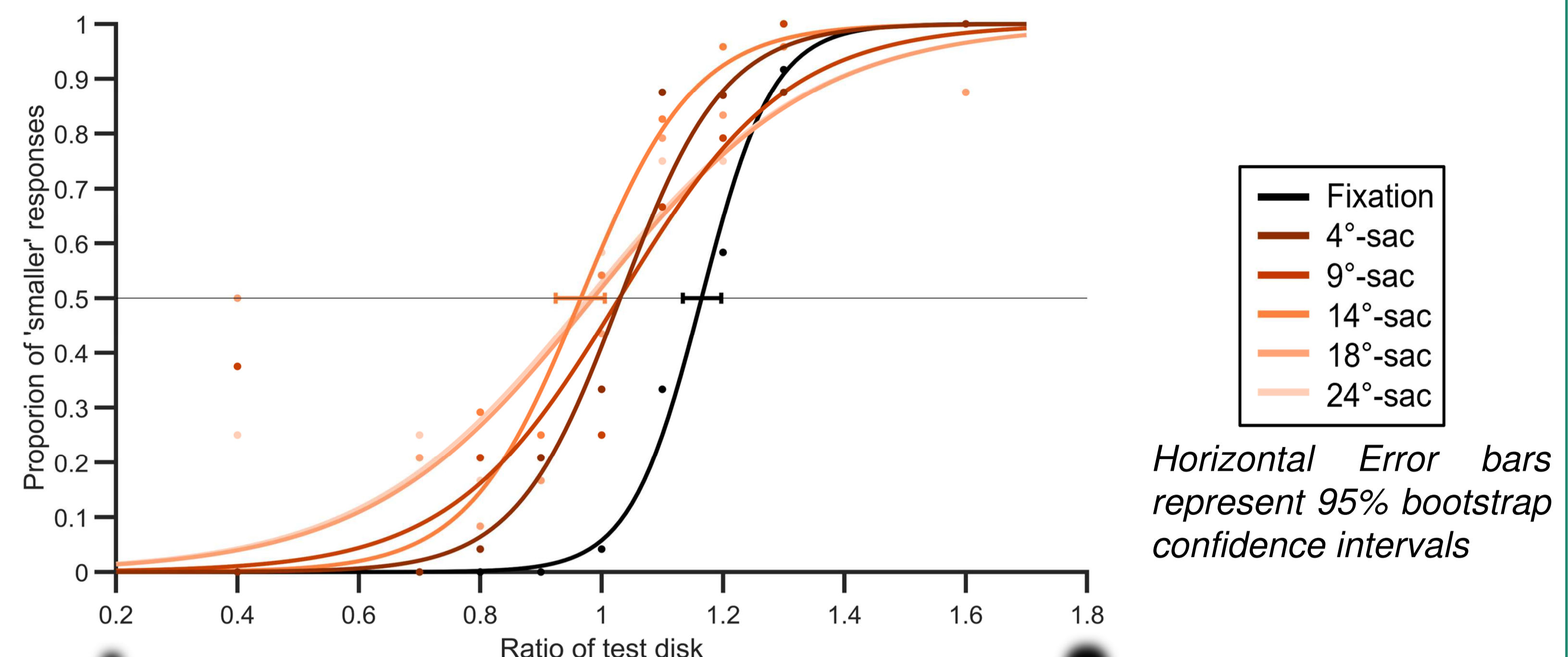
The 14° condition was presented first to further familiarize participants with the procedure. The order of the remaining conditions was randomized across participants. The experiment consisted in three one-hour sessions performed on three consecutive days.

Dependent variables: Psychometric functions were fitted to each individual's data, and two parameters were estimated:

- **The Point of Subjective Equality (PSE)** refers to the size of the presaccadic test disk judged to be equal to the reference disk.
- **The Just-noticeable Difference (JND)** refers to the smallest difference perceived between two stimuli and is related to the function steepness. This parameter is linked to perceptual sensitivity.

Results

Example of individual data:

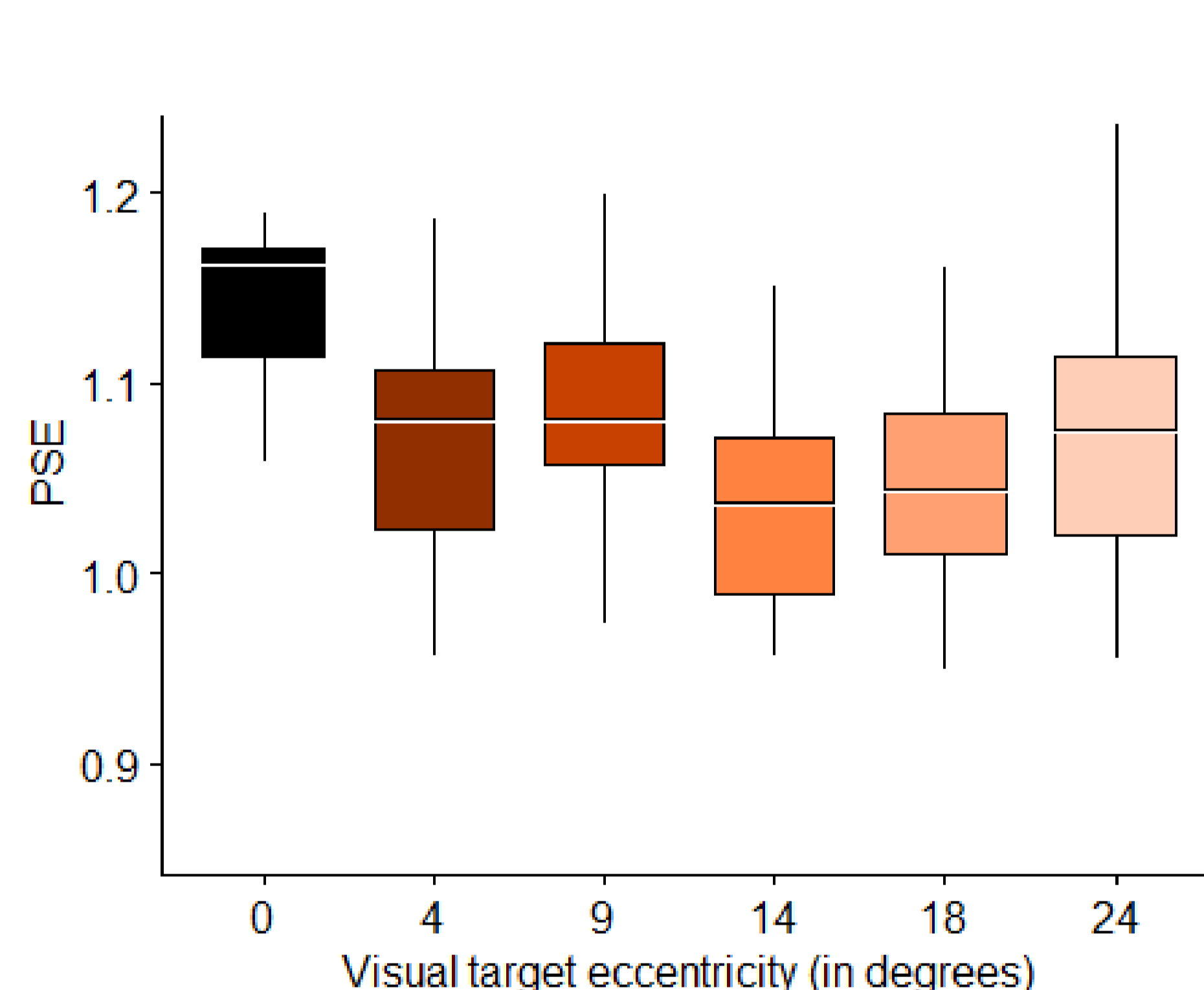


Psychometric functions for each target eccentricity for one representative participant

As for this participant, all observers underestimated the size of the test disk presented in the periphery, especially during the fixation condition ($M = 1.15$, $SD = .05$). During saccade conditions, they tended to approach the objective size equality of the two stimuli; their PSEs were closer to 1 ($M = 1.05$, $SD = .07$).

Size perception in function of saccadic target eccentricity

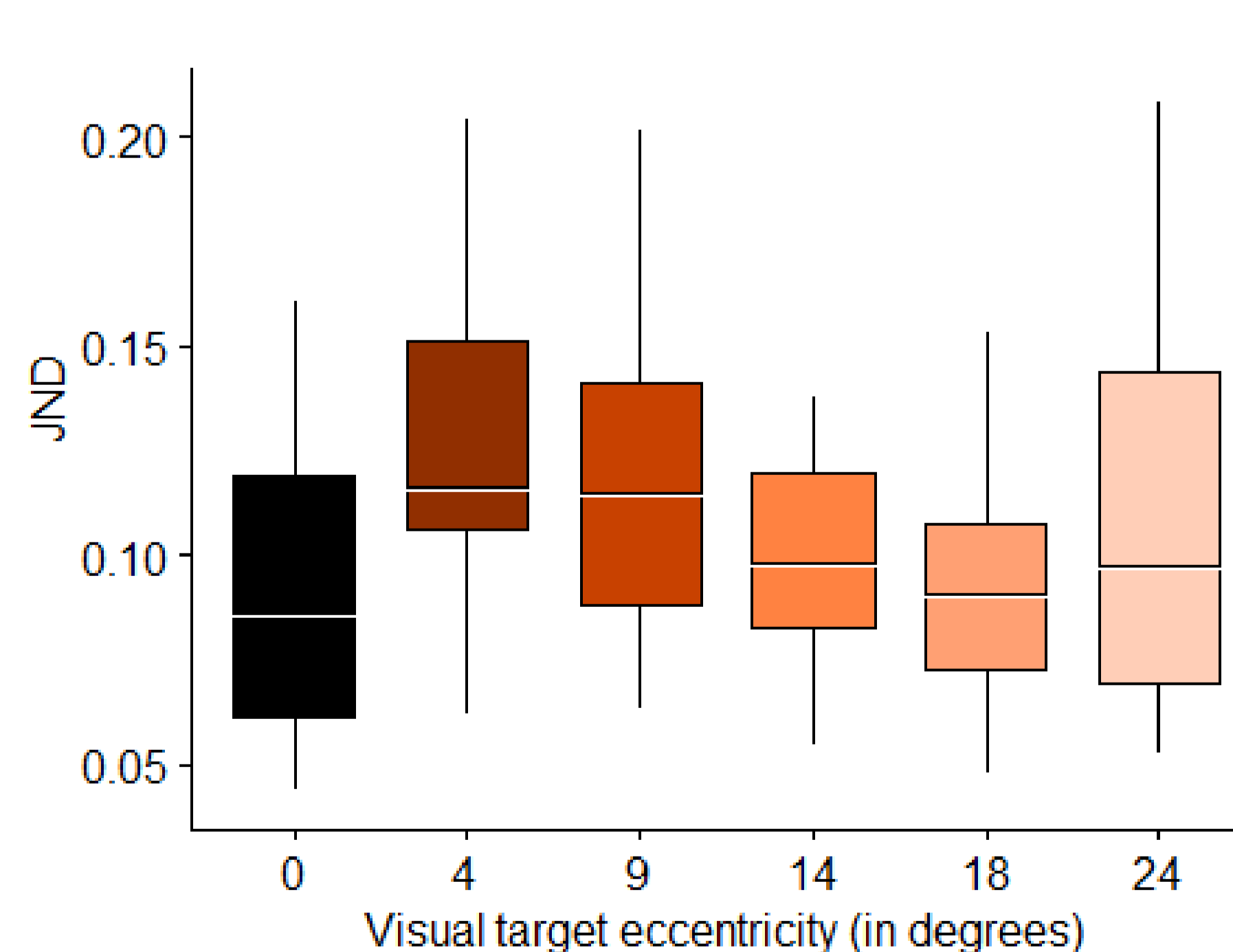
PSE Analyses



$PSE \sim Condition + (1|Participant)$
 $F(5,70) = 6.83, p < .001$ (Satterthwaite's method)

PSEs were smaller when participants made a saccade in comparison to the fixation condition (all $p_s < .036$). In addition, PSEs did not differ between saccade conditions (all $p_s > .45$). These results indicate that the perception of the size of a disk presented in peripheral vision is more accurate when participants have to make a saccade, regardless of its amplitude.

JND Analyses



$\text{Log}_{10}(\text{JND}) \sim Condition + (1|Participant)$
 $F(5,70) = 3.11, p = .026$ (Satterthwaite's method)

Analyses only showed a slight difference between the 0° ($M = .09$, $SD = .04$) and the 4° ($M = .13$, $SD = .04$) conditions. Importantly, participants' perceptual sensitivity appeared good through the experiment for all conditions ($M = .12$, $SD = .05$). JND values were consistent with our previous results^[5] and confirm the reliability of our PSE estimates.

Conclusion

Our results indicate that visual attention coupled to saccades magnifies the size of stimuli presented in the visual periphery. This effect is observed when the stimuli is presented 200ms before the saccade onset, that is, before its preparation and outside the saccadic compression timeframe. This phenomenon allows an enhancement of size perception and compensates the size-eccentricity effect. Producing an action such as a saccade thus has a strong impact on perception, independently of the movements' parameters.

References

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- [4] Burr, D. C., Ross, J., Binda, P., & Morrone, M. C. (2011). Saccades Compress Space, Time, and Number. In *Space, Time and Number in the Brain* (p. 175-186). Elsevier.
- [5] Pressigout, A., Paeye, C., & Doré-Mazars, K. (2020). Saccadic adaptation shapes perceived size : Common codes for action and perception. *Attention, Perception, & Psychophysics*, 82(7), 3676-3685.

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This work was supported by the ANR-19-CE28-0001

ESCOPE, 29 aug. – 01 sept., Lille