Секция «Когнитивная психология»

Perceiving collinear, parallel, and perpendicular contours

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The human visual system processes configurations of contours more efficiently so that their perception cannot be simply represented as a sum of perception of the individual contours [1]. I studied perception of collinear contours configuration and compared it with perception of other contour configurations.

Importance of perception of contour configurations has been discussed from Gestalt Psychology. But, it is difficult to measure the effect of the configurations quantitatively. Koshmanova and Sawada proposed a psychophysical method that can represent the effect of configuration as uncertainty of individual contours perception which is called an orientation threshold [1]. Method of Constant Stimuli is based on assumption that process of junction perception can be considered as integration of precepted singular lines. If this approach is correct, the thresholds will remain constant in all observations of all configurations. On the contrary, difference between thresholds of configurations means that visual system does not process different types of configurations by a linear integration.

Apparatus

Stimuli were displayed on 120Hz 24-inch LCD monitor (BenQ Zowie XL2411) in a dark room. The subjects viewed the display binocularly from a distance of 160cm. The head of observer was fixated by a chinrest. In order to avoid cues for orientation judgments a black panel with a circular aperture (29 cm in diameter) was used.

Stimuli

The stimuli consisted of two contours. The were 3 types of junction - parallel, collinear and perpendicular. The length of a contour was 7.5 cm +- 1.25 cm. The width of a contour was 1 mm. The stimuli can be described as white contours located in the circular aperture (29 cm) with varied eccentricity in different trials, which are shown for 250 ms to observer. The second stimuli are rotated clockwise or counterclockwise relative to the orientation of first contour. The eccentricity of junction varied from 1 to 3 cm in different conditions. There were 9 conditions in total (рис. 1).

Procedure

The modified Method of Constant Stimuli with the two-alternative-forced-choice design was used. A fixation point was shown in each trial (250 ms). An observer pressed a mouse button and two intervals of visual stimuli were shown. Duration of each stimulus demonstration was 250 ms with 250 ms interval between stimuli. Two choices were shown after 250 ms of the disappearance of the second stimulus. The task for observer was to judge which of two junctions was more collinear, perpendicular or parallel. Observer chose the answer using the mouse. An audio feedback about the accuracy of the response was given after each trial. An observer ran one session for each condition of the experiment. Each session consisted of 180 trials. The order of trials was randomized for each participant (рис. 2).

The observers were the author of this study and 5 volunteers with normal vision.

Results

The results of Experiment show that the visual system is more sensitive to a parallel and collinear contour than to a perpendicular junction. The effect of the configuration type was significant ($F(2,37) = 8.123$, $p = 0.001$). Post-hoc tests (Tukey) showed that difference of the threshold between the perpendicular and collinear configurations ($p = 0.001$) and between the perpendicular and parallel configurations ($p = 0.10$), but not between the collinear and parallel configurations ($p = 0.684$). The effect of the eccentricity ($F(2,37) = 1.485$, $p = 0.240$) or the interaction effect between the eccentricity and the configuration type ($F(4,37) = 1.306$, $p = 0.286$) were not significant.

General discussion

The results of the experiment suggest that the visual system is as sensitive to collinear contours in a retinal image as it is to parallel contours in a retinal image. Note that parallelism and collinearity of contours are non-accidental properties while perpendicularity is not. Results of our experiment shows that the visual system continues to be sensitive towards collinear contours when they are rotated in eccentric positions.

The sensitivity towards collinearity of human visual system can be explained by two possible mechanism of perception of collinearity and curvature. The observer can judge the orientation of a stimulus based on the straightness of two segments. If two segments are estimated to be spatially located on common meridional axis, they can be presumed as collinear by visual system. Another possible explanation for collinearity perception is an estimation of external and internal endpoints of segments by visual system. The visual system judges the contour to be collinear in case than four endpoints of two-segmented contour are approximated to be spatially located on one straight axis.

Koshmanova and Sawada notes possible limitations of the study which we can possibly face too [1]. The structure of experimental session causes response bias, based on visual memory. This happens due to distortions of remembered configurations, because the first shown contour should be remembered for a longer time - time after its exposure and during the time of second configuration exposure on screen. So, the first contour junction can be considered by the observer as more regular one, because it could have been affected by visual memory. We expect that our study will have the similar response bias due to similar experimental design. This issue will be addressed in my future study.

Acknowledgements

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Источники и литература

1) Koshmanova E., Sawada T. Perceiving perpendicular and parallel contours in the frontoparallel plane //Vision research. – 2019. – Т. 154. – С. 97-104.

Иллюстрации

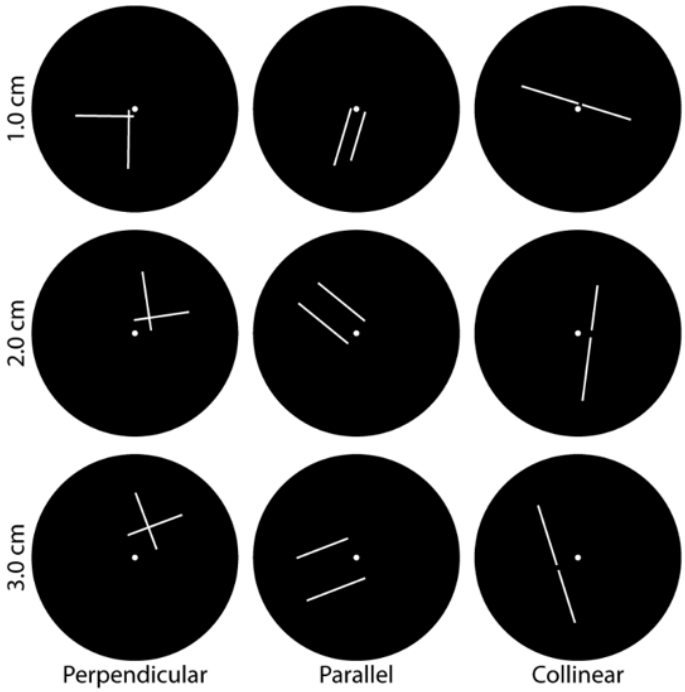

Рис. 1. Three types of contours configuration: parallel, perpendicular and collinear. Black circles represent a circular aperture which was attached to the computer screen during the procedure. Three levels of eccentricity of the individual contours from the center of the screen (1.0, 2.0, or 3.0 cm) are depicted.

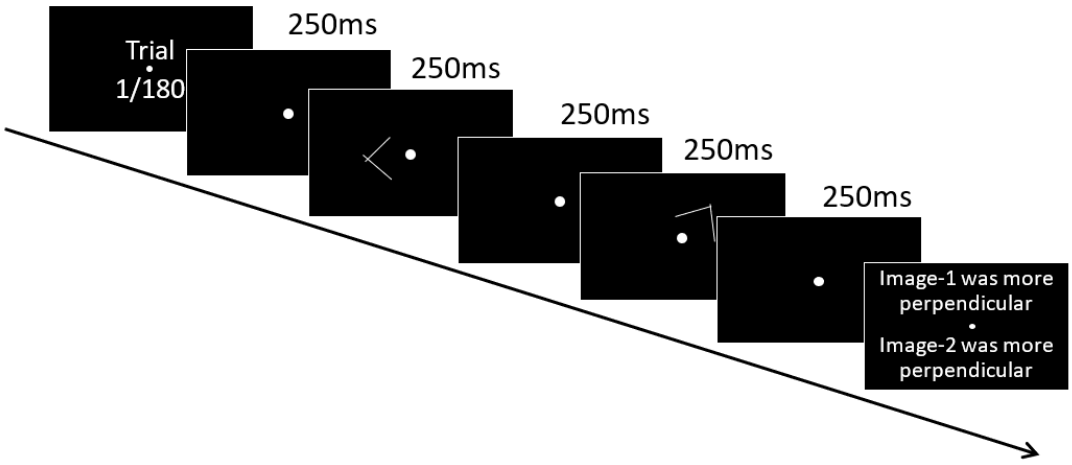

Рис. 2. The structure of the experimental trial.