Displacement of the edges of the filled intervals in the Oppel-Kundt illusion

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Introduction. In the Oppel-Kundt illusion a filled visual area appears to be larger than an empty area of equal size. Typical Oppel-Kundt illusory pattern comprises two contiguous spatial intervals: one filled with a regular sequence of dividers (stripes or spots), and the other empty one. It is known that the illusion is most prominent when the filled interval is divided into 5 - 10 parts [1, 2]. In our previous work [2] we have showed that the illusion exists also for figures comprising three spatial intervals: either when a filled interval is flanked by two empty ones or when an empty interval is situated between two filled. It was demonstrated that the illusion was greatest when the empty interval was placed between two filled ones, and that the illusion magnitude is defined mainly by changes in length of filled parts of stimuli.

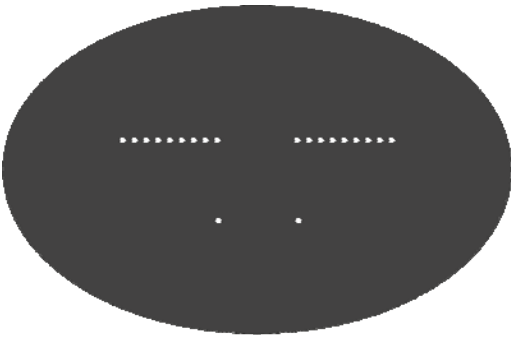

Fig. 1. Example of stimuli used in experiments

In the present pilot work we have raised a question whether the perceived distortions of length may be caused by local displacements of the edges of the filled intervals of the Oppel-Kundt figure rather than by their homogeneous expansion. It was also interesting to investigate how the illusion depends on the number of dividers and the length of the filled intervals of stimuli. In the stimuli used, the length of the empty interval situated between two filled parts of the Oppel-Kundt figure could be compared with that of separate test interval placed below the figure (Fig. 1). Such organization of stimuli let us to change spatial parameters of flanking filled intervals and maintain the same length of the central empty part.

Methods. Visual stimuli were generated by the Cambridge Research Systems VSG 2/3 and presented on the monitor EIZO T562. The monitor was

placed at a distance of 260 cm from the observer. The stimuli were presented monocularly at the center of the monitor screen. Movements of observer's head were limited by a chin holder, and an artificial pupil with a diameter of 3 mm was used to minimize the optical aberrations.

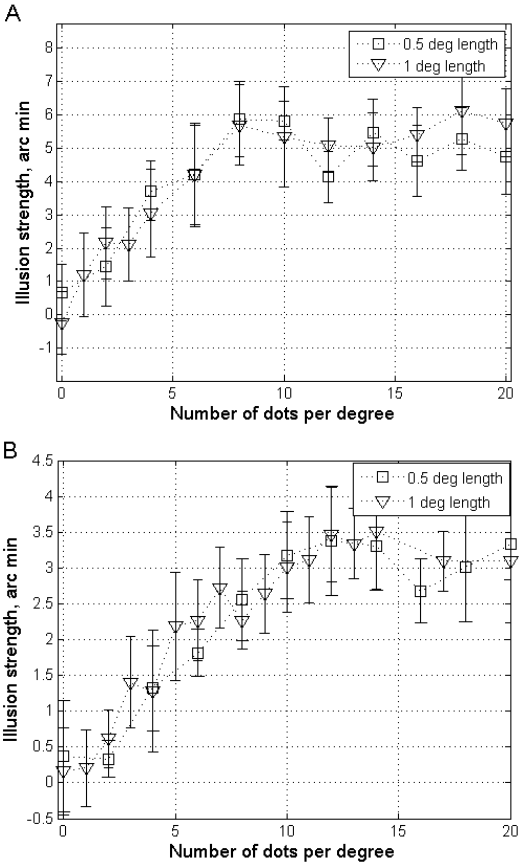

Fig. 2 The Oppel-Kundt illusion strength as a function of number of stripes per arc degree. The range of stripes of 1 deg length (squares) or 0.5 deg (triangles) were used. Vertical bars, 0.95 confidence intervals. Data of two subjects (A and B).

Stimuli were formed by spots which size was 2x2 min-of-arc. The empty interval of the Oppel-Kundt figure (the upper part of Fig. 1) was considered as to be the referential one; its length was 1 deg-of-arc. The lower stimulus interval was the test one. The referential interval was flanked by two filled ones which length was either 0.5 or 1 deg-of -arc. The distance between the test and referential parts of stimuli was 1 deg-of-arc. Subjects were asked to direct their gaze in middle between the upper and lower stimulus part. The luminance of spots was 40 cd/m^2 and the background luminance was 3 cd/m^2.

During experimental session subjects were asked to adjust the length of the test interval (Fig. 1, lower) in order to make it equal to the referential one (Fig. 1, upper). The independent variable, the number of spots per degree (density of filling) varied from 0 to 20. Two series of experiments with two different lengths of the filled parts of stimuli were performed. For every data point the measurements were repeated at least 10 times. Two subjects: woman (age 42) and man (age 36) participated in the experiments.

Results. The effect of illusion was observed in both series of experiments. For both subjects, the referential empty space appeared smaller in comparison with the length of the test interval. Because stimulus manipulations did not change the physical length of the referential interval, we believe that the illusion had emerged due to the perceptual displacements of the edges of flanking intervals inward the figure. As it can be seen from the graphs (Fig. 2), the illusion strength gradually increased with increasing of the density of filling of intervals up to 11 – 13 spots per degree; for the higher densities, the effects of some saturating of the illusion strength appeared. In agreement with our previous findings [2], the length of the filled interval (0.5 or 1 deg-of-arc) had not any influence on the magnitude of the Oppel-Kundt illusion as a function of density of filling - the data for both stimulus conditions do not differ significantly (Fig. 2, *squares* and *triangles*).

The presented study continues our researches on subjective geometry of the visual space. However, some unanswered questions still remain, e.g., what minimal length of the filled interval is needed to get considerable effect of illusion, and does the same densities of filling (spatial frequencies) are equally effective for all stimulus intervals lengths?

References

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In the present study the possible role of the local positional shifts of the edges of the filled parts of the Oppel-Kundt figure was tested. The stimuli consisted of two filled (by spots) spatial intervals with an empty (referential) one between them. For length comparisons the separate test interval was employed. It was demonstrated that the illusion strength increased with increasing of the density of filling and that the data for different length of the filled part of the stimulus do not differ significantly. The results support the suggestion that the perceptual positional shifts of the edges of the filled intervals may be considered as one of the main causes of emergence of the Oppel-Kundt illusion.