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NEW ARGUMENTS AGAINST THE HYPOTHESIS OF CONSTANT CURVATURE OF VISUAL SPACE (*)

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SUMMARY.

The scalar curvature K of visual space was computed from large visual alleys 5m x 1m and 60m x 12m in 2 Ss. Three conditions were analyzed: binocular vision, left monocular and right monocular. The values of K varied widely in each subject suggesting that binocular cues play an important role also in large open fields.

The widespread use of experimental visual alleys to test the Luneburg's hypothesis (1947) of a constant curvature in visual space is subject to many criticisms.

First, Hardy et al (1951) report that the measure of scalar curvature K of visual space is quite variable and that the visual alleys cannot be reliably applied to ophthalmology. Second, the findings of Zajakowska (1956) suggest that the value of K may depend on the size of the alley. In a former article Battro et al. (1976) have shown that visual space is not homogeneous and that no geometry of constant curvature can describe the construction of big visual alleys (up to 240m x 48m). The observed variability of $K (-1 < K < +1)$ was

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primarily attributed to the size of the alleys and visual perception itself was considered *scale-dependent*. Ehrenstein (1976) has stressed the importance of the psychophysical method used in estimating visual alleys and he reports the findings of Haubensak (1970) where variability of K is also found in small visual alleys, a fact that seems not to be specific of size, he argues. We agree, of course, with Ehrenstein that many other factors other than big size may contribute to change the value of K, but we still maintain that change of scale is of paramount importance.

One of us, (Battro, 1976), has suggested that the change of scale may even produce a "visual catastrophe" in the sense of Thom (1972). Ehrenstein stresses also the fact that over-constancy is not a good argument for accepting the hyperbolic structure of space, Blank (1959) notwithstanding. We also agree with this statement because in a recent research Battro and Reggini (1976) have shown in large open fields that the change from under-constancy to over-constancy is clearly dependent, first, on the age of the subjects and, second, on the position (proximal or distal — up to 238m) of the objects. The observed variation of the Thouless index as a function of distance and age can also be indirectly used to reject the hypothesis of the constant curvature of visual space.

An important question remains however open: Did we have the right to use Luneburg's method to test the scalar curvature of visual space in large alleys? We know, in fact, that binocular cues are more useful in the estimation of the proximal space than of the distal space. In this article we intend to answer affirmatively to this question.

THE EXPERIMENT

Luneburg's theory is a theory about binocular vision. If binocular cues were not relevant at all in big open fields it could be wrong to test his model using large alleys as we have done in our previous experiment (Battro et al 1976). An *indirect* way to find out whether binocular vision continues to furnish relevant information during the construction of the visual alleys is to test it against monocular vision. A coincidence between the values of K obtained under both situations would imply that monocular vision is perfectly able to furnish the same scalar curvature as binocular vision.

In that case, binocular cues would be irrelevant, and the binocular model useless. We found that this is not the case because the values of K vary widely in binocular vs monocular vision, and even between the right and the left eyes. Negative as well as positive K were found and this implies that human subjects employ binocular cues also in large open fields.

Two adults were tested in both monocular and binocular vision with a small alley: 5m x 1m and a big alley 60m x 12m. The setting was prepared as described by Battro et al (1976) in an open field using stakes. The head was fixed in all situations and 12 measures of K were computed. Table I shows the variability of the scalar curvature K, measured by the Luneburg's method.

We think these results invalidate the idea that binocular cues play a minor role in the perception of depth at great

TABLE I

VALUES OF K TESTED IN DIFFERENT ALLEYS UNDER BINOCULAR AND MONOCULAR VISION

ALLEY	VISION	VALUES OF K	
		SUBJECT 1	SUBJECT 2
5m x 1m	Binocular	—0.20	—0.02
	Left monocular	—0.12	—0.88
	Right monocular	0.24	0.20
60m 7 12m	Binocular	—0.32	0.29
	Left monocular	—0.71	0.01
	Right monocular	0.81	0.34

distances, otherwise monocular vision would yield the same results in terms of curvature as binocular vision. Therefore Luneburg's model can be rightly used to test the curvature of visual space using large visual alleys. The important fact, however, is that this curvature has no constant value.

RESUMO

A curvatura escalar K do espaço visual foi calculada, em 2 sujeitos, a partir de grandes avenidas visuais 5m x 1m e 60m x 12m. Três condições foram estudadas: visão binocular, visão monocular esquerda e visão monocular direita. Os valores de K variaram consideravelmente em cada sujeito, o que sugere que os índices binoculares também têm um papel importante nos grandes espaços abertos.

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