Abstract for the EMPG 1999 Meeting in Mannheim

A Method for Approximating the Shape of Latent Fields of Single Visual Points for Predicting Geometric Optical Illusions.

Günter Lehmann

University of Wuppertal
Department of Psychology
Gaußstr. 20, 42097 Wuppertal, Germany
Lehmann@uni-wuppertal.de

The length illusions within geometric figures, e. g. the Müller-Lyer figure, can be predicted to a certain degree by the additive superposition of the illusions caused by interactions among pairs of lines. We therefore focussed our investigations on basic experiments, where the subject had to reproduce a line S out of two random lines (S, G). G had a constant length of 10 cm. The averaged length illusions of the reproductions of S of about 1300 stimuli (S, G) could be predicted with correlations of $.60 - .80$ by a two-parameter field model. It postulates an influence of G on S by a potential field around G resulting from the superposition of concentric fields emitted by the visual points on G. In the model the strength of the field in a point s on S emitted by a point g on G is defined by a two-parameter function $f = f(d(s, g))$ depending only on the distance $d(s, g)$. The theoretical length illusion $\theta(S, G)$ of S in the field of G then results from a double line integral of the function f over G and S:

$$\begin{aligned}\theta(S,G) &= \int_S \int_G f(d(s,g))dg\,ds \\ &= \int_{x_0}^{x_1}\int_{\xi_0}^{\xi_1} f\left(\sqrt{(x-\xi)^2 + (ax+b-\alpha\,\xi-\beta)^2}\right) \\ &\quad \cdot\sqrt{1+\alpha^2}\,\sqrt{1+a^2}\,d\xi\,dx\end{aligned}$$

with S: $ax + b$ and G: $\alpha\,\xi + \beta$. The two integrals postulate an infinitesimal additivity holding as well for the concentric fields of the points g on G as for the assumed local illusions in S. On the other side, by testing about 12 elementary two-parameter distance functions f, we found that for 4-5 different functions the model fitted the data almost equally well. Apparently, the data fulfilled the two additivity conditions to such a high degree, that the choice of the distance function f turned out to be of secondary importance. The problem was, how to determine the "true" distance function f from the data. The new result is, that we found a method which allows to estimate the shape of the latent function f from our experimental data. We approximate the two integrals of $\theta(S, G)$ by a weighted linear function $w = w(d(s, g))$ of the distances $d(s, g)$ of all pairs of points (s, g) within our stimuli (S, G). The weight function w obtained from the data approximates the shape of the latent function $f(d(s, g))$. The shape turned out to have the form of a damped oscillation. Moreover, we found very similar oscillatory functions f for three geometrically different subclasses of our stimuli. The oscillatory functions probably can be reduced to a neurological background. The next problem is to find a mathematical model predicting the obtained damped oscillaton.