Perceptual segregation and retinal position

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Abstract—This study is concerned with the dependence of perceptual segregation performance on the retinal position at which the performance is evaluated. Segregation performance consisted in detecting a target texture composed of line elements of constant length and orientation embedded in a background texture. The background texture was made up of the same line elements as the target texture but the background line elements were set at 90 deg to the target elements. Results showed that, at least for 40- and 50-ms presentation times, this task could be much more effectively completed outside the fovea centralis than within this area. These findings indicate that extrafoveal areas of the retina may make a significant and previously underestimated contribution to perceptual segregation.

INTRODUCTION

A well-investigated stimulus property that has a significant effect on the perceptual segregation of textures is the variation in orientation of the basic elements that constitute the texture (e.g., Beck, 1966, 1967, 1972, 1982; Olson and Attneave, 1970; Beck and Ambler, 1972, 1973; Ambler and Finklea, 1976; Caelli and Julesz, 1978; Caelli, 1980; Nothdurft, 1985a; Sagi and Julesz 1987). This effect is particularly clear if the basic elements are composed of simple lines, if the length of the lines and the extent of the orientation differences do not fall below a certain measure, and if the distance between the individual line elements is kept small (Nothdurft, 1985a, b).

The concept of 'perceptual segregation' ('segmentation') has been adopted (see also Grossberg and Mingolla, 1985) in order to characterize the phenomenal impression in which various areas, differing in the orientation of their basic elements, are perceived directly as separate fields.

This direct perception has led to the widespread assumption that perceptual segregation performance runs at high speed and, apparently, to a large extent 'automatically' or 'preattentively'. It is therefore proposed that such performance should be assigned to the 'early stages' of visual information processing.

Beck (1972) suggested that the size of the retinal eccentricity at which the required performance can be achieved is a possible indicator of the extent of the automatic processing with which a perceptual grouping task can be carried out: The further in the retinal periphery a difference between two textures can be recognized, the stronger the segregation impression that proceeds from the border between the two textures. This suggestion implicitly contains the assumption that the performance ability of those information processing structures through which the segregation is conveyed (such as visual acuity) always decreases as they approach the retinal periphery.

Meinecke (1987) has pointed out that such a continuous decrease in performance ability with increasing eccentricity does not necessarily hold true. In her experiments,
she was able to demonstrate that, although under certain conditions a required segregation performance initially showed the suggested decline with increasing eccentricity, performance improved again when eccentricity was further increased.

These findings suggest that the frequent assumption that the performance ability of information-processing structures continually decreases as the retinal periphery is approached (at least as far as perceptual segregation performance is concerned) requires revision.

The goal of the experiments presented below was to investigate further the relation between retinal position and segregation performance that can be achieved at that position, the textures requiring segregation being composed of easily describable and relatively well-investigated elementary structures.

**EXPERIMENT 1**

The aim of Experiment 1 was to test in what manner perceptual segregation performance depends on the particular retinal position at which it is evaluated. In order to do this, we produced a stimulus that was composed of oblique linear elements of constant length. Within this line matrix, a target texture could be embedded that was composed of linear elements showing an inclination difference of 90 deg to the context vectors. An example of such a stimulus configuration is given in Fig. 1.

![Figure 1. Typical stimulus pattern used in Experiment 1. The horizontal position of the target texture (presented with a probability of $P = 0.5$) was varied randomly.](image-url)