学位論文の要旨

Abstract of Thesis

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学位論文題目 Title of Thesis（学位論文題目が英語の場合は和訳を付記）

A Psychophysical Study on Detection and Recognition of Contour Shape across Visual Field

輪郭形状の検出と認識の視野依存性に関する心理物理学的研究

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In humans, up to 80% of the information received from the outside world is processed by the visual pathway. The visual cortex devoted to each degree of visual angle decreases in an approximately linear manner with retinal eccentricity, visual information in the peripheral visual field is processed differently from such information in the central visual field. Most visual performance shows a decline with eccentricity (eccentricity effect). However, degraded recognition for complex stimuli does not always follow predictions from cortical size-scaling and acuity measures. One strategy of the visual system is to exploit information about surface textures and object boundaries, or contours, as cues to image segmentation and shape recognition. Therefore, in this research, we used simple stimuli to investigate dependency of contour shape recognition on retinal eccentricity of visual field.

Firstly, to reveal the dependency of the fundamental elements of the contour shape on retinal eccentricity. A regular polygons discrimination task was used, and we changed the stimuli size, the line width and exposure duration of stimuli during the experiment. We found that the stimuli size and the line width showed a large dependency on retinal eccentricity of visual field. But the exposure duration of stimuli showed a small dependency on retinal eccentricity of visual field.

Secondly, to further clarify the contour shape recognition mechanism of the central and peripheral vision field. Radial frequency (RF) patterns, which have frequently been used to investigate aspects of shape processing, were used as target stimuli here. We examined the

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dependence of the pattern radius on deformation modulation amplitude to discriminate the RF patterns from a circle by a modulation amplitude discrimination task. The deformation threshold vs. radius functions for the constant circular contour frequency (CCF) RF patterns showed different functional forms dependent on the CCF (0.159, 0.239 and 0.358 cycles/cl-deg). The high CCF, 0.358 cycles/cl-deg, resulted in a monotonically increasing function, the middle CCF, 0.239 cycles/cl-deg, resulted in a gradually increasing function, and the low CCF, 0.159 cycles/cl-deg, resulted in a flattened function. The different functional forms could be ascribed to the different eccentricity effects of the processing units responsible for encoding the RF patterns. The deformation threshold vs. radius functions for the magnified RF patterns were all relatively flattened for all radial frequencies (4 ~ 18 cycles/360 deg) used, indicating that the eccentricity effects observed for the high and middle CCF RF patterns were neutralized by retinocortical mapping.

Thirdly, to further explore the processing mechanism of RF patterns. Using a radial frequency discrimination task that has not been tested in many previous studies, we examined the dependence of the pattern radius (4 to 16 deg) on discriminable radial frequency thresholds of two different frequency RF patterns. Our results suggest that the radial frequency discrimination is processed by a radial frequency-selective channels mechanism that is subject to the orientation of the RF patterns or a polar angle-selective channels mechanism that is subject to polar angles between two points of maximum curvature of the RF patterns.

Lastly, to investigate another important factor affect the processing mechanism of contour shape. We measured the contrast discrimination threshold of circular contour patterns on retinal eccentricity of the visual field. The contrast discrimination thresholds for the standard stimuli increased with increasing the retinal eccentricity. However, those for the cortically magnified stimuli remained constant irrespective of change of retinal eccentricity.

According to the current situation, future studies will focus on improving experiment method (e.g. event-related potential (ERP) or functional magnetic resonance imaging (fMRI)) to uncover the cerebral cortex mechanism of RF patterns processing and to provide further important basis for our behavioral experiment here.