別紙４－１（課程博士（英文））

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Abstract (Doctor)

Title of Thesis	Anisotropy of subjective brightness revealed by pupillary response.

Approx. 800 words

Anisotropy in the visual field (VF) has been investigated in terms of spatial resolution of attention, spatial frequency, and semantic processing. Brightness perception differences are also reported between the VFs. The brightness perception is evoked by the mismatch between the physical luminance and the subjective perceptual of the stimuli. Brightness perception can be influenced by low- (objects' surface reflectance) and high-order cognition (human memory system). Furthermore, indexing the subjective brightness perception by measuring pupil diameter (pupillometry) has been successfully demonstrated and showed its correlation to cognitive factors (e.g., memory and visual experience). For example, to test the effect of high-order cognition on subjective brightness perception using pupillometry, colored glare illusion was presented in the previous study, and it is proven that the ecological factors influenced subjective brightness perception. The glare illusion is a robust optical illusion to enhance the perceived brightness of a central white area surrounded by a luminance gradient. Many studies to understand cognitive load (low- and high-order cognition) influence on subjective brightness perception instructed the participants to fixate their gaze on a reference object and keep their heads stable, and used the presented stimuli's content. However, the anisotropy of subjective brightness perception in the peripheral VFs and world-centered coordinates by performing pupillometry and presenting the glare illusion remains have not been investigated.

Motivated by these challenges, this thesis aims to investigate the anisotropy of subjective brightness perception in the peripheral VFs and world-centered coordinates by manipulating the retinal and world-centered coordinates using pupillometry that reflects subjective brightness perception.

Before doing the main studies in this thesis, a preliminary study was conducted to contribute to additional evidence that perception is more predominant than the physical luminance of image stimuli by investigating the pupillary response to the ambiguous images of the sun and moon and instructing the participants to fixate their eyes and keep their heads stable during the stimuli presentation. The result of the preliminary study showed constricted pupils in response to the image perceived as the sun image despite the fact that the average physical luminance of sun images was lower than moon images. Thereafter, two primary experiments in this thesis were conducted.

First, by manipulating the retinal coordinates, the pupillary response to the glare illusion and halo stimuli in peripheral (upper, lower, left, and right) VFs were measured. The upper visual field (UVF) generated the highest degree of stimulus-evoked pupil dilation due to the disadvantages of UVF (spatial resolution of attention, visual accuracy, and contrast sensitivity – low-order cognition), and the highest degree of reduced pupil dilation in response to the glare illusion compare with other VFs might be influenced by the cognitive bias formed by statistical regularity in the processing of natural scenes in the UVF (higher-order cognition). These results confirm that low- and higher-order cognition evoked VFs anisotropy on subjective brightness perception.

Second, to investigate the anisotropy of subjective brightness perception in the world-centered coordinates, a further experiment was conducted by manipulating the world-centered coordinates, the pupillary responses to the glare and halo stimuli in a virtual reality (VR) environment (top, bottom, left, right, and center positions) were measured with (*active scene* experiment) and without head movement (*passive scene* experiment). The bottom location obtained the highest degree of pupil constriction caused by the bottom location linked to the peripersonal region by Previc (1998). In addition, the stimuli at the top location were perceived as darker than the bottom, which may be formed by statistical regularity in the processing of natural scenes (e.g., the influence of the bright sky). These results indicate that the extraretinal information influenced subjective brightness perception in the world-centered coordinates and

demonstrate the independence of pupillary response from head movement.

This thesis is part of a growing body on the anisotropy of subjective brightness perception in VFs and world-centered coordinates may be affected by the high-order cognition derived from the cognitive bias formed by statistical regularity in the processing of natural scenes (e.g., the sun's existence) in using glare illusion and pupillometry method. Besides, the results of this thesis would be contributions to informing architectural, light, and application design of a glare source (such as improving nighttime driving behavior) and to the ophthalmology field owing to the findings of the independence of head movement in pupillary response to the stimuli.