別紙４－１（課程博士（英文））

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Abstract（Doctor）

Title of Thesis	The Covert Visual System: Unconscious Vision is Influenced by Both Bottom-up Sensory Input and Top-down Categorical Priors

Approx. 800 words

The human brain can perform sophisticated analyses of sensory information even when that information never reaches subjective awareness, undermining the longstanding notion that complex cognition invariably demands consciousness. In this dissertation, we attempt to clarify the principles that govern high-level visual processing beneath the threshold of awareness by asking how unconscious vision is shaped simultaneously by culturally acquired expertise and by inherent sensitivities to biologically significant categories. To investigate these mechanisms, continuous flash suppression (CFS), a psychophysical paradigm in which dynamically changing masks are presented to the dominant eye, rendering a stimulus shown to the non-dominant eye invisible for several seconds. Because CFS preserves early retinal input while silencing conscious perception, it cleanly dissociates conscious from unconscious processing. The time required for a stimulus to "break through" suppression—its breaking time (BT)—therefore serves as a sensitive index of pre-conscious priority: shorter BTs denote more efficient unconscious processing. Two empirical studies anchor this work, each targeting a domain supported by specialized neural circuitry.

The first study examines how orthographic expertise shapes unconscious processing of written language. In two experiments, native Japanese adults viewed letters from familiar scripts—Katakana and Hiragana—and from unfamiliar or archaic scripts—Korean Hangul and historical Itaigana. All characters were presented both upright and inverted by 180 degrees, and low-level visual properties, such as stroke count, overall size, and pixel density, were carefully matched to eliminate trivial confounds. In the first experiment, angular letters (Katakana and Hangul) were suppressed for equally long durations, likely due to strong feature-based masking from the angular Mondrian patterns. In contrast, the second experiment revealed that curvilinear, highly familiar Hiragana characters broke suppression significantly faster than similarly curvilinear but unfamiliar Itaigana, demonstrating that years of reading experience confer a pre-conscious advantage on orthographically familiar, correctly oriented forms. A pronounced inversion effect, driven chiefly by inverted Itaigana, suggested that holistic representations typically applied to handwritten-like characters collapse when canonical orientation cues are disrupted.

The second study explores an innately salient domain—faces—to determine how categorical perception guides unconscious vision. Participants viewed standard grayscale faces and structurally minimal two-tone, or binary, faces under CFS. The classic face-inversion effect—faster BTs for upright than inverted grayscale faces—was robustly replicated, yet it disappeared for binary faces, suggesting that the sparse pictorial information in these images is insufficient to sustain orientation-dependent holistic processing. Crucially, however, an item-level analysis revealed a strong linear relationship between subjective face-likeness ratings and BTs for the binary stimuli: the more a configuration was perceived as a face, the faster it emerged from suppression, even when pixel count was held constant. These findings suggest that the visual system can utilize minimal configurational cues to prioritize face-like patterns, operating based on perceived category membership entirely outside of conscious awareness.

Taken together, these investigations establish that unconscious visual selection is not a purely bottom-up process; instead, it is sharpened by both culturally acquired expertise and an evolved bias toward biologically important categories. Both orthographic familiarity and perceived face-likeness operate pre-consciously, tilting the competition for awareness long before conscious identification begins. Building on this evidence, we articulate a principle of domain-specific unconscious processing. The selective gating of information into awareness is governed not only by raw stimulus salience but also by content-specific priors. Facilitation for familiar letters accords with the early engagement of left-hemispheric pathways specialized for reading, notably the Visual Word Form Area (VWFA). In contrast, the prioritization of highly face-like stimuli reflects the recruitment of right-hemispheric networks dedicated to faces, such as the Fusiform Face Area (FFA). Thus, unconscious vision inherits and profitably exploits the functional specialization that characterizes the conscious perception of humans.

These results further illuminate major theories of consciousness. They lend support to Global Workspace Theory, which proposes that top-down biases related to expertise and significance modulate a stimulus's adequate strength in the race to enter the global workspace. In addition, the findings align with Predictive Coding accounts, which suggest that the brain continuously generates hierarchical predictions to explain sensory input. From this perspective, familiar letters and face-like patterns carry higher-precision priors that reduce prediction error and enable more efficient perceptual inference, even under the challenging conditions of interocular suppression.

In conclusion, the research presented here provides compelling evidence that the covert visual system is an active, structured, and intelligent component of human cognition, demonstrating that what ultimately reaches conscious perception is the outcome of a sophisticated, competitive selection process that begins outside awareness. Accordingly, this work provides insights into our understanding of how cultural expertise and evolutionary pressures cooperate to shape perceptual awareness. Critically, this selection mechanism ensures that our limited conscious resources are preferentially allocated to information that is most meaningful both to the individual and to the species.