Biased Competition Theory

Introduction

The human visual system is an incredibly complex and highly integrated system, responsible for processing vast amounts of visual information that we encounter in our daily lives. The visual system is organized in such a way that the processing of visual information is highly selective, with only a small fraction of the incoming visual stimuli being processed by the brain. Biased competition theory is an influential theoretical framework that explains the selectivity of the visual system by positing that neurons in the visual cortex engage in competitive interactions, with the winner-takes-all. This paper will review the biased competition theory and its implications for visual processing in different parts of the visual field.

Biased Competition Theory

The biased competition theory was first proposed by Desimone and Duncan in 1995, as a way of explaining the mechanisms underlying selective attention in the visual system. According to the theory, neural activity in the visual cortex is highly competitive, with different neurons competing for access to limited resources. The competition is biased towards neurons that are more strongly activated, either by virtue of their receptive field properties or by the influence of top-down attentional mechanisms.

The theory suggests that competition between neurons in the visual cortex is mediated by inhibitory connections, which allow the most strongly activated neurons to suppress the activity of their competitors. The result of this competition is that only a subset of the incoming visual stimuli are processed by the brain, with the remainder being ignored.

Visual Fields

The visual field is the area of the world that can be seen by the eyes when they are fixated on a point. The visual field is divided into two parts: the central visual field and the peripheral visual field. The central visual field is the area directly in front of the eyes, while the peripheral visual field is the area to the sides.

Research has shown that the biased competition theory applies to both the central and peripheral visual fields. In the central visual field, competition between neurons is biased towards stimuli that are located at the fovea, the area of the retina responsible for high-acuity vision. This bias is thought to reflect the fact that the fovea contains a higher density of cones than the rest of the retina, allowing for more detailed visual processing.

In the peripheral visual field, the competition is biased towards stimuli that are more salient or attention-grabbing, such as bright colors or high-contrast edges. This bias reflects the fact that visual processing in the periphery is less detailed than in the fovea, and the brain relies more heavily on saliency signals to guide attention.

Implications for Visual Processing

The biased competition theory has important implications for visual processing in the human brain. By selectively processing only a subset of the incoming visual stimuli, the brain is able to efficiently allocate its limited processing resources to the most behaviorally relevant stimuli. This allows us to navigate complex visual environments and respond to changing stimuli in a timely and adaptive manner.

The theory also has important implications for understanding the mechanisms underlying visual disorders, such as visual neglect, where patients fail to attend to stimuli in one-half of the visual field. It is thought that visual neglect may result from an imbalance in the competitive interactions between neurons in the two hemispheres of the brain, leading to a bias towards stimuli in one visual field over the other.

Conclusion

The biased competition theory is a powerful theoretical framework that helps to explain the mechanisms underlying selective attention in the visual system. By highlighting the competitive interactions between neurons in the visual cortex, the theory provides important insights into how the brain selectively processes visual information in different parts of the visual field. Further research is needed to fully elucidate the neural mechanisms underlying biased competition and to develop new treatments for visual disorders that result from imbalances in competitive interactions.