

## **An Ecological Basis for the Oblique Effect**

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Psychophysical observers are better at a range of discrimination and detection tasks when stimuli are oriented horizontally and vertically rather than at oblique angles. This is known as the Oblique Effect. As there is a higher prevalence of horizontal and vertical energy in natural scenes, it seems natural to ask whether the effect flows from the visual system's attempt to efficiently represent its input. One approach is to find out if models of vision that efficiently incorporate the statistics in natural images also exhibit the oblique effect. Here I show that the Olshausen and Field model of simple cells which attempts to extract the sparse, independent, linear components of natural images produces (1) more units tuned to cardinal than oblique angles, (2) narrower orientation tuning for units tuned to cardinal axes, and (3) greater overall activity in response to cardinal inputs than oblique. The narrower orientation tuning is specifically due to non-linear interactions between competing output units. All of these attributes have either been observed in primate brains or have been postulated as possible causes for the psychophysically observed oblique effect. In the first two cases listed above, the oblique versus cardinal differences for the model are greater (by about 30%) than those observed in neural studies. When images of a modern, carpentered environment are used in place of natural images, the differences become larger still. In other words, efficient representation of naturally encountered images under the Olshausen framework predicts an exaggerated oblique effect. This indicates that efficiency is likely to be an important contributor to the oblique effect but that other factors also play a role, effectively moderating the exaggerated effect produced by efficient coding considerations on their own.