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Ambiguous stimuli

Ambiguous stimuli can be perceived in more than one way. The stairs at right, for example, can be seen as viewed from above or below. The interpretation typically changes from one percept to the other every few seconds. We have used this phenomenon to study what happens to the suppressed percept. Human subjects viewed an ambiguous stimulus and test stimuli were delivered during the suppression state. Sensitivity was found to be reduced during suppression. Moreover, sensitivity loss increased with the sophistication of test judgments (Figure 2). This finding indicates that suppression of the visual stimulus increases as signals progress through the series of processing stages in visual cortex.

Figure 1. Examples of ambiguous stimuli

Figure 2. Increasing suppression depth with increasing task complexity (Nguyen, Freeman & Alais, 2003)
Modelling the visual system

Another major component of the laboratory's work is modeling of signal processing in the visual system. Our aim is to describe simple physical systems that mimic, and therefore help to explain, aspects of visual behavior. Figure 3 shows a model for binocular rivalry, the alternating percept that occurs when the two eyes are presented with incompatible stimuli. The model has a pathway leading from each eye to primary visual cortex. There, mutual inhibition between the two inputs leads to periods in which neural activity alternates between two states. Further, the response to a monocular stimulus becomes progressively more suppressed as the signal moves from one cortical stage to the next, mimicking empirical observations (Figure 4).
Rapid serial visual presentation (RSVP)

The third component of our research program concerns the effect on object visibility of other objects that are nearby in space or time. Our approach is to present a rapid stream of objects, such as a series of randomly oriented gratings, and to ask a human subject to respond when a specific object is seen. Going backwards in time from the response reveals not only the object that produced the response but also other objects that have either a facilitatory or suppressive effect on the response. This analysis shows, for example, that two gratings with similar orientation mutually improve their visibility, but a grating orthogonal to the target reduces the target’s visibility (Figure 7). It seems, therefore, that this reverse correlation technique may reveal a number of important ways in which the responses to differing objects can interact.

Figure 5. Both eyes were presented with a series of randomly oriented gratings at a rate of 30 per second (Roeber, Wong & Freeman, 2008)

Figure 6. The probability that an orientation occurred at a specific time prior to a key-press

Figure 7. A model for cross-orientation interaction