Discovery of a New Visual Mechanism —Using Motion to Perceive Shape

NTT has found that the human brain can perceive the shape of a moving object using motion information. This discovery, which was made during experiments involving visual illusions, runs counter to the current consensus in neuroscience that shape and motion are processed separately in the brain. The knowledge gained by this discovery is expected to be useful in guidelines for developing image-display technologies.

Separate processing of the shape and motion of an object by independent and specialized neural mechanisms in the human brain has been an established theory in neuroscience. Our discovery overturns that theory and indicates that shape and motion processing are tightly intertwined right from the initial stage of visual information processing. The discovery also means that moving an image makes that image even easier to see—a fact that should be useful in preparing guidelines for the design of future image-display technologies.

The experiments that gave birth to this discovery analyzed the human visual mechanisms involved with "multi-slit viewing" [1] and clarified the important role of motion information in the perception of shape. Multi-slit viewing is an image-display system that presents patterns such as alphanumeric characters through an array of narrow slits. Pattern shape cannot be recognized unless the pattern is scrolled behind the stationary slits. The traditional interpretation of multi-slit viewing is that the observer's eyes track the pattern's motion causing the original pattern to be drawn on the retina. To evaluate the validity of this interpretation, we performed all experiments under conditions that prevented observers from tracking pattern motion and found that shape perception improved with pattern motion even under this restriction, thereby refuting that interpretation. Since it is commonly believed that motion information and shape information are unrelated, the results of these experiments clearly set the stage for debate on whether motion information is used in pattern reconstruction. An important feature of the neural mechanism that processes motion is "direction selectivity" in which response differs according to the direction of image motion. In our research, we demonstrated experimentally that shape perception in multi-slit viewing possesses direction selectivity based on the direction selectivity of blocking effects due to noise patterns (masking) (**Fig. 1**) and on direction selectivity associated with the quality of the perceived pattern.

In future research, we plan to investigate the effects of motion on the perception of other visual attributes such as color in addition to shape. By understanding human cognitive functions, NTT aims to uncover basic principles behind new information-display and compression technologies and to contribute to the realization of an enriching information-sharing society.

Reference

[1] S. Nishida, "Human Visual Mechanism," NTT Technical Review, Vol. 1, No. 2, pp. 13-17, 2003.

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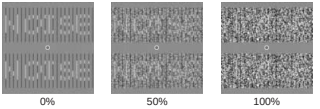

Three noise intensity conditions are shown. Letter recognition is more difficult when the noise moves in the same direction as the letters than when it moves in the opposite direction. Demonstration movies are available as "Demo 2" at http://www.brl.ntt.co.jp/people/nishida/demo/multislitview/index.html

Fig. 1. Direction-selective masking by noise.