The Steerable Spiral

Peter B. Meilstrup and Michael N. Shadlen
University of Washington, Seattle

As you fixate the central dot during the first part of this demonstration, you see a number of blobs that spiral counterclockwise and inwards towards the center. In the second part of the demonstration, more blobs appear, forming circles that spiral inwards, but now clockwise. In the third part, the field fills with blobs, and the overall motion is seen to be still clockwise, but now outward. Last, we remove some of the blobs, and motion is seen, still outward, along spokes that now move counterclockwise. During the demonstration you may shift your gaze to track the path of any of the individual blobs, and confirm that they travel inward and counterclockwise at all times. The moving blobs used in each condition are identical, but by merely adding and removing copies of the same repeated element we can steer the perceived motion in four different directions.

We believe this illusion exposes the brain's mechanism for integrating local visual cues into global percepts. It exploits an interaction between self-cuing (Verghese and McKee 2002) and crowding (Pelli 2008). Each of the blobs contains a grating that drifts outward and counterclockwise, opposite the path the blob travels. When a blob is viewed in isolation, this local cue is easily overridden by the blob's global movement. But when other blobs are present nearby, even though they do not overlap, the low level cue comes to dominate the percept.

Why does this happen? In tracking a moving object, the visual system seeks to associate the visual features that were present a short while ago with visual features that are currently present, now in somewhat different positions. Local motion signals provide the cues that the visual system uses to help establish these correspondences. If an object appears carrying a local motion signal outward and clockwise, this predicts that the object might soon be found displaced outward and clockwise of its present position. The visual system anticipates the appearance of the displaced object, which has been termed "self-cuing" (Verghese and McKee 2002; Verghese 2009). If the object appears by itself, opposite the predicted displacement, the prediction is disconfirmed. But a distractor object appearing in the expected direction can furnish support for the initial prediction, placing the original target and distractor into a false correspondence. Such false correspondences explain the misperception of the motion of the blobs in our illusion.

Interestingly, false correspondences are made when the distractor is farther away than the object's true extension. We measured the distance at which the false correspondence took over from the true one. It did not depend strongly on the physical properties of the object, but depended on the object's position in the visual field, similarly to the way that "crowding" interferes with the recognition of shapes. (Bouma 1970; Toet and Levi 1992) A log-polar transformation from spatial coordinates to locations in visual cortex reveals that the critical distances are equally sized patches of cortex throughout the visual field. This suggests that the process of finding correspondences between features might operate on "neighborhoods" of constant size in cortex.

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