Where has all the motion gone?

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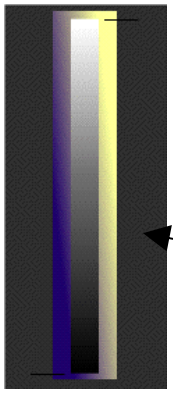
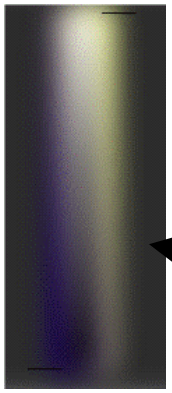
We have placed an html file that contains a series of interactive movie demonstrations at the website www.shapirolab.net/IC2007/ShapiroKnight. The central point of the demonstrations can be summarized in the following two figures, in which a vertically shaded achromatic bar is surrounded by a horizontally shaded yellow-blue bar. The field behind both bars modulates in time from light to dark.



Field modulates from light to dark at 1 Hz

When the image is not blurred, the configuration produces no motion percept. This is true even though an X,t plot showing the response of a spatially low-pass filter indicates a considerable amount of motion energy in the display.



Field modulates from light to dark at 1 Hz

When the image is blurred, the perception of motion is dramatic. One can easily verify that the effect is due to the blur and not to a digital artifact by looking at the unblurred image through a defocused lens.

Why is this illusion interesting? Blur does not add information to an image; it simply eliminates the high spatial frequencies. This means that the motion seen in the blurred movie is physically present in the non-blurred movie. The addition of the high spatial-frequency information in the non-blurred movie inhibits the motion percept—hence the question in the title: "Where did all the motion go?"

Why does motion disappear when high spatial frequencies are present? We offer two hypotheses:

1. Edges capture and define the range over which motion can occur. Put another way, motion signals produced by low spatial-frequency channels are actively inhibited by responses to high spatial-frequency information.

2. Some visual processes actively discard unnecessary low spatial-frequency information. This hypothesis could be phrased as an efficiency argument: once an area or visual patch is defined as an "object," spatial frequencies lower than the area of the object are relatively uninformative about the object. An efficient system would attenuate responses to this information.

Additional buttons and demonstrations on the html page show corollary illusions that argue (albeit inconclusively) for hypothesis #1. First, the addition of thin lines to the blurry condition above decreases the strength of the motion. Second, the direction of motion in the barbell illusion (Shapiro et al, 2005) can be changed either by thin internal edges or by blurring the display.