Integration across directions in dynamic random dot displays: vector summation or winner take all?

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Zohary, E, Scase MO, Braddick OJ. 1996.

Abstract:

Recent studies have clearly demonstrated that the activity of directionally selective neuronal populations in the middle temporal (MT) and medial superior temporal (MST) cortical areas plays a direct role in the judgment of the direction of visual motion. However, the way in which the information is derived from a population of neurons remains unknown. Two principal models have been suggested in the past: the vector summation model suggests that the responses of neurons encoding all directions of motion are weighted and pooled to obtained an accurate estimate of the mean direction of motion; the winner-take-all model is based on a competition between different direction-specific channels, so that decisions are cast in favor of the channel generating the strongest directional signal. To discriminate between these two models we generated random dot stimuli that contained an asymmetric distribution of directions of motion. Human subjects were asked to adjust the global direction of motion to the upward vertical direction. When the directional signals were of similar strength, subjects tended to perceive global motion in the mean direction of motion (corresponding to vector summation), but as one directional signal became more prominent, most subjects' settings diverged from the mean towards the modal direction of motion. Some subjects could either match the mean or the modal direction of motion in the display, depending on the task instructions. These results suggest that the perceptual judgment of direction of motion is not based on any rigid algorithm generating a single valued output. Rather, human observers are able to judge different aspects of the distribution of activity in a cortical area depending on the task requirements.

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