COMPARING MODELS OF SYMMETRY PERCEPTION

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Abstract

It has been suggested that the perception of visual regularities plays a fundamental role in structuring the visual world. One form of regularity that has attracted a great deal of research in the visual perception literature is mirror symmetry. In human vision symmetry appears to play an important role in the low-level processing of visual scenes, object recognition, and shape representation. Although a large number of empirical studies have investigated symmetry perception it is as yet unclear how the human visual system manages to perform this process as quickly and efficiently as it does. One way that researchers have attempted to understand the processes underlying symmetry perception is through the use of formal models, or computer simulations. Models can be thought of as theories or explanations for a given psychological phenomena and are potentially useful because they force researchers to be highly specific about the types of processes underlying the phenomena of interest.

In the field of computational geometry one of the most powerful tools for describing spatial relations is Voronoi tessellation. Psychophysical and physiological evidence is reviewed suggesting that the visual system may be employing a process similar to Voronoi tessellation to extract the spatial relations necessary for the organisation of visual stimuli. Against this background a Voronoi tessellation based model of symmetry perception is outlined. The Voronoi model was developed in response to three key findings from the human symmetry perception literature: that symmetry perception is a graded response; that the perception of symmetry is more salient at, or close to, the axis of symmetry; and that the processes underlying symmetry perception can be generalised to other similar structure and regularity detection tasks.

A major weakness of previous papers outlining models of symmetry perception has been the lack of comparison between model output and empirical data sets. Furthermore, little effort has been made to compare the performance of different models and, where this has occurred, the comparisons have been qualitative rather than quantitative. This study addresses these weaknesses by employing Bayesian model selection to compare the performance of a number of models across a range of previously published and new empirical data sets.

The results of the model comparisons indicate that the Voronoi model is able to match and, for the most part, beat the performance of the rival models of symmetry perception. However, there are a number of problems with the Voronoi model that suggest that it provides an insufficient explanation for the processes underlying symmetry perception. The comparisons also provide useful insight into how the Voronoi model and the alternative models might be modified to address their specific weaknesses and suggest the need for a number of new empirical studies.

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