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Dot Density Effects on Stereoscopic Transparency: A Cross-Correlation Model Analysis.

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SUMMARY

- We confirmed that the cross-correlation model explains the depth reduction phenomenon well, except when binocular disparity is large.
- Dot density was found to have no effect on cross-correlation, as in psychophysical studies..

INTRODUCTION

In early vision, various depth cues are used to estimate the three-dimensional structure of the external world. Among these, binocular disparity is one of the most powerful depth cues. As physiologically valid models of binocular stereopsis, cross-correlation models has been analyzed and disparity detection algorithms based on these models have been studied intensively.

Stereo transparency is RDS with multi-ple binocular disparities, and when fused, multiple overlapping planes are perceived in the same depth direction. The problem of stereo transparency is expected to have implications for the problem of information representation in the brain. The depth reduction phenomenon is that the amount of perceived depth decreases as the number of surfaces comprising a Parallel Overlapping Transparent Stereoscopic Surface (POTS) stimulus increases.

APPROACH

In this research, we conducted simulation experiments on binocular disparity of ste-reoscopic stimuli using a cross-correlation model. The purpose of the experiment was to confirm whether the cross-correlation model can explain phenomenon of depth reduction in which the stimulus with a larger number of faces is perceived as having less depth when the stereoscopic stimuli have the same binocular disparity and to investigate the effect of dot density.

METHODS

Surface number: 2-POTS, 3-POTS.
Disparity: 12, 16, and 20 pixels.
Density: more low, low, high, more high.

Before computing the cross-correlation of the computer-generated left and right half-field images (random dot pattern), the images were low-pass filtered. The filtered left and right eye images were sent to the binocular cross-correlation function. The sub-pixel estimates (peak binocular disparity) were obtained using parabola fitting.

Using the above procedures, simulation experiments with the cross-correlation model were performed for each binocular disparity, surface stimulus, and density condition for 10 trials.

RESULTS

Table 1 summarizes whether the depth reduction phenomenon was confirmed by the cross-correlation model; conditions in which 3-POTS was reduced relative to 2-POTS were marked with a “〇" and conditions in which it was not reduced were marked with an “×".

Table 1. Summary of the results of Experiment.

	More low density	Low density	High density	More high density
Small disparity	〇	〇	〇	〇
Medium disparity	〇	〇	〇	〇
Large disparity	×	×	×	×

ANALYSIS

After running simulations for all conditions, the mean and 95% confidence interval (95% CI) were determined for each condition.

First, a three-way repeated measures ANOVA (2 POTS × 4 density × 3 binocular disparity) was conducted on the mean simulated disparity.

Next, we analyzed the 95% CI of the mean simulated disparity for each condition as an indicator of the depth reduction phenomenon, and if the respective 95% CI for 2POTS and 3POTS did not overlap, we considered that the depth reduction phenom-enon was occurring between 2-POTS and 3-POTS.

DISCUSSION

The results showed that the cross-correlation model was able to detect the number of faces of 2-POTS and 3-POTS in all conditions. It was found that the depth reduction phenomenon could be explained by the cross-correlation model, except for the condition with large binocular disparity.

The depth reduction phenomenon was confirmed regardless of dot density. The simulation results showed that binocular disparity was simulated without being affected by dot density. This suggests that the cross-correlation model can well explain the perceived binocular disparity of stereoscopic transparency stimuli.

CONCLUSIONS

1. The simulation was able to detect the number of surfaces.
2. The cross-correlation model effectively accounts for the depth reduction phenomenon except when large binocular disparities are involved.
3. Dot density was not a significant factor in affecting the simulation results.

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