The Perceived Trajectory of Objects Crossing the Perceptual Horizon in a 3-D Scene

Kerem Ozkan Myron L. Braunstein

University of California, Irvine

Background

We reported previously (VSS, 2007) that the perceived layout of objects and the relation between the judged size and judged distance of objects in a 3-D scene depends on the position of the objects relative to the perceptual horizon. With the horizon not explicitly present in the display, the height at which the sign of the relative size effect reverses was used to estimate the location of the perceptual horizon.

Our studies (VSS, 2006, 2007) showed that the location of the perceptual horizon was determined by a weighted combination of the implied vanishing point and the termination of the visible surface texture. Also, we showed that the height of the perceptual horizon is inversely proportional to the height of the texture when the vanishing point is not explicit in the scene. We showed that lower texture heights puts a weaker constraint on the height of the perceptual horizon, allowing it to be closer to the implied vanishing point. Conversely, when the visible boundary of the surface extends higher in the visual field and there is an increased amount of information on the background surface, the visual system may locate the horizon close to the visible boundary of the surface and not rely on extrapolating converging lines.

In the current study, we examined the relation between the location of the perceptual horizon and motion trajectories of objects shown against scene backgrounds.

Research Questions

How does the location of the perceptual horizon affect the perception of an object's motion trajectory?

Experiment 1: Perceived Change in the Perception of Motion Trajectories

Method

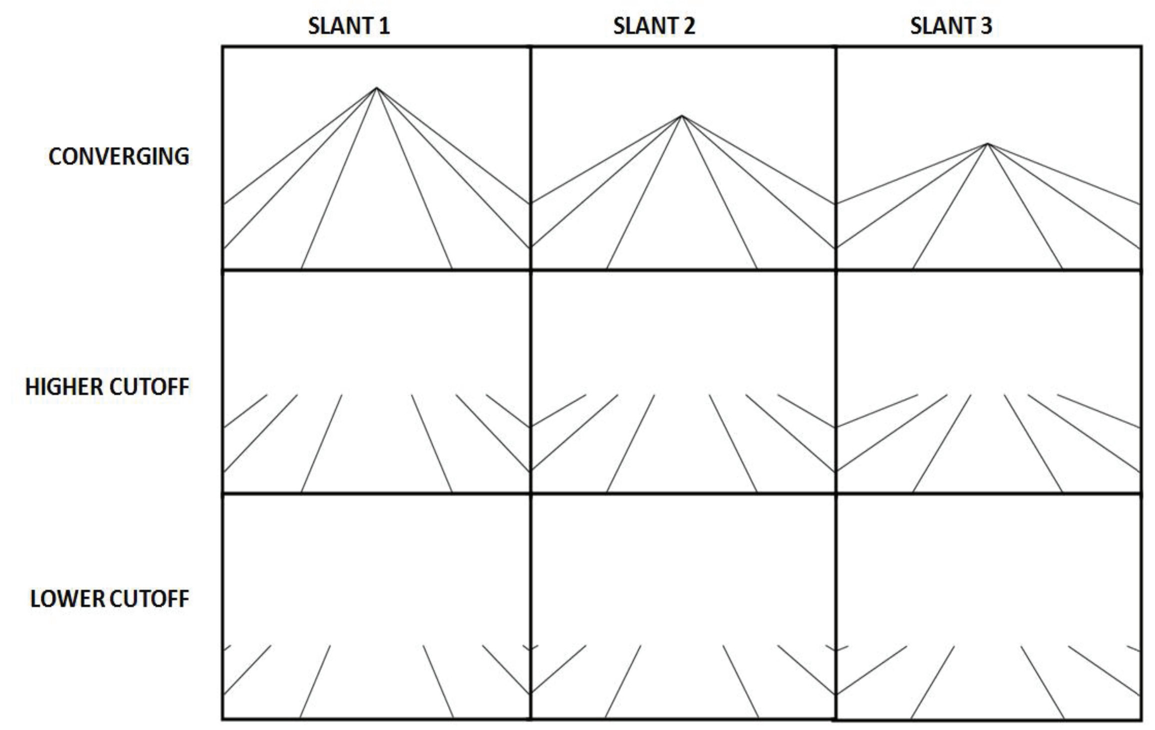
The observers were 5 undergraduate students at the University of California, Irvine.

Observers viewed scenes in which an elliptical object moved against a linear perspective background. Objects moved with a constant projected speed to a constant height along one of three linear motion paths.

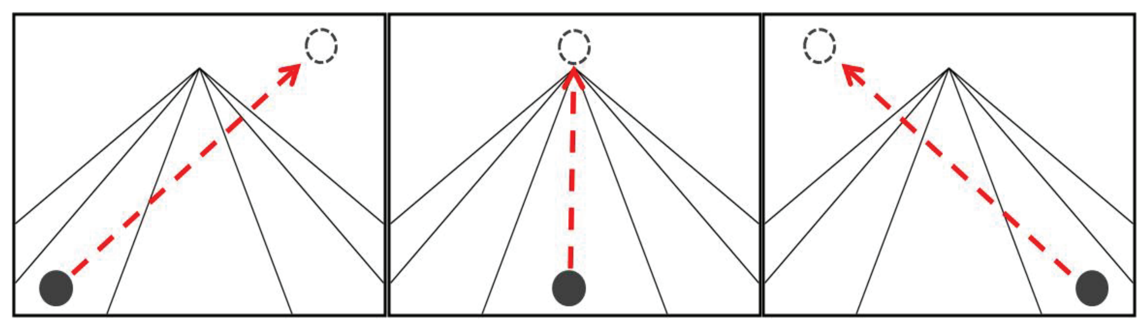
Observers were asked to judge whether the object had changed its motion path in 3D or traveled along a straight path.

Factors

1. Slant of the ground surfaces (3 slants)
2. The height at which the ground surface terminated (3 levels)



3. Motion path of objects (diagonal from lower left to upper right, diagonal from lower right to upper left or vertical from bottom to top)

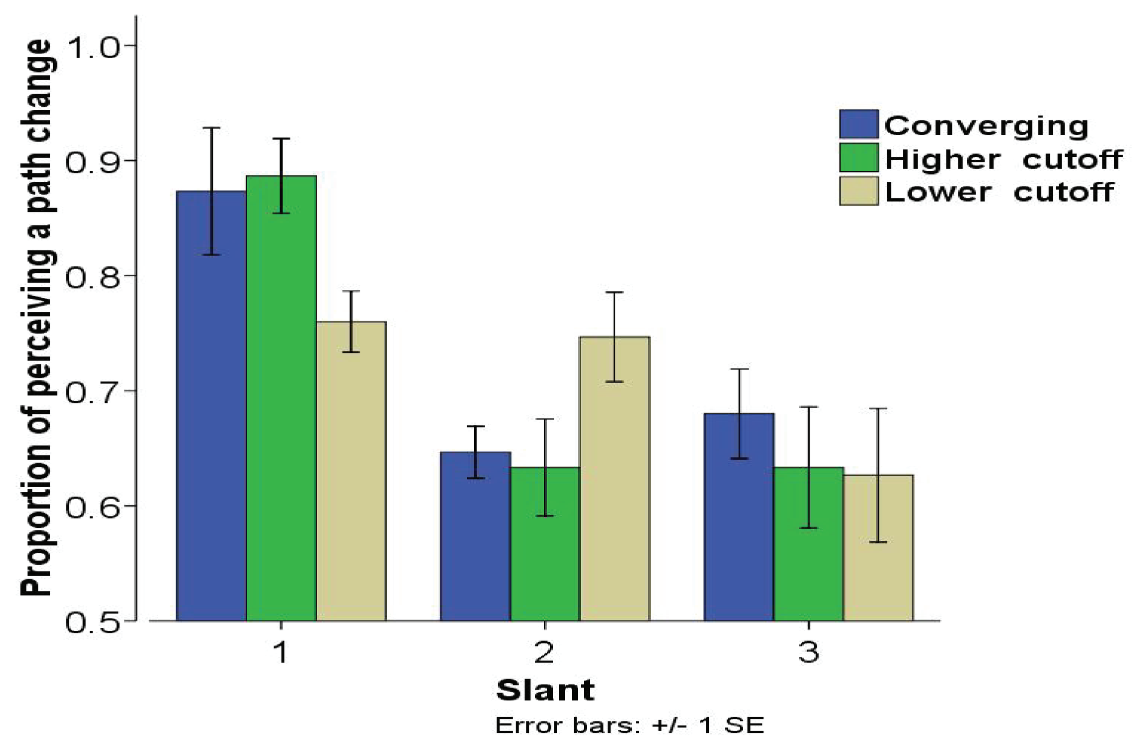


Results

ANOVA results using an arcsin square root transformation of the observers' judgments of perceiving path change revealed a significant main effect of the level of the implied vanishing point (surface slant), $F(4, 36) = 3.89$, $p<0.05$.

The height of the visible surface texture and the motion path of the objects did not have a significant main effect on observers' judgments.

ANOVA results also showed a significant interaction between the height of the texture boundary and the level of the implied vanishing point (surface slant) in determining observers' perception of the motion trajectories.



Experiment 1 Conclusions

The perceived trajectories of objects on a scene background depend the location of the perceptual horizon, which is determined by the implied vanishing point and by the height at which the ground surface terminates.

Experiment 2: The Location of the Perceived Change in Motion Trajectories

Method

The observers were 9 undergraduate students at the University of California, Irvine.

Observers viewed a computer-generated 3-D ball moving against background surfaces composed of line drawing scenes.

Background surfaces were the same as in the first experiment and the location of the perceptual horizon was varied by changing the height of the implied vanishing point and the height of the texture boundary. In each trial, the ball moved with a constant projected speed to a constant height along one of three linear motion paths.

To obtain quantitative measures of the perceived location of path change, a horizontal bar was placed in each scene that could be moved up and down by the observer.

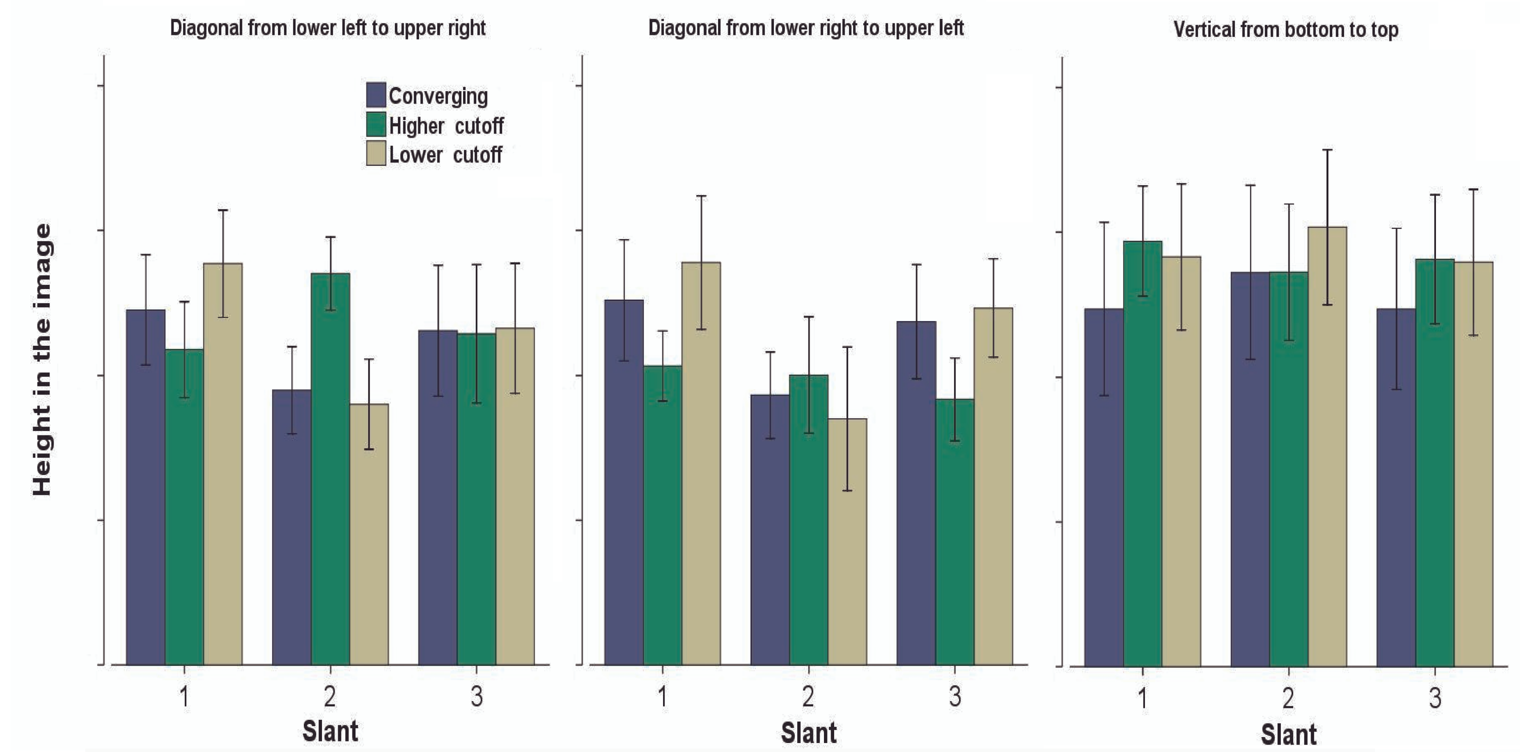
Observers adjusted the bar to indicate the height at which they perceived a path change. If observers failed to see any path change, they indicated that instead.

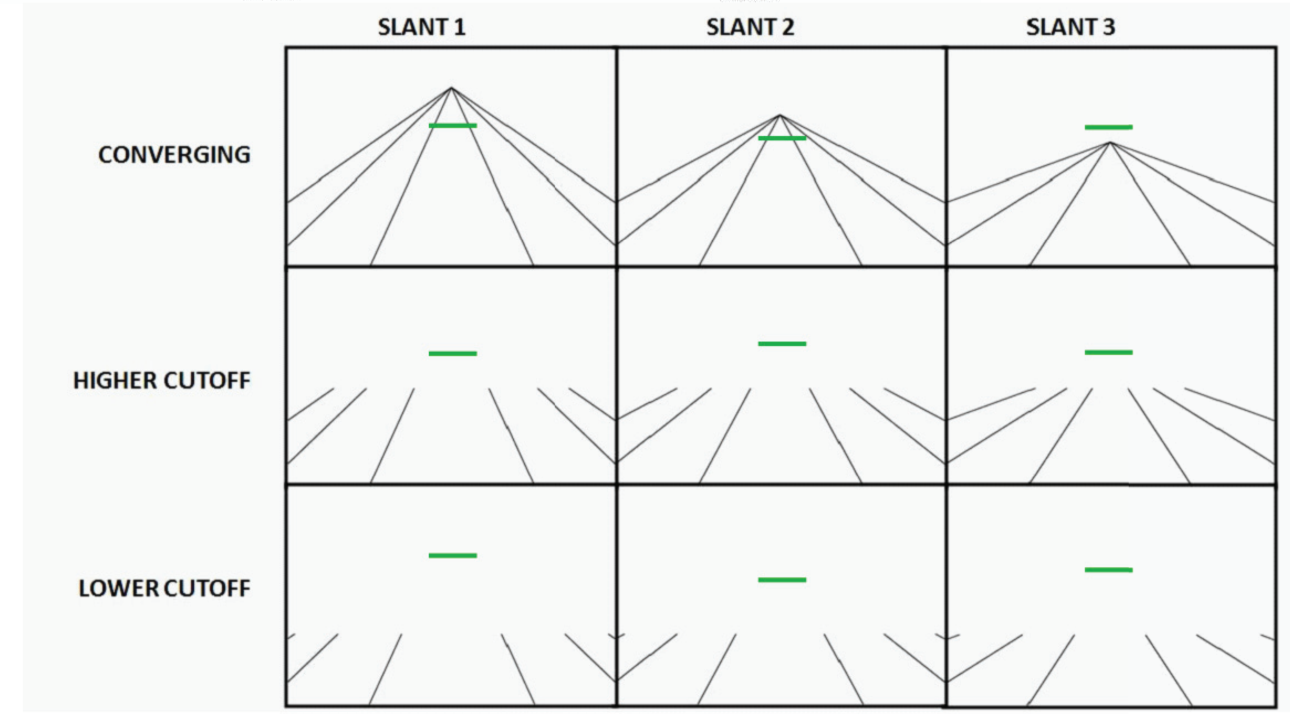
Results

ANOVA results over the perceived locations of path change failed to show significant main effects of implied vanishing point, height at which the surface terminated or motion path of the ball (linear or diagonal).

ANOVA results showed a significant interaction between the height of the texture boundary and the level of the implied vanishing point in determining the location where the perceived motion trajectories had changed, $F(4,24)=3.36$, $p<0.05$. These are the two variables shown previously to determine the location of the perceptual horizon.

ANOVA results also showed a significant three-way interaction between the level of the implied vanishing point, the height of the texture boundary and the direction of motion, $F(8,48)=3.29$, $p<0.01$.





Heights at which observers indicated a path change in each background condition, averaged across the two diagonal motion directions.

Experiment 2 Conclusions

Our results showed an interaction between the height of the texture boundary and the level of the implied vanishing point in determining the location of the perceived path change. This suggests that the location of the perceived path change for objects in a 3-D scene depends on the location of the perceptual horizon.

Results for the lower cutoff level were similar to those found with the converging condition. This is in agreement with previous studies in which we found that that lower texture heights put a weaker constraint on the height of the perceptual horizon, allowing it to be closer to the implied vanishing point.

General Conclusions

1. The perceived path of a moving object in a 3-D scene changes as it passes the horizon.
2. The point at which the change occurs is determined by a combination of the horizon level implied by the converging line pattern and the level at which the visible background terminates. These are the factors previously shown to determine the level of the perceptual horizon.

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