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Examining the Instability of the Necker Cube

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Abstract

Temporal processing is an important dimension influencing the rate at which bistable images change (Wemery et al., 2015; Atmanspacher and Filk, 2013). This study was conducted to determine if space is another contributing factor to the perception of bistable images. Subjects were shown three versions of the Necker cube including a cube and two prisms with the length of one side either 1.5 or 2 times the length of the cube. Results show that increasing the length of one side increases the stability of the image. A similar result was found with illusory images.

Introduction

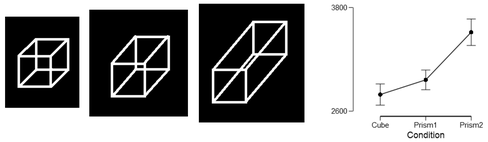
Louis Albert Necker described the ambiguity associated with a wire frame drawing of a cube. Although the drawing of the cube is two-dimensional, a three-dimensional object is typically seen as either facing down to the left or up to the right. The Necker cube is a classic example of a bistable image. Images, like the Necker cube, switch or flip back and forth between two possible representations. Bistable images highlight that perception is not necessarily based on the physical stimulus but on our interpretation of it.

The rate at which the image appears to switch orientations has been the focus of many researchers. Rate of apparent change (RAC) appears to be influenced by a number of factors. For instance, focusing on different parts of the cube can create a more stable (i.e., less frequently changing image; Einhauser, Martin, & König, 2004). Size of the stimulus (Bergum and Flamm, 1975), age (Patel and Reed, 2016), psychopathy (Lidberg, Levander, Scahlling, & Lidberg, 1978), and gravity (Clément and Demel, 2012) are other variables associated with RAC. Several (e.g., Wemery et al., 2015; Atmanspacher and Filk, 2013) have suggested that temporal processing is an important dimension influencing the rate at which bistable images switch. This study was conducted to determine if space is another contributing factor to bistable perception.

Experiment 1a

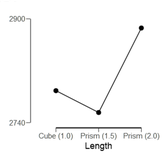
Participants. Seventeen psychology students participated in the experiment for class credit. All participants had normal or corrected to normal visual acuity.

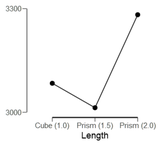
Procedure. Participants were shown Jastow's rabbit-duck and given a brief description of bistable images. They were then shown a Necker cube and instructed where to focus their gaze. Participants were instructed to press the 2 key on the number pad whenever the image changed orientations. There were six practice trials followed by 90 experimental trials with an equal number of trials for each version of the stimulus. Versions included a standard Necker cube, a prism with d one and a half times the length of the cube, and a prism with d two times the length of the cube.



Experiments 1b and 1c

Experiments 1b and 1c followed that exact procedure as Experiment 1a. The only difference between the three versions of the experiment was the dimension of the cube being manipulated. While depth was varied in Experiment 1a, the horizontal and vertical dimensions were varied in 1b (n = 26) and 1c (n = 8) respectively. A shown in the figures below, a similar pattern was found for each dimension. Increasing the horizontal (left) and vertical (right) dimensions to twice the length of the standard cube also increased the stability of the image.





Experiment 2

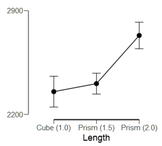
In Experiment 2, the images were changed from line drawings to illusory contours (Bradley and Petry, 1977).

Participants. Thirty-three psychology students participated in the experiment for class credit. All participants had normal or corrected to normal visual acuity.

Procedure. The procedure was identical to that used in Experiment 1. There were 90 randomly presented experimental trials with 30 trials for each of the three illusory images.

Results

The results were similar to those found in Experiment 1. As the length of a dimension, height (h) in this case, increases so does the time for the image to change orientation indicating that the image is becoming more stable ($F92, 64) = 5.30$, $p < .007$, $\eta^2 = .14$). While there was no difference between the cube (M = 2354, SD = 1302) and 1.5h (M = 2408, SD = 1290) trials, both the cube and 1.5h trials produced shorter RAC times (i.e., more instability) compared to the 2.0h trials (M = 2733, SD = 1368).



Discussion

This study was conducted to determine if changing a dimension of the Necker cube alters the bistable nature of the image. Increasing the length of one side of the cube increases the time to detect a change in the orientation of the prism. This finding suggests that increasing the length of a side makes the Necker cube more stable or less susceptible to change orientation. Therefore, it appears that the Necker cube is affected by both temporal and spatial factors.

Aks and Sprott (2003) manipulated binocular disparity in a Necker cube task. Similar to this study, low-depth conditions produced more instability while high-depth conditions yielded fewer orientation changes. The present findings expand on this, however, suggesting that stability can be influenced by any dimension, even when that dimension is inferred as in Experiment 2.

Although not examined in this particular study, it is possible that modifying the dimensions of the cube may also modify the impact of attention on viewing the Necker cube (cf., Dieter, Brascamp, Tadin, & Blake, 2016). For instance, as the size of the stimulus changes (e.g., Bergum and Flamm, 1975), the need to scan the image may also increase (cf, Orlandi, 2012).

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