"ROLLING EYES ON A HOLLOW MASK"

Thomas V. Papathomas, Rutgers University, Papathom@RCI.Rutgers.edu

Please visit http://coewww.rutgers.edu/classes/bme/bme615/movies/MaskRingRollEyesTVP2.mov for a video demo.

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Introduction – Summary. The hollow-mask illusion is well known: a hollow mask appears as a normal convex face. As a result of the depth inversion, the mask exhibits illusory motion. It moves vividly as viewers move in front of it [for an explanation, see Papathomas 2007]; as a corollary, when rotated, its perceived direction of rotation is opposite to the actual direction.

An interesting question is: If we add 3-D objects to the mask (such as a smoking pipe or a nose ring), what will the percept be under rotation? Answer: The result is a **compelling illusion in its own right. You get rotation in the opposite direction to that of the mask.**

Significance. Understanding how the brain perceives a stable environment as we move about is an essential problem, and these stimuli are powerful tools in this research. My explanation [Papathomas 2007] assumes that the visual system uses a 3-D representation of the environment, as well as vestibular and proprioceptive inputs, to predict the retinal flow under self-motion. External objects' motion is determined by the degree to which the predicted retinal flow differs from the actual retinal flow.

Examples: The illusion is shown in Fig. 1 (upright) and Fig. 2 (sidewise mask). Fig. 1 shows 3 frames of an animation sequence: an upright hollow mask with 3-D spherical eyeballs and a nose ring rotates clockwise (CW), if it were seen from above; instead, it appears to turn counter-CW. Notice that, as we go from frame 1 to 3, the face appears to turn to its left (red arrows). However, the nose ring rotates in the opposite direction (blue arrows). Less obvious is the rolling of the eyeballs; it is more visible in Fig. 2 and in the video.

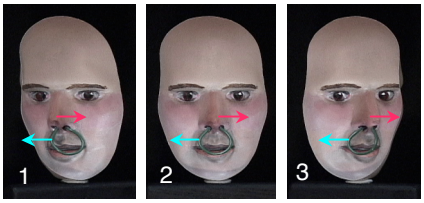

Fig. 1. Three frames in a sequence of a hollow mask with a nose ring and 3D eyeballs. The ring rotates opposite to the mask. **Arrows indicate rotation about a vertical axis**.

Fig. 2 shows 4 frames of a sequence in which the same hollow mask, in a "reclining" posture, rotates CW (if it were seen from above); instead, it appears to turn counter-CW (red arrows). Notice how the nose ring rotates in the opposite direction. In this figure, the rolling of the eyeballs (blue arrows) is much clearer than in Fig. 1; this illusion is compelling in the video.

Explanation of illusory motion under self-motion. Why does the mask "move" as we move in front of it? Fig. 3 offers one possible explanation. Fig. 3 shows a hollow mask in solid black lines. For a viewer in position 1, the perceived illusory convex face is shown in dotted blue lines. A feature F, such as the *left* nostril, on the hollow mask can be perceived in depth anywhere along the line of sight. The viewer in position 1 perceives a normal convex face (dotted blue lines) and F is perceived as the *right* nostril located at F1. When the viewer moves to position 2, as long as he/she maintains the convex face, feature F has to move, because it has to pivot around its location F on the actual mask (see red solid lines). This is why it moves from F1 to F2, as the viewer moves from position 1 to 2. This happens with all features on the mask, causing the entire illusory face to move as we move in front of it. Please see the video.

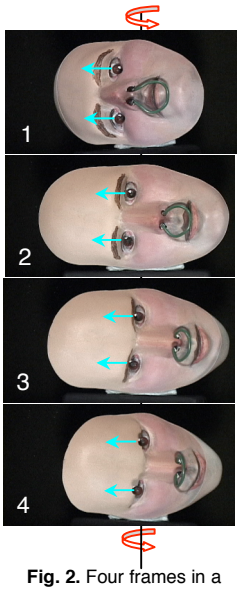

Fig. 2. Four frames in a sequence with a "reclining" hollow mask. Rolling of the eyes is much more evident. **Arrows indicate rotation**.

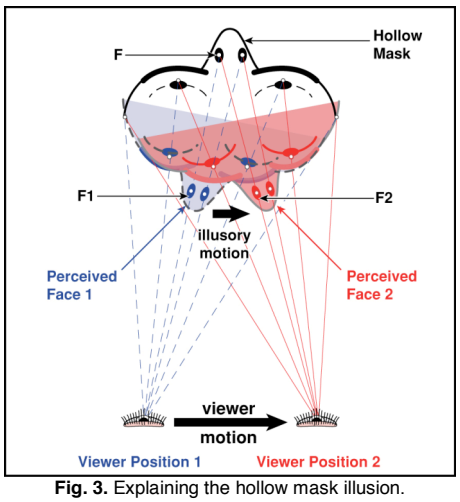

Fig. 3. Explaining the hollow mask illusion.

Now, if we add an external 3-D object, such as the nose ring, it is highly unlikely that it will be assigned an illusory depth; hence it will not be subjected to the illusory motion that the mask is subjected to, and it will rotate in the veridical direction, opposite to that of the mask. This creates the motion illusion.

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Reference: Papathomas TV. "Art pieces that 'move' in our minds – An explanation of illusory motion based on depth reversal," *Spatial Vision*, 21, 79-95, 2007.