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after birth severe skeletal and cardiac muscle abnormalities begin to appear, symptoms that almost perfectly recapitulate those of human EDMD patients. While various animal models have been developed that mimic human laminopathies, the aetiology of these diseases at the molecular level is still uncertain. Most likely many of these disorders arise through multiple pathways involving nuclear structural defects as well as the loss (and sometimes gain) of binding sites at the nuclear periphery for lamin-associated proteins that are themselves expressed in a tissue-specific manner. Advanced microscopic technology, such as single molecule localization microscopy (SMLM) or correlative microscopy (a combination of SMLM with EM), hold promise for delineating the nuclear lamina at the nanoscale level *in vivo*. To this end, approaches combining biochemistry, cell biology and developmental biology would greatly improve our understanding of lamin-linked disease processes and also would provide insight into more fundamental nuclear functions.

Where can I find out more?

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Laboratory of Nuclear Dynamics and Architecture, Institute of Medical Biology, Agency for Science, Technology and Research (A*STAR), 8A Biomedical Grove, Immunos, Singapore 138648.
*E-mail: wei.xie@imb.a-star.edu.sg

Correspondence

Perceived three-dimensional shape toggles perceived glow

Minjung Kim[1,2,*], Laurie M. Wilcox[1], and Richard F. Murray[1]

Most surfaces reflect light from external sources, but others emit light: they *glow*. Glowing surfaces are often a sign of an important feature of the environment, such as a heat source or a bioluminescent life form, but we know little about how the human visual system identifies them. Previous work has shown that luminance and luminance gradients are important in glow perception [1,2]. While a link between glow and shape has been suggested in the literature [3], there has been no systematic investigation of this relationship. Here we show that perceived three-dimensional shape plays a decisive role in glow perception; vivid percepts of glow can be toggled on and off, simply by changing cues to three-dimensional shape while holding other image features constant.

We used two types of stimuli (Figure 1A). We created *dark-valley* stimuli by rendering stereoscopic pairs of wavy, randomly generated three-dimensional surfaces under diffuse light, like the non-directional lighting on a cloudy day; these stimuli had bright peaks and dark valleys [4]. We created *bright-valley* stimuli by reversing the binocular disparity of the same images [5]; these stimuli had dark peaks and bright valleys. Subjectively, dark-valley stimuli looked like matte surfaces evenly lit from the front, whereas bright-valley stimuli elicited a strong impression of glow. In the Supplemental Information, we provide code that illustrates how we generated the stimuli (Code S1).

On a mirror stereoscope, we showed the dark-valley and bright-valley stimuli side by side (Experiment 1A). We asked observers to choose the stimulus that appeared to glow, which we described as "emitting light", "having a light source inside or behind the surface", and "not just bright because of an external light source". Five of the six observers consistently identified the bright-valley stimuli as glowing, and the sixth observer chose the two stimulus types equally often (Figure 1B). Note that the retinal images for dark-valley and bright-valley stimuli were nearly identical, differing only in binocular disparity. Thus, we were able to toggle glow percepts on and off simply by reversing disparity cues to three-dimensional shape.

In Experiment 1B, we assessed how well the same observers perceived depth from disparity in these stimuli, by asking whether a small blue probe dot was on a peak or in a valley. The five observers who perceived bright-valley stimuli as glowing in Experiment 1A performed this depth task almost perfectly (Figure 1C). However, the sixth observer was unaffected by disparity cues in this experiment, and always judged bright regions to be peaks and dark regions to be valleys. We conclude that this observer gave atypical responses in Experiment 1A because the disparity information did not affect their three-dimensional shape percepts. These individual differences are understandable, as shading and disparity cues were in conflict for the bright-valley stimuli, and individuals vary in the extent to which they see depth from binocular disparity [6]. Furthermore, the correlation between individual differences in perceived glow and perceived shape lends additional support to our proposal that perceived three-dimensional shape has a causal effect on perceived glow.

In Experiment 2, we tested whether the glow percept reported here is driven by perceived three-dimensional shape in general or by disparity in particular. We manipulated perceived three-dimensional shape using structure-from-motion instead of disparity. Again, we showed dark-valley and bright-valley stimuli side by side, but on a two-dimensional display, with each stimulus rotating back and forth at a moderate speed (Movie S1). We tested the same observers as in Experiment 1. All six observers, including the atypical observer, consistently identified the bright-valley stimuli as glowing (Figure 1D).

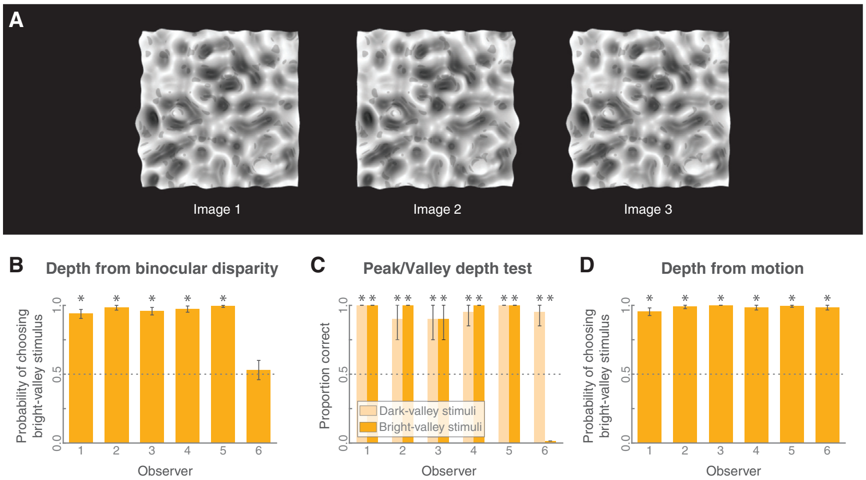

Figure 1. Perceived glow depends on perceived three-dimensional shape.
(A) Sample stimuli from Experiment 1. Cross-fusing Image 1 and Image 2 yields a dark-valley stimulus; cross-fusing Image 2 and Image 3 yields a bright-valley stimulus. Free-fusing these stimuli is difficult, as shading and binocular disparity cues give conflicting shape information for the bright-valley stimuli. We ran our experiment on a mirror stereoscope to facilitate fusion. If you are unable to fuse the stereoscopic stimuli, please see Movie S1, which shows sample stimuli from Experiment 2. (B) Results of Experiment 1A. (C) Results of Experiment 1B. Observer 5 participated in this study twice, as they initially did not see depth from binocular disparity. We report the data from the second set of trials only. (D) Results of Experiment 2. All error bars are 95% confidence intervals. The same observers participated in all experiments (n = 6).

We conclude that the effect of three-dimensional shape on perceived glow is not tied to a particular depth cue, and that any shape cue manipulation strong enough to reverse perceived depth in such stimuli will elicit a percept of glow.

In our experiments we used a broad definition of glow, namely that a surface appears to emit light rather than reflecting light from an external source. However, there may be more than one type of perceptual glow. Colleagues have suggested that our bright-valley stimuli seem to be made of a translucent material that glows because it contains an interior light source. This is unlike other types of glow, where the object appears to generate light on its surface, as in a fluorescent light fixture. This points to possible connections between the glow studied here and the increasingly active field of material perception. Furthermore, it suggests that in general usage, the term ‘glow’ may actually cover several distinct kinds of percepts, a notion that is supported by the wide range of phenomena that have been called ‘glowing’ or ‘self-luminous’ in the literature [1,2,7].

The perception of glow — and more generally, the perception of light sources — is important to any biological organism that relies on vision. All images are highly ambiguous, and to perceive scenes correctly, the human visual system must infer the physical causes that generated the image, such as lighting, surface shape, and surface colour. It is clear that the human visual system has an understanding of the relationship between light sources and three-dimensional geometry [8,9], and our results show that this understanding extends specifically to the identification of light-emitting surfaces. It remains to be seen how sophisticated this understanding is. Perceived glow in three-dimensional surfaces may be based on a cue as simple as correlation between concavity and luminance, or it may be based on a more physically realistic understanding of which spatial arrangement of light sources and surfaces would best explain the pattern of luminances in a retinal image. Regardless, our experiments show that glow perception is not based solely on two-dimensional image features, but also depends on a representation of three-dimensional shape that is not tied to a specific cue to depth.

SUPPLEMENTAL INFORMATION

Supplemental Information includes experimental procedures, one movie, and one code package, and can be found with this article online at http://dx.doi.org/10.1016/j.cub.2016.03.031.

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[1]Department of Psychology and Centre for Vision Research, York University, Toronto, ON, M3J 1P3, Canada. [2]Department of Psychology, New York University, New York, NY, 10003, USA.
*E-mail: minjung.kim@nyu.edu