Visuospatial Resonance

A phenomenon in which an image achieves optimal clarity due to resonance between the spatial frequency of the image and the observer's distance from the image.

Interpreting images is a process that involves interplay between visual information received by the eyes and information stored in memory. The process begins with the eyes first locating the primary lines, edges, and boundaries in an image, pattern-matching these elements against elements in memory, and then proceeding in this back-and-forth manner between eyes and memory at increasing levels of detail until the interpretation is complete. The visibility of the lines, edges, and boundaries in the image is a function of the spatial frequency of the image and the distance to the observer. Images rendered at a high spatial frequency appear as sharp outlines with little between-edge detail. High-spatial-frequency images are easily interpreted up close, but are not visible from a distance. Images rendered at a low spatial frequency appear as blurry images with little edge detail. Low-spatial-frequency images are not visible up close, but are easily interpreted from a distance. Images rendered at different spatial frequencies can be combined to stunning effect, creating what are referred to as *hybrid images.*[1]

Perhaps the first known hybrid image effect is the elusive smile of Leonardo da Vinci's *Mona Lisa.* When observed up close and direct, Mona Lisa does not appear to be smiling. However, when observed out of the corner of the eye or at a distance, her subtle smile emerges. This effect is the result of two different expressions rendered at different spatial scales—the nonsmiling mouth is rendered at a high spatial frequency, which dominates direct proximal observation, and the smiling mouth is rendered at a low spatial frequency, which dominates indirect and nonproximal observation. Although da Vinci could not have understood the modern science behind visuospatial resonance, it seems clear that he understood the practical mechanism of the effect using shading—in the case of the *Mona Lisa,* the elusive smile is achieved by applying shaded regions at the corners of the mouth.[2] This technique has been refined to create emotionally ambiguous facial expressions, called *gaze dependent facial expressions*—that is, as an observer gazes at an image, the image appears to morph.[3]

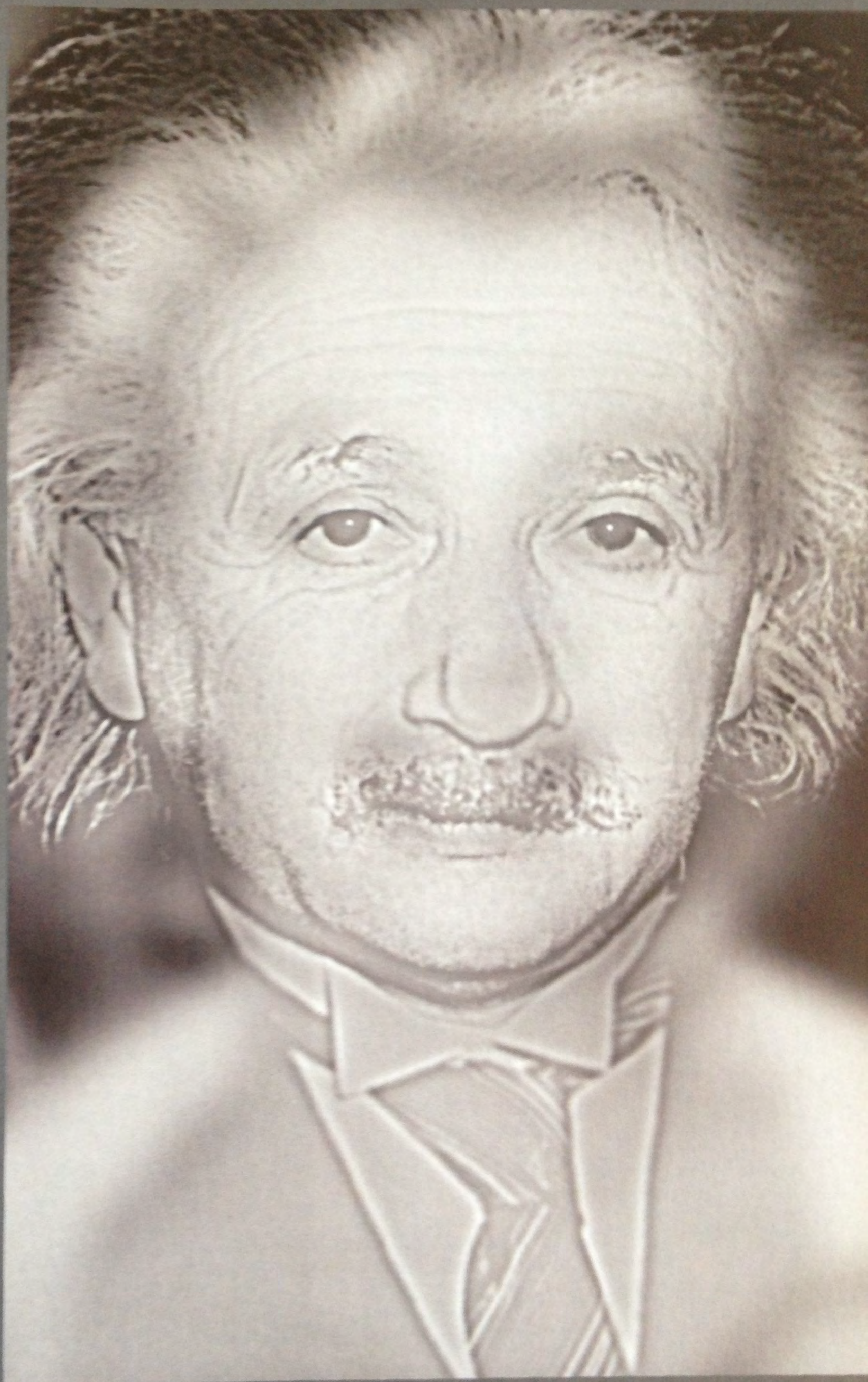
Consider visuospatial resonance as a means of increasing the propositional density of static displays, increasing the interestingness of advertising posters and billboards, masking sensitive text or image information, and creating emotionally ambiguous facial expressions in artistic or photographic renderings of faces. Although it is clear that visuospatial resonance can be achieved using hybrid images with two images, it is not yet clear whether two images is the limit—that is, whether visuospatial resonance is strictly a bimodal phenomenon (near and far) limited to two-image hybrids, or a multimodal phenomenon potentially accommodating any number of images.

See also Attractiveness Bias, Figure-Ground Relationship, and Law of Prägnanz.

[1] The seminal work on visuospatial resonance is "Masking in Visual Recognition: Effects of Two-Dimensional Filtered Noise" by Leon D. Harmon and Bela Julesz, *Science,* June 15, 1973, vol. 180(4091), p. 1194–1197; and "From Blobs to Boundary Edges: Evidence for Time- and Spatial-Scale-Dependent Scene Recognition" by Philippe Schyns and Aude Oliva, *Psychological Science,* 1994, vol. 5, p. 195–200. See also "Hybrid Images" by Aude Oliva, Antonio Torralba, and Philippe Schyns, *ACM Transactions on Graphics,* 2006, vol. 25(3), p. 527–532.

[2] "Is It Warm? Is It Real? Or Just Low Spatial Frequency?" by Margaret Livingstone, *Science,* November 17, 2000, vol. 290(5495), p. 1299.

[3] "Is That a Smile? Gaze Dependent Facial Expressions" by Vidya Setlur and Bruce Gooch, in *NPAR '04: Proceedings of the 3rd International Symposium on Non-Photorealistic Animation and Rendering, ACM Press,* 2004, p. 79–151.



This hybrid image depicts two familiar figures rendered at different spatial frequencies. Up close, you see only Albert Einstein, who is rendered at a high spatial frequency. At a distance, you see only Marilyn Monroe, who is rendered at a low spatial frequency. The distances at which the clarity of each image is optimal are the points of visuospatial resonance.