in the melt (or magma) viscosity. Conversely, the dehydration of the magma as a result of ascent-driven bubble formation in the melt phase generates a steep vertical gradient in the viscosity of the magma precisely where the growth of bubbles and possibly crystallites are also contributing to higher viscosity. The vertical gradient in volume viscosity translates into a steep vertical gradient in pressure, with the result that the ascent of magma, driven from below, passes through a filter zone of extreme decompression rates. Here fragmentation by brittle failure may well be feasible.

The higher deformation rates implied by the recent simulations help to close the gap between the strain rates necessary for brittle failure in silicate melts and those provided by physical models of the magma ascent process. Yet, the parameterization of the physical properties of magmas on which such simulations are based are incomplete at best. A recent reanalysis of the influence of water on the viscosity of an analog rhyolite demonstrated that the nonlinearity of the viscosity increase during dehydration is even more extreme than previously estimated (*6*). Degassing of the magma is thus likely to proceed more efficiently down to a critical water content of perhaps 0.2 to 0.4 weight %, but then the magma would hit the catastrophe of a skyrocketing viscosity value, which blocks further viscous growth of bubbles. This effect has been dubbed the "viscosity quench" (*7*). Such a scenario, based on improved viscosity data, is likely to be capable of explaining the widespread occurrence of rhyolitic glass with water contents of a few tenths of a weight percent.

How much of the fragmentation in volcanic eruptions can be explained by brittle failure? For dome collapse and landslide-induced eruptions, brittle failure appears to be likely. For centrally fed eruptions, the debate currently rages. This vital issue is likely to generate considerable discussion and stimulate theoretical and experimental advances in volcanology and petrology in the next few years.

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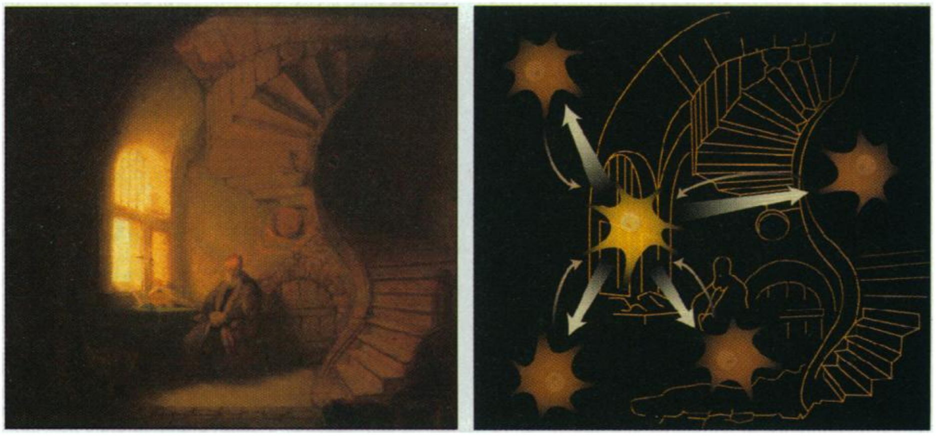
An Excellent Lightness

Thomas D. Albright

For many centuries before the present one, much of Western art aspired to high-fidelity reproduction of the world as it is naturally seen. Achieving visual equivalence or trompe l'oeil presents numerous technical challenges, the resolution of which became a major preoccupation for Renaissance artists such as Leonardo da Vinci. Notable among these challenges is that the range of light intensities one experiences when viewing an ordinary natural scene vastly exceeds—typically by some orders of magnitude—the range that can be brought forth by applying paint to canvas. A variety of tricks or illusions known collectively as chiaroscuro (literally, light-dark), which are now standard elements of the painter's trade, were developed to exploit the play of pigment in an effort to deceive the eye. These chiaroscuro effects are detailed in Leonardo's *Treatise on Painting* (*1*) and are among the earliest recorded insights into the nature of visual perception. The report by Rossi *et al.* (*2*) in this issue of *Science* sheds new light on the neural events that underlie one of most striking of chiaroscuro effects—a phenomenon known today as brightness induction (*3*). In doing so it brings us closer to understanding how the brain encodes the properties of surfaces in our visual environment.



(Left) *Philosopher in Meditation*, Rembrandt, 1632 (Louvre, Paris). Rembrandt was a master of chiaroscuro, using it to bring about illusory expansion of the range of light in the image, a phenomenon known today as brightness induction. (By viewing through a small aperture, one can see that the lighted window is very much darker than the page upon which it is printed.) **(Right) Reciprocal connections between neurons representing different regions of visual space are thought to contribute to brightness induction.** Reciprocal connection strength (indicated schematically by arrow width) is determined by local light intensity, such that the net activity of neurons representing areal brightness is influenced by spatial contrast.

In his tutorial *Treatise*, Leonardo noted that "if you wish to produce an excellent darkness, give it an excellent lightness by way of contrast" (*1*, p. 84). In these simple words of advice to the aspiring painter, Leonardo captured what is now known to be an essential principle of visual perception: that perceived intensity of light (brightness) is not informed solely by the physical intensity of light (luminance) at a given point in space, but rather is determined largely by the contrast between the luminance at that point and the luminance of surrounding regions. By setting up contrast through adjacency of light and dark paints, Leonardo effected an illusory expansion of the range of light intensities perceived from the pigments. This illusion of induced brightness, which can be seen on page 1104 of this issue (Fig. 1A of Rossi *et al.*), is striking, and its use is pervasive in Western painting of the last 500 years.

The phenomenon began to attract the interest of vision scientists in the 19th century, when it became a focal point for debates as to whether sensory information is processed in a direct or a relational manner. The Austrian physicist Ernst Mach (*4*) was among the first to suggest a specific and detailed mechanism to account for brightness induction, which he thought involved "reciprocal action of neighboring areas of the retina" (p. 267) representing different areas of visual space (see figure). Mach's proposal was

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fleshed out by Ewald Hering (3) and reverberated throughout the latter half of the 19th century. Fueled by growing recognition of the importance of relational processing (5) and by the birth of modern neuroscience, Mach's ideas of reciprocal action have since inspired an enormous number of behavioral and biological studies of visual perception. Celebrated among them was the discovery in the 1940s (6) of the existence of neuronal circuitry—known as "lateral inhibition"—that conforms to Mach's predicted spatial interactions.

Although lateral inhibition is now believed to underlie the perceptual sharpening of local edges of contrast (3, 7), the neuronal signals that underlie perceived light intensity of extended surfaces (areal brightness) have remained a mystery. The new report by Rossi *et al.* (2) offers intriguing new evidence for the locus and the nature of these signals. By varying luminance relations within a simple visual pattern, these investigators were able to manipulate the brightness of a target area in two ways: (i) directly, such that brightness paralleled changes in area luminance; or (ii) inductively, such that area luminance remained unchanged but its brightness inversely paralleled changes in the surrounding luminance. The target area was placed within the receptive fields of individual neurons in primary visual cortex, and the activity of the neurons was recorded in the presence of both direct and induced brightness changes. A substantial fraction of neurons exhibited responses that covaried with areal brightness, regardless of whether brightness changes were caused directly or induced by changes occurring well beyond the margins of the receptive field. In other words, these neurons appear to encode perceived intensity of light in a manner that is independent of cause.

Areal brightness induction thus satisfies the painter's need and can be accounted for in neuronal terms. But what function does it serve when viewing natural scenes? The simple answer is that it is borne of an exquisite sensitivity to contrast—for it is contrast, not local light intensity, that offers the most important information about the viewer's environment. The reason for this is clear: The intensity of light arising from a surface is a product of both the reflectance of the surface and the intensity of the light by which it is illuminated. The reflectance, which is critical for object recognition, is commonly dissociable from the intensity of the illuminating light—a phenomenon von Helmholtz characterized as "eliminating the differences of illumination" (8, p. 287). Diffuse illumination changes (for example, sunlight versus shadow) alter luminance everywhere in the image, but luminance ratios (that is, contrast) remain unchanged, mirroring the physical constancy of surface reflectance. Not surprisingly, surface reflectance generally appears constant under these conditions, a phenomenon known as "lightness constancy." By contrast, changes in luminance ratios—such as those used by Rossi *et al.*—are indicative of reflectance changes. These are, of course, the conditions that lead to brightness induction.

Considered in this light, it is tempting to speculate that the neurons discovered by Rossi *et al.* do not merely represent brightness but may underlie the more behaviorally significant quantity of perceived surface reflectance (lightness). As we have seen, recovery of surface reflectance is marked by the complementary perceptual phenomena of lightness constancy and brightness induction, and these are the gold standards by which we should judge potential neural substrates. Rossi *et al.* have documented induction. If these neurons mediate lightness perception, however, we would expect the same cells to exhibit an invariant response under conditions that mimic variations in diffuse illumination—that is, when luminance changes uniformly, such that contrast remains unchanged. Although this test for lightness constancy has yet to be performed, Rossi *et al.* have opened the door to an exciting exploration of the ways in which the multiple physical causes of light in the retinal image are isolated and identified by the brain.

More generally, these experiments exemplify a growing and welcome trend in studies of sensory processing. Traditionally, this discipline has focused on neural events that encode local characteristics of the retinal stimulus. However illuminating this approach has been for understanding sensory coding, few would argue that the way we actually see the world is tied directly to these characteristics. On the contrary, it is the remarkable constancy of perception in the face of ever-changing retinal conditions that is a hallmark of visual experience. By adopting stimulus configurations that bring about a dissociation between local retinal image properties and perceptual state—such as those that elicit brightness induction—it becomes possible to tease apart the neural structures and events that give rise to perception. And therein lies one of our greatest hopes for understanding the substrates of vision.

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Small Nucleolar RNAs Guide Ribosomal RNA Methylation

David Tollervey

In all organisms, proteins are synthesized by ribosomes that share extensive similarities in structure and function. These ubiquitous particles contain the mature ribosomal RNAs (rRNAs), which are excised from a large common transcript [the rRNA precursor (pre-rRNA)] and undergo extensive covalent nucleotide modification, together with about 80 ribosomal proteins. In eukaryotic cells, ribosomes are assembled in a specialized compartment within the nucleus of the cell, the nucleolus.

Over the past few years, an extraordinarily large number of small RNA species (snoRNAs) have been found to reside in the nucleolus. Each human pre-RNA molecule transiently associates with more than 100 different snoRNA species, but the role of each species in ribosome synthesis remained largely unknown. Two recent papers (1, 2) now report that members of a large family of snoRNAs act as guides for rRNA methylation. For each site of ribose methylation, base pairing between the pre-rRNA and a specific guide snoRNA targets the site for methylation and identifies the nucleotide to be modified.

The snoRNAs are associated with proteins in small nucleolar ribonucleoprotein particles (snoRNPs) (3). Two evolutionarily conserved motifs (box C and box D) are present in many snoRNAs and are implicated as protein-binding sites, although the proteins that interact with these sequences have not been identified. Many snoRNAs that contain box C and box D have two

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