Our results, therefore, suggest that the cellular populations in the experimentally induced lesions are fundamentally different in origin from those in the human lesions. The lesions produced in the hares more closely resemble the human fatty streak, whose values cluster in the center of the range. However, isoenzyme values for human fatty streaks have a wider spread, and a small but significant minority (3.0 percent) of these lesions have been shown to be monoclonal (*2*).

It is concluded that the lesions produced in the hares' arteries by a combination of cholesterol feeding and balloon-catheter injury lack monoclonal characteristics and therefore are not analogous to naturally occurring atherosclerotic plaques in man. However, the hybrid hare provides an animal model in which both the production of "atherosclerotic" lesions and the quantification of the G6PD enzyme markers are feasible, but further studies, including longer term experiments, are needed to determine which experimental procedure, if any, provides a true atherosclerotic lesion.

THOMAS A. PEARSON, JOHN DILLMAN
KEVIN J. WILLIAMS, JON A. WOLFF
ROBERT ADAMS, KIM SOLEZ
ROBERT H. HEPTINSTALL
Departments of Pathology and *Comparative Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland 21205*
HAQVIN MALMROS
University Hospital, Lund, Sweden
NILS STERNBY
University of Lund, General Hospital, Malmo, Sweden

References and Notes

1. D. Linder and S. M. Gartler, *Science* **150**, 67 (1965); P. J. Fialkow, *N. Engl. J. Med.* **291**, 26 (1974).
2. E. P. Benditt and J. M. Benditt, *Proc. Natl. Acad. Sci. U.S.A.* **70**, 1753 (1973); T. A. Pearson, A. Wang, K. Solez, R. H. Heptinstall, *Am. J. Pathol.* **81**, 379 (1975); T. A. Pearson, J. M. Dillman, K. Solez, R. H. Heptinstall, *Circ. Res.* **43**, 10 (1978); *Am. J. Pathol.* **93**, 93 (1978).
3. P. Constantinides, J. Booth, G. Carlson, *Arch. Pathol.* **70**, 712 (1960); P. Constantinides, *J. Atheroscler. Res.* **1**, 374 (1961); E. M. M. Besterman, *Atherosclerosis* **21**, 75 (1970).
4. J. T. Prior and W. H. Hartmann, *Am. J. Pathol.* **32**, 417 (1956); M. Friedman and S. O. Byers, *Arch. Pathol.* **79**, 345 (1965); S. Bjorkerud, *J. Atheroscler. Res.* **9**, 209 (1969); C. B. Taylor, D. Baldwin, G. M. Hass, *Arch. Pathol.* **49**, 623 (1950); S. Moore, *Lab. Invest.* **29**, 478 (1973).
5. T. B. Clarkson, *Adv. Vet. Sci. Comp. Med.* **16**, 151 (1972).
6. S. Ohno, J. Poole, I. Gustavsson, *Science* **150**, 1737 (1965).
7. The availability of the hybrid hare as an experimental animal has been limited by difficulties in the breeding process. The mating of the two species is successful only under certain conditions and between selected *L. timidus* females and *L. europaeus* males.
8. P. Trinder, *Ann. Clin. Biochem.* **6**, 24 (1969).
9. Supported in part by grant HL-18473 from the Public Health Service.

19 April 1979; revised 31 July 1979

Perception of Size of One Object Among Many

Abstract. *Adaptation to a grating of properly chosen frequency may lead to two apparently conflicting observations: Another grating may then appear to be of increased frequency (compared with its "unadapted" frequency) while the individual bars of the grating appear to have widened. This perceived widening parallels previous results with single bars. By attending to only one grating bar, the subject effectively seems to change the grating frequency spectrum to that of a single bar.*

The concept of size is basic to all science. One does not "define" length, width, height, or depth, in other, more primitive terms. One simply provides standard units and prescribes the operations whereby size may be measured in their terms.

Size might be a psychological primitive as well. We report experimental results that appear paradoxical if size is indeed primitive. The paradox appears resolvable if a model currently popular in vision research is applied, with one additional, ad hoc hypothesis.

The paradoxical observation is that when, by a process of adaptation, a set of bars (a "grating") is made to appear to be of a higher spatial frequency (more bars per centimeter), the bars also appear to be wider (more centimeters per bar). Geometrically, this is impossible in a grating with light and dark bars of equal width. If either bar, light or dark, has width w cm, the spatial frequency f is given by $f = 1/(2w)$ cycles per centimeter. If either frequency or width increases, the other must decrease. Our results indicate that the psychological correlates of f and w do not fit the equation (more correctly, the definition of f).

Figure 1 [based on figure 1 of (*1*)] offers a demonstration of an adaptation procedure that leads to a shift in perceived spatial frequency. An observer adapts to the large high- and low-frequency gratings by holding the page about a foot away and scanning back and forth across the horizontal fixation bar for at least 1 minute. A glance at the fixation square between the short gratings should then demonstrate the apparent difference of spatial frequency between them, with the upper one (which falls within the retinal region that has been adapted to the upper, low-frequency grating) appearing higher in spatial frequency. (The effect is fleeting when the adaptation time is only 1 minute.)

To measure perceived width, we allowed the viewer to adjust the height of the grating bars to equal their widths, both before and after adaptation. This "make-a-square" method has previously (*2*) enabled viewers to report the perceived widths of single bars (rectangles). The methods of this experiment were identical to those in an earlier report (*2*).

Figure 2 shows data derived from individual subjects' settings to make the bars in the short test grating look square. After adaptation to gratings whose bars are narrower than, equal to, or wider than the test grating bars (that is, higher, equal, or lower in spatial frequency), the

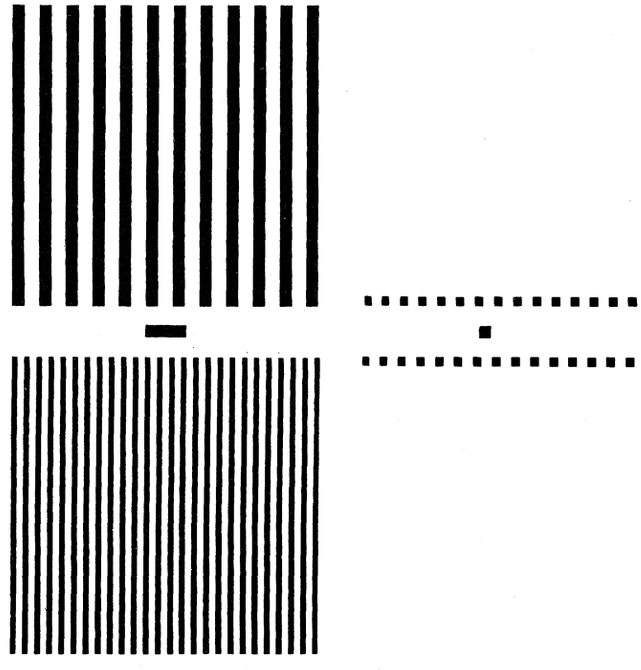

Fig. 1. The Blakemore and Sutton (*1*) demonstration with short gratings.

0036-8075/79/1221-1425$00.50/0

bars in the test grating appear wider. However, as indicated by the demonstration in Fig. 1 and the data of Blakemore and Sutton (*1*), adapting to gratings lower in spatial frequency would increase the apparent spatial frequency of a test grating. Thus, a paradox is presented by comparison with the data in Fig. 2: Adapting and test grating frequencies that lead to increases in apparent spatial frequency (for example, 3:2) also increase the apparent width.

Earlier results had presented a similar paradox along with a plausible solution. A process of adaptation that made a set of bars appear to be of higher spatial frequency (*1*), made a single rectangle appear to be wider (*2*). The following rationale for these results was offered, based on assumed frequency channels in the visual system: While the notion of width for a single bar is simple, the spectrum of the bar is more complex than that of a grating. Adaptation to a sinusodial grating is adaptation to a single frequency. The resulting loss in sensitivity around that frequency produces different shifts in the "center of gravity" of the effective spectra of a single rectangle and of gratings, and thus different shifts in apparent size and frequency. The earlier paradox was thus resolved.

But there is no way to rationalize the current findings of inconsistent shifts in apparent size and frequency by appeal to a difference in stimulus spectra, since the same stimulus (multiple bars) was used for both frequency and width judgments. Nor can one escape the paradox by noting that adaptation could increase apparent spatial frequency while increasing the apparent width of the light bars at the expense of that of the dark bars (that is, by altering the apparent duty cycle). No shifts in apparent duty cycle were found when subjects adjusted apparent duty cycle before and after adaptation (*3*). The paradox remains; identical stimuli result in perceptions of both higher spatial frequency and wider size.

We suggest the following resolution: Assume that the observer changes the effective spectrum at will. Attention is a sufficiently familiar (and loosely defined) mechanism for the purpose. Carpenter and Ganz (*4*) have used a similar hypothesis in a not-too-different context. We propose that, when observers are asked to "make a square" with either a single rectangle or multiple rectangles (our shortened grating), they discount all parts of the visual field except those relevant to their task. In terms of frequency, something like a $(\sin x)/x$ function—the window function—might be imposed on an observer's visual system. (The exact nature of the function surely differs. Our data do not suggest a more complete description.) As a result, when observers are asked to make a square, a single rectangle is attended to, whether it is alone or in the presence of other rectangles. Thus, the effective spectra for single and multiple rectangles are much the same (as are the experimentally obtained settings).

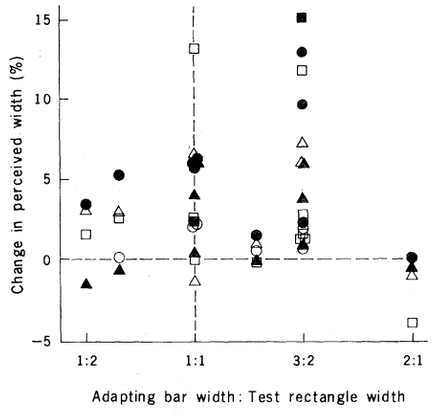

Fig. 2. Percentage increase in perceived widths of rectangles in a short grating after adaptation to a long grating. Different symbols indicate different observers.

The results from the earlier experiments with the single rectangular test stimulus (*2*) indicated that the visual system encodes size on the basis of spatial frequency components. It is natural to think that such a spatial frequency analysis would be performed over a wide region of the visual field (*5*). However, the present results and proposed interpretation suggest that viewers can, when necessary, restrict their spatial frequency analysis to a limited region of the visual field. This selective spatial filtering would reflect an active process, which may provide a link between spatial frequency analysis and selective attention.

JOHN Z. LEVINSON
Department of Psychology, University of Maryland, College Park 20742

FRANCINE S. FROME*
Department of Psychology, University of Massachusetts, Amherst 01002

References and Notes

1. C. Blakemore and P. Sutton, *Science* **166**, 245 (1969).
2. F. S. Frome, J. Z. Levinson, J. T. Danielson, J. E. Clavadetscher, *Science* **206**, 1327 (1979).
3. F. S. Frome, thesis, University of Massachusetts.
4. P. A. Carpenter and L. Ganz, *Percept. Psychophys.* **12**, 57 (1972).
5. N. Weisstein and C. S. Harris, in *Visual Coding and Adaptability*, C. S. Harris, Ed. (Erlbaum, Hillsdale, N.J., in press).
6. These data were collected at the University of Maryland and the University of Massachusetts and were reported at the 1975 Annual Meeting of the Association for Research in Vision and Ophthalmology. Partially supported by NIH grant EY01640 (to J.Z.L.), NIH research fellowship award EY05116 (to F.S.F.), SRI International, and Bell Laboratories. We thank C. S. Harris for helpful comments.
* Present address: Bell Laboratories, Holmdel, N.J. 07733.

8 February 1978; revised 13 August 1979

Legionnaires' Disease: Concentrations of Selenium and Other Elements

Abstract. *Selenium concentrations in the serums of 17 acutely ill Legionnaires' disease patients were significantly lower than in their matching convalescent-phase serums. This trend was not observed in ten similarly paired samples of serum from control patients with pneumonia. There were no significant differences in the concentrations of nickel, copper, bromine, rubidium, lead, barium, or titanium in the serums of Legionnaires' disease and control patients.*

We previously reported toxically high nickel concentrations in lung specimens taken at autopsy from the first victims of Legionnaires' disease (*1*). We also reported a significant correlation ($P < .0004$) between nickel concentrations and the dry weights of the lung specimens. We concluded that the high nickel concentrations were probably not caused by a toxic substance but rather by exogenous nickel contamination occurring after death. Subsequently, a bacterium was identified as the etiologic agent in Legionnaires' disease (*2*).

We report here the concentrations of selenium and other elements in 17 paired samples of serum from the acute and convalescent phases of Legionnaires' disease patients and in ten similarly paired samples of serum from control patients with pneumonia. The selenium concentrations in the acute-phase serums of the Legionnaires' patients were significantly lower ($P < .001$) than those in the matching convalescent-phase serums. This trend was not observed in paired samples of serum from acute- and convalescent-phase controls. We found no significant differences in the serum nickel concentrations of the Le-

0036-8075/79/1221-1426$00.50/0