Fluctuating Brightness of Quasi-Stellar Radio Sources

Banesh Hoffmann suggests [*Science* **144**, 319 (1964)] that a quasi-stellar radio source can alter its brightness in a time short compared with the light-time across its diameter, if the fluctuation originates at the center of the source and arrives nearly coherently at its surface.

However, since light from different parts of an extended object takes different amounts of time to reach an observer, a large coherent fluctuation, of duration small compared with the light-time across the object, will not be observed as an appreciable intensity fluctuation.

For example, imagine that we could magically turn off such an object completely for a year and then turn it on again. If the radius of the source exceeds 1 light-year, a distant observer will "see" the year of darkness as a dark zone that appears in the middle of the apparent source disk and spreads outward (that is, *away* from the observer) with time. If the radius of the source is 10 light-years, the maximum darkening observed will be only 19 percent; if the radius is 100 light-years, the drop in intensity will be only 2 percent.

As the observed brightness fluctuations of 3*C* 48 and 3*C* 273 are of the order of 50 percent in a few years, they evidently cannot have diameters larger than a few dozen light-years.

ANDREW T. YOUNG
Harvard College Observatory, Cambridge 38, Massachusetts

27 April 1964

Action of Tetrodotoxin: A Reply

The comment by C. Y. Kao (*1*) on a report by Loewenstein, Terzuolo, and Washizu (*2*) on the separation by tetrodotoxin of transducer and impulse-generating processes in two receptor organs (the crayfish stretch receptor and the Pacinian corpuscle) needs an answer, since both the findings and the conclusions of the report were incorrectly stated by Kao. His comment starts from the premise that "in both the crayfish stretch receptor and the cat Pacinian corpuscles" the spikes were "clearly recorded in axonal extensions of the sensory receptors."

If by "axonal extension" Kao means the axon, the statement is in error, for it is explicitly stated in the report that the cell soma of the sensory neuron of the stretch receptor organ was impaled with a microelectrode. This was used both to record the electrical activities (see *2*, Fig. 1*A*) and to apply cathodal pulses of current. By this last procedure it was unequivocally demonstrated that if the soma is depolarized no impulse activity can be induced following treatment by tetrodotoxin. Therefore, Kao's contention that "more proximal [in respect to the axon] spike-producing mechanisms" were not shown to be blocked by the compound is contradicted by the published data.

This point is emphasized only to remove any ambiguity, although the dismissal of the premise would be sufficient to dispense us from considering any further Kao's comment, including his conclusion. We would like, however, to touch also upon this point since Kao writes: "Thus, *it cannot be concluded unequivocally* that different membrane patches in the sensory receptors are responsible for generator potential and spikes" (italics ours). The difference between this statement and the conclusions of the original paper is so evident that no additional comment is required. This conclusion was: "The above-described findings indicate that spike and generator potential in the two receptors examined are independent events being subserved by different mechanisms. If so, *these are likely to reside in separate regions of membrane*, although the spatial arrangement may vary in different receptors (coarsely discernible regions of the cell, separate membrane patches within a region, and submicroscopic mosaic)."

CARLO A. TERZUOLO
Department of Physiology, University of Minnesota Medical School, Minneapolis
WERNER R. LOEWENSTEIN
Department of Physiology, Columbia University College of Physicians and Surgeons, New York City

References

1. C. Y. Kao, *Science* **144**, 319 (1964).
2. W. R. Loewenstein, C. A. Terzuolo Y. Washizu, *ibid.* **142**, 1180 (1963).

30 April 1964

Visual Display of Speech by Means of Oscillographic Roulette Figures

In a recent report (*1*), Barton and Barton describe the visual display of speech by means of oscillographic roulette figures, and suggest that this method of display might be useful in speech therapy with deaf children. With their method, a speech signal is applied across two identical circuits in parallel, each comprising a resistor and a capacitor in series. The output voltage to the vertical deflection plates is taken from across *R* in one leg of the network and that to the horizontal deflection plates from across *C* in the other leg. They indicate that the resulting patterns tend to be similar when a given speech element is pronounced by various speakers, and to differ between different speech elements.

It should be noted that the display of a signal versus its derivative is not novel to the literature. Servo engineers have long made use of plots of signal versus derivative (termed "phase-plane plots" or "phase portraits") in the study of systems by phase-plane analysis (*2*). The display of signal versus derivative was previously depicted (*3*) for speech elements and analyzed (*3*, *4*) by Marcou and Daguet. Lerner (*5*) used all-pass networks and obtained distinctive patterns that for many utterances were talker invariant (*6*).

The Bartons state that their display shows "essentially sound pressure versus the time derivative of sound pressure." This is not in general true, for with their condition that "the *RC* time constant of the circuit be placed well below the lowest fundamental frequency to be viewed," the display is essentially a plot of input signal versus its integral. Thus, their statement would be appropriate only in the somewhat unusual case that microphone output is proportional to the derivative of sound pressure.

We have experimented with apparatus according to the Bartons' description, and we think that this display method has only limited value for the stated purpose, though it may perhaps be useful in other applications. We examined the display with the input signal plotted versus both its integral and its derivative.

Our observations may be summarized as follows, for the case that an