"the changes in visual input that is time-locked to the stimulus," referred to by Horel and Vierck, should have appeared in the stimulus-averaged record—and they did not. The importance of finding a process in the striate cortex that is sensitive to response-linked events should not be underestimated, regardless of whether the mechanism turns out to be central or a response-initiated peripheral stimulus. In either case, a mechanism exists within the primary sensory receiving systems for collating information about environment-initiated events with those that are response-dependent.

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Horel and Vierck have raised the question of whether the differences in evoked-response wave shape in generalization trials (CR) and in trials in which no behavioral response (NR) was elicited by the test stimulus might be attributed to changes in head or eye position or movement toward the manipulandum. Of course, this question is relevant to proper interpretation of our observations and was also of concern to us. Our opinion that our findings were not due to such factors is based upon three kinds of considerations.

1) The animals in our study (*1*) were highly trained, having performed these responses consistently for well over 1 year. Recording sessions sometimes lasted as long as 6 hours, with periods during which trials were presented about once a minute. Gross changes in position occasionally occurred but were not accompanied by major changes in evoked-response wave shape. Usually, however, the cats sat relatively motionless in front of the manipulandum, mounted on an otherwise blank panel under overhead lighting which illuminated the entire cage. Little movement of head or eyes could be observed during either CR or NR events. On numerous occasions the cats were carefully observed to establish whether any change in head or eye position occurred as the change in the evoked-potential wave shape took place; no indication of movement was detected.

The early appearance of component II, in the 21 trials resulting in generalization, shown in Fig. 2 of our paper, occurred long before any response was made and did not correlate with the response latency, as one might expect from an anticipatory movement.

2) As illustrated in Fig. 1 of our paper, component II also appeared in nucleus reticularis, which does not map the retina. More intensive analysis of this phenomenon (*2*) shows that, during generalization, component II arises from an apparently endogenous process which appears in the visual cortex and the mesencephalic reticular formation with shortest latency and subsequently propagates to the lateral geniculate. Therefore, this component would appear to have a central, rather than a retinal, origin. Similar potentials have been observed in other cats under comparable conditions, frequently in nonsensory specific structures.

3) These endogenous components of evoked responses seem to be related to the endogenous electrical activity seen in recordings from animals and man in studies that use intermittent rhythmic stimuli. There exists abundant evidence of neural responses which reflect past rather than present stimulation: "assimilated rhythms" at the frequency of an absent stimulus have been observed in many species during intertrial intervals in various laboratories (*3*); "evoked" potentials appear at the time of expected stimuli in man (*4*); frequency-specific responses in various structures can be elicited by a steady tone after pairing with a rhythmic flash (*5*); release of potentials at the frequency of stimuli used during training has been observed during generalization to novel stimuli in various brain structures of the intact cat (*6*) and on the trained but not the untrained side of a split-brain cat (*7*); release of previous temporal patterns of stimulation after change in the stimulus frequency has also been reported in the isolated cortical slab (*8*) and in single cortical cells (*9*). Phenomena of this sort have been reviewed (*10*).

These various findings seem to support the idea that certain components of the sensory evoked response and portions of ongoing electrophysiological activity reflect the release of patterns of neuronal activity which relate to the perception of the stimulus and to the previous relevant experience of the organism.

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Venus: Tectonic Activity

Davidson and Anderson (*1*) proposed that the rate of volcanism and tectonic activity is greater on Venus than on Earth. Actually, the degree of tectonic activity, at least, is likely to be smaller on Venus if tectonic activity is caused primarily by convection currents in the mantle.

Davidson and Anderson's conclusion was based on two assumptions. The first is that the surface temperature of Venus is about 200°C hotter than that of Earth. The second is that the thermal gradient in the crust of Venus is about twice that in Earth's crust

(2). If the temperature gradient in the crust is linear, the first assumption leads to the conclusion that the Venusian isotherms lie about 10 km closer to the surface than the analogous isotherms in Earth (for a gradient of 19°C per kilometer) do. A consequence of the second assumption is that the 1300°K isotherm must lie even closer by 20 km. Davidson and Anderson therefore concluded that the crust of Venus could even be floating on molten rock.

If one makes the more reasonable assumption that the thermal gradients in the crusts of Venus and Earth are similar, the differences in the temperatures of the two planets at comparable depths become more modest. Qualitatively, however, the arguments of Davidson and Anderson are not affected by dropping the second assumption.

Suppose that the temperature gradients in the crusts and upper mantles of Venus and Earth are similar. Suppose further that the upper mantles of Venus and Earth are similar in constitution. An effect of a higher surface temperature of Venus is a decrease in the distance from the surface at which the (presumed) low-viscosity (low-strength) layer lies. In the case of Earth, the low-viscosity layer presumably starts at a depth somewhat below 140 km. If the surface temperature of Venus is indeed 200° to 300°C higher than Earth's surface temperature, its low-viscosity layer would begin at a depth of about 125 to 130 km.

A low-viscosity or low-strength layer can cause mechanical decoupling of the crust from convection currents in the mantle of a planetary body (3). Whether or not decoupling occurs depends on the depth of the low-strength layer (4). If the depth is shallow, decoupling occurs, but it does not occur if the low-strength layer lies deeper. In the latter case, convection currents below the low-strength layer cause deformation of the crust. We estimated (3) that the critical depth of the low-viscosity layer, above which the crust is mechanically decoupled from the interior and below which it is mechanically coupled, is of the order of 140 km. In the case of Earth, the low-viscosity layer appears to lie just deep enough to insure that the crust and upper mantle are mechanically coupled to convection currents in the lower mantle. We suggest that, if Venus has a surface temperature which is appreciably higher than that of Earth, the low-viscosity layer may be raised to a level above the critical depth. The Venusian crust then is decoupled mechanically from the interior. If this decoupling does occur, tectonic activity arising from mantle convection currents must be less vigorous on Venus than on Earth. Whether volcanic activity is greater or less in this situation is a nice question. Intuitively, one might expect that, if there is less deformation of the crust, there will be less volcanic activity. However, the increased temperatures at depth could lead to increased volcanic activity, as suggested by Davidson and Anderson.

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References and Notes

1. G. T. Davidson and A. D. Anderson, *Science* **156**, 1729 (1967).
2. These authors believe that the higher surface temperature of Venus is a consequence of a higher rate at which heat is transported from the interior of Venus. Because, in the case of Earth, the geothermal heat is such a minute term in the overall heat budget of Earth's atmosphere, it is very difficult to understand why doubling the value of the geothermal heat should lead to a substantially higher surface temperature on Venus. We believe that it is much more reasonable to assume that the amount of heat transported to the surface of Venus from its interior is just about the same as the amount of heat transported to Earth's surface.
3. J. Weertman, paper presented at Upper Mantle Symposium, Newcastle, England, February 1966, and *Geophys. J. Roy. Astron. Soc.*, in press; *Research Report No. 203* (U.S. Army Cold Regions Research and Engineering Laboratory, May 1966).
4. Why the depth of the low-viscosity zone (LVZ) is critical in determining whether or not the upper mantle (defined here to be the region above the LVZ) and the crust are coupled to the lower mantle may be explained as follows. Suppose that the strength of the LVZ is so small that no appreciable shear stress can be transmitted across it. The upper mantle cannot be deformed by convection within the lower mantle through any "drag" mechanism, regardless of the depth of the LVZ. However, if no phase changes occur in the LVZ, this zone is not a barrier to vertical thermal-convective motion in the mantle. The upper and lower mantles will be coupled if vertical convective motion does occur through the LVZ. Convective motion will occur in the upper and lower mantles only if the conductive (and radiative) heat-transfer mechanisms are inadequate for transporting the geothermal heat to Earth's surface. If the LVZ lies at a shallow depth, the heat-conduction mechanism is adequate for transporting all the geothermal heat through the upper mantle. No convection need occur in the upper mantle, although it may occur in the lower mantle. In that no appreciable shear stress can be transmitted across the LVZ, the upper mantle will not deform plastically. It is decoupled from the interior. If the LVZ lies at a great depth, the conduction (and radiation) heat-transfer mechanisms are inadequate to transport the geothermal heat through the upper mantle as well as through the lower mantle. Vertical convective motion through the LVZ can be expected to occur. Large tensile stresses, whose origin is the same as that of the stresses within floating ice shelves, will be set up and will plastically deform the upper mantle within rising convective currents. Compressive stresses will deform the upper mantle within the sinking currents. Despite the fact that no shear stress is transmitted across the LVZ, the upper and lower mantles are coupled. (If the LVZ did act as a barrier to vertical convective motion, convection still could occur within the upper mantle and cause its deformation. This convection would not be coupled with that occurring within the lower mantle. The size of a convective cell in the upper mantle would be comparable to the depth of the LVZ. The convection would not be part of a very much larger cell whose dimensions are of the order of the thickness of the lower mantle. Such convection would be inadequate to explain continental drift, unless the LVZ lies at a depth of the order of 1000 km.)
5. Supported by the Advanced Research Project Agency of the Department of Defense through the Northwestern University Materials Research Center.

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We admit that there is little well-confirmed data from which to infer surface conditions on Venus. We wish to point out, however, that the radiation-balance equations allow a considerable outflow of heat from the planetary interior. The interior heat may even be necessary to maintain the surface temperature if the atmosphere is indeed made nearly opaque by suspended dust. Perhaps an interior heat flow that is larger than expected might resolve some of the difficulties inherent in the greenhouse model for the atmospheric heat balance (1). Therefore, it is not unreasonable that the temperature gradient at the surface might be much greater than on Earth (a factor of 2 is conservative). Of course, further speculation would be useless unless measurements of subsurface thermal structure are forthcoming. Perhaps, as suggested by Pollack and Sagan (2), the phase variation of decimeter radiation might be used to deduce thermal gradients.

If the crust is very thin, an extreme degree of crustal deformation would probably not be necessary to initiate volcanism; almost any subsurface fracture would result in molten material and gases being forced to the surface. In this regard, it would be very helpful to know with more certainty the variations with pressure (and depth) of the melting points of crustal materials.

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