Table 1. Apparent heat content of titanium dioxide samples in four capsules. Drop 1, α-PbO_2 plus transformation; drop 2, rutile. The average for drop 1 was 10.29 ± 0.07 kcal per mole; that for drop 2 was 11.05 ± 0.16.

Pt (mg)	TiO_2 (mg)	$(H^\circ_{965} - H^\circ_{294})$ kcal/mole	
		Drop 1	Drop 2
0.11940	0.11164	10.215	10.953
.13100	.13927	10.381	11.287
.12506	.15521	10.314	10.989
.14500	.16465	10.254	10.979

of transformation. This is indicated by the appearance of the powder diffraction pattern of the transformed sample, which shows sharp lines characteristic of rutile. Consequently, the enthalpy of transformation of the unstrained high-pressure polymorph to rutile would be somewhat less exothermic than that of the strained sample.

Gross (*6*) showed that the stored energy in heavily deformed calcite represents some 1 to 2 cal/g. If this value is typical of simple ionic crystals, we estimate that the contribution of strain energy to the observed enthalpy of transformation represents some 10 to 20 percent of the measured quantity. However, a significant fraction of this correction, perhaps more than one-half, would be compensated by the presence of 5 to 10 percent rutile in the untransformed sample. Because we lack more quantitative data on the magnitude of the stored energy, we shall not attempt to pin down this effect.

If information is available on the standard enthalpy, standard entropy, and standard volume change of a given transformation, we can estimate in principle the equilibrium pressure (P_{eq}) at a given temperature by means of well-known thermodynamic methods. Among the mentioned quantities, we do not now have any data on the entropy of transformation from rutile to the α-PbO_2 modification.

Because this transformation is accompanied by a relatively small volume (V) change ($\Delta V = -2.8$ percent), we estimate ΔS° to be small, probably of the order of ± 0.5 cal/deg^{-1} mole^{-1} or less. At room temperature (T) and below, the term $T\Delta S^\circ$ for reaction 1 presumably will be small compared to ΔH°. This provides a justification for making a very rough estimate, of the equilibrium pressure for the considered phase transformation, based on neglect of the entropy contribution and compressibility effects:

$$P_{eq} \simeq \Delta H^\circ_{298}/\Delta V^\circ_{298}$$

If we set $\Delta V^\circ_{298} = -0.028$ $V^\circ_{rutile} = -0.0126$ cal/bar, this yields an estimated equilibrium pressure of 60 kbar at 298°K. It is difficult to ascertain the uncertainty in this figure, but it is probably less than ±20 kbar.

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Basilar Membrane Vibration Examined with the Mössbauer Technique

Abstract. *The tuning curve has been measured, in vivo, at a point approximately 1.5 millimeters from the stapes in the first turn of the guinea pig cochlea. Curves for constant stapes movement and constant sound pressure were obtained over the range 350 hertz to 30 kilohertz, with an amplitude peak at about 18 kilohertz.*

Bekesy (*1*) has published observations of the movement of the basilar membrane and has presented approximate drawings of the relative amplitude of vibration as a function of frequency, as determined at several points along the membrane. No absolute values of these amplitudes were presented, however, and all the observations were made on the apical coils, as the technique did not permit the observation of the higher frequencies associated with the basal turn. This was very unfortunate, since much of cochlear electrophysiology is based on recordings from the round window and the basal turn.

The Mössbauer effect permits the measurement of very small velocities, and this technique has been applied to the study of vibrations of the eardrum and of the ossicular chain (*2*). We have used the technique to measure, in vivo, the absolute amplitude of vibration of the basilar membrane in the first turn of the guinea pig cochlea. By simultaneous measurement of the stapes displacement, we were able to refer the basilar amplitude to a constant stapes amplitude, as well as to a roughly constant sound pressure.

The basilar membrane of the first turn was exposed by enlargement of the round window, and a source of Co^{57} in 5-μ-thick stainless steel foil (area, 0.008 mm^2; mass, 0.3 μg) was placed on the membrane about 1.5 mm from the stapes. A similar source (area, 0.014 mm^2) was placed on the incostapedial joint. A small, thin copper shield, sufficient to stop the 14-kev Mössbauer line, was arranged so that each source could be covered in turn. The absorber was a stainless steel foil enriched in Fe^{57}; this had a nominally zero isomer shift with respect to the source. Sound was turned on for 4 seconds every 8 seconds, and the output from the detection system was fed to two scalers gated to record for sound on and off, respectively. The sound pressure was adjusted, usually between 60 and 95 db SPL (that is, relative to 0.0002 dyne/cm^2), so as to give a count rate difference between the scalers of 10 to 30 percent; these differences correspond to velocities of 0.2 to 0.6 mm/sec. Thus, at 20 khz, a peak amplitude of 15 Å could be measured. The count rates were such that a statistical accuracy of 10 percent in each determination could be achieved in about 3 minutes. The difference in count rate in terms of velocity amplitude was calibrated with the sources mounted on a vibrator driven through an LV syn; the voltage output from this gave the velocity amplitude directly. Care was taken to duplicate the conditions of the actual experiment in which there is an increase of background in the counting channel over that from one source alone due to the presence of a background from the other shielded source.

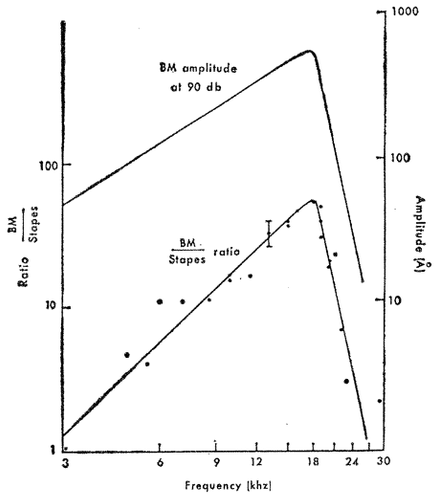

Fig. 1. Tuning curve of the basilar membrane at 1.4 mm from the stapes. The lower curve is referred to a constant stapes amplitude. The upper curve is for a constant sound-pressure level of 90 db SPL; the amplitudes are peak ($\sqrt{2}$ times the root mean square) values.

Tuning curves were obtained for the membranes of ten animals, and all had maximums between 18 and 21 khz. Figure 1 shows the result for one guinea pig. Other animals gave very similar curves, but the results were not so complete: in one case, measurements were continued down to 350 hz; in another case, more accurate data were recorded at 0.5-khz intervals in the region of the peak. The correction of each basilar measurement to constant stapes amplitude completely eliminated the large fluctuations of sound pressure introduced by standing wave patterns in the vicinity of the ear; this was particularly important at the shorter wavelengths in the region of the peak.

The amplitude of the stapes motion for constant sound pressure was observed to fall at 4 db per octave with increasing frequency. With this result it was possible to calculate the absolute amplitude of the basilar membrane movement; the upper curve in Fig. 1 shows the result for a constant sound-pressure level of 90 db SPL. The uncertainty of this level would not exceed 5 db.

The tuning curves, illustrated by the lower curve of Fig. 1, resemble those obtained by Bekesy but are more sharply peaked, with a Q (resonance frequency divided by the half-power band width) of 2.5 (most of Bekesy's curves have a Q around 1.6 or less). This value of Q is still smaller than that for a typical first-order neural tuning curve. The slope on the low-frequency side is 13 ± 1 db per octave, and this is maintained down to about 3 khz; from here down to 350 hz the slope is slightly reduced to around 10 db per octave. The high-frequency slope is 70 ± 10 db per octave. The maximum ratio of basilar membrane amplitude to stapes amplitude is about 50 to 1, and the maximum basilar membrane amplitude at 90 db is 600 Å at 18 khz. The main systematic error in the amplitude ratio will arise from the uncertainty in the angle between the direction of motion of the source on the stapes and the direction of the line from the source to the detector. It is unlikely that this angle exceeded 60° to 70°, and, since the detector subtended an angular range of about 45°, the maximum correction to the ratio would be by about one-half. The shape of the tuning curve and the absolute amplitude curve are not affected.

Bekesy (*3*) gives a value for the maximum amplitude of motion of the basilar membrane measured at high sound-pressure levels in the human ear; in the range of 2 to 3 khz his results would suggest a value of 400 Å at 90 db SPL. Bekesy (*4*) also gives some values for the ratio of basilar membrane to stapes amplitude derived from his work (*1*); at 3 khz the ratio is about 10, and Bekesy remarks that it should increase with increasing frequency as the surface area of the membrane that is set in motion becomes smaller. Both these results are quite consistent with our work.

Changes in the source mass by a factor of 2 did not produce any significant change in our results. Furthermore, it did not seem to matter whether the first turn of the scala tympani was dried or full of perilymph, a result in accord with the model experiments of Bekesy (*1*).

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Dissociation of the Visual Placing Response into Elicited and Guided Components

Abstract. *Kittens reared without sight of their limbs extended their forelimbs when carried down toward the edge of a horizontal surface. However, unlike normally reared kittens, they were not capable of guiding their paws accurately to the solid parts of an interrupted surface. This fractionation of the visually controlled placing response reveals that the guided reach requires an integration of sensorimotor systems not necessary for development of the elicited extension response.*

As a cat is carried down toward a visible surface, its forelimbs extend automatically as if to prevent collision. This response, called visual placing, is common to many mammalian species. It has been used as an indicator of integrity of the neural mechanisms underlying visuomotor behavior since Rademaker's report in 1931 (*1*). More recently, it has served to measure deficits resulting from special conditions of rearing, removal of brain tissue, and combinations of the two (*2*). By the use of a special rearing procedure and a refined testing technique, we have been able to show that, even though a cat will extend its forelimbs on approach to a surface, it may be quite unable to guide these limbs toward particular objects. This hitherto undescribed dissociation of two aspects of the placing response can serve to distinguish gross from subtle deficits in the visual control of response. As a consequence, new distinctions may be made among underlying neural mechanisms.

Visually controlled placing is conveniently tested without special apparatus or training of the animal. Typically, the hindlimbs and torso of an animal are supported in the experimenter's hands while the forelimbs and head are free. The animal is carried down toward the edge of a horizontal surface. A normal animal extends its forelimbs when close enough to reach the edge, but prior to contact of the head or paws with the surface. To eliminate tactual cues from the whiskers, they are cut prior to testing. Several alternative experimental procedures may be used: (i) The animal may be moved either forward or sideways toward an edge; (ii) the surface, rather than the animal, may be moved to