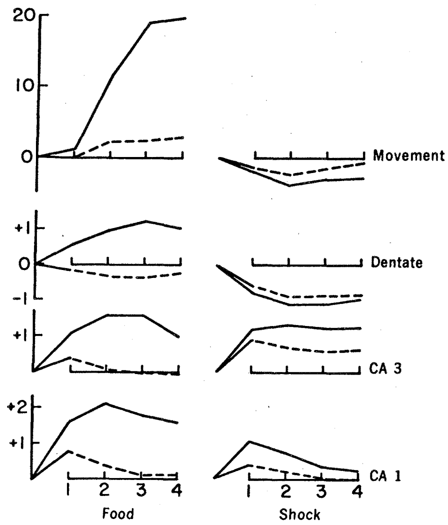

Responses in days 5 and 6

Fig. 2. Averaged response curves in the various hippocampal areas. The data of the kind presented in Fig. 1 were reduced to four periods, 250 msec each, for the 1-second CS-US interval. The amount of activity in each of these periods is presented in terms of deviation from a background level. Figure 2 shows an average of the units in the various areas under the two experimental conditions. Solid line = response to CS+; dashed line = response to CS−. The ordinate scale is of standard scores. The sample sizes are: dentate, $n = 13$; CA-3, $n = 9$; CA-1, $n = 11$. Gross movement: $n = 12$ (the total number of animals in the experiment).

septal nucleus (*13*) or directly from the reticular formation. (These possibilities have to be explored in further experiments.) If this were the case, it would mean that the dentate gyrus has to do mainly with positive reward, and that the hippocampus proper is more easily activated through the dentate circuit, in a positive reward situation. In any event our data clearly indicate a differential response between dentate and the CA-3, CA-1 system when a fear-inducing stimulus is supplied, in spite of their similar response to stimulations which could be expected to instigate more positive anticipations. This differentiation of dentate activity from that of the hippocampus into which it projects mitigates the possibility that there is some gross arousal function of the formation which includes both of these large groups of highly organized neurons, and favors a more complex role for this system in the processing of information.

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5. The shock was a continuous ¼-second, 50-hertz pulse, 1.5 to 2.5 ma, applied through two wires 4 to 5 cm apart implanted under the shoulder skin.
6. Movement was detected by means of a "noisy" wire attached to the animal's head. Head movements generated potentials in the wire which were amplified and fed through a schmitt-trigger to the computer. For further details see (*4*).
7. A total of 48 (four out of each rat) units was recorded; 15 of them were excluded from the final sample prior to any analysis because of (i) disappearance of the unit during the experimental session (five cases), (ii) various quality criteria [see (*4*)] (three cases), and (iii) units which were found in other structures or were not clearly localized within the hippocampus (seven cases).
8. After termination of the experiment the rats were killed by an overdose of Nembutal. A 10-μa d-c lesion current was applied for 15 seconds through the electrode before perfusion with 10 percent formaldehyde. The brains were sectioned in 60-μ slices on a freezing stage and stained by cresyl violet and Weil methods. Probe tips were easily located.
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27 September 1971; revised 12 November 1971

Nuclear Magnetic Relaxation Time of Blood and Blood Velocity

Morse and Singer (*1*) reported the nuclear magnetic resonance (NMR) longitudinal relaxation time T_1 of blood samples as 0.4 ± 0.03 second both in vivo and in vitro. They claimed that T_1 is constant, and, based on this value of T_1, they calculated the blood flow velocity. It is not probable for blood to have the same relaxation time both in vivo and in vitro as the milieu interior of the blood may affect the relaxation time of blood in vivo.

There are a few other factors, in addition to velocity, which affect the relaxation time of a fluid, and T_1 cannot be the same for all types of blood. One of us (J.K.) has studied several phenomena of flowing fluids using the NMR technique (*2*). This study showed that the variations in the amounts of oxygen and paramagnetic materials in a fluid would affect T_1 to a considerable extent. The value for T_1 of $0.0015M$ $MnSO_4$ solution was found to be 0.278 second, and that of $0.0005M$ $MnSO_4$ solution was 0.675 second. Similar variations in T_1 were noted for fluids containing $FeCl_3$ or other paramagnetic materials.

Saraf (*3*) reported that changes in concentrations of different ions in a fluid would affect the T_1 of that fluid. He determined that the NMR signal for a solution consisting of 0.1 mole of NaCl per liter of solution was 50 units, and the NMR signal for a solution consisting of 1 mole of NaCl per liter of solution was 38 units.

Therefore, the presence of varying amounts of oxygen, paramagnetic materials, and other salts in blood can give different values of T_1, even though the blood has the same flow velocity. Similarly, blood samples having the same flow velocity may have different values of T_1. It is very important to take into consideration the effects of these factors if the NMR technique is to be used for determining blood flow velocity.

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Kumar and Kumar are correct in saying that the nuclear magnetic resonance (NMR) relaxation time (T_1) of blood does vary. In fact, we have been engaged in a yearlong study of the magnetic relaxation times of blood samples (*1*). However, the measurement of blood flow velocity by means of our techniques (*2*) does not depend on the NMR relaxation time. In order to illustrate this point, I here briefly recapitulate our technique for the measurement of blood flow.

The flow channel is placed in a magnetic field long enough for nuclear polarization to occur. There are two separated radio-frequency coils arranged along the flow path. Coil 1 is connected to a radio-frequency pulser coil. We call the region of deorientated fluid the "bolus." The NMR signal detector "sees" normal NMR signals until the bolus region arrives at the region of the detector coil (coil 2). At that instant of time the detector "sees" a sharply reduced (in some arrangements a negative) NMR signal. By measuring the distance between coil 1 and coil 2, and dividing by the time between the pulse initiation and the reception of the reduced NMR signal, the average flow velocity is obtained. The value of T_1 does not affect the flow measurement. It is only necessary that T_1 not be much smaller than the time needed for the bolus to reach the detector coil.

The principle of the design of this type of NMR flow measurement has been more completely described in our earlier papers (*3*). The Badger Meter Company manufactures a commerical NMR flowmeter based on that design suitable for fluids of widely differing T_1 values.

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22 November 1971

Absolute Dating Techniques

In their report (*1*) on the ages of crystalline rocks from the Apollo 14 mission, Husain, Sutter, and Schaeffer present some important results using the ^{40}Ar-^{39}Ar method. This technique, which has been used by several other workers, depends critically on the use of mineral or rock standards of precisely known $^{40}Ar/K$ ratio. The "age" of the standard is not directly relevant. What is required is the $^{40}Ar/K$ in the standard. These standards should be adequately documented somewhere in the literature. Often the point is missed that the ^{40}Ar-^{39}Ar age is not absolute, but is *relative* to $^{40}Ar/K$ of the standard sample. The uncertainty of absolute ages determined by this method *must* include any uncertainty in the $^{40}Ar/K$ ratio of the comparison sample. At the present stage of development of argon-potassium dating in particular, and geochronology in general, it is rather surprising to find that workers continue to determine ages on lunar samples, using "standards" (terrestrial or otherwise) which are themselves uncertain to several percent. In the work by Husain *et al.* it would appear that the actual uncertainty in age due to both analytical error and the error in the hornblende monitor is $3.77 \pm 0.15 \pm 0.15$ eons, or $3.77 \pm \sim 0.30$ eons. Analytical techniques which have been available for some years easily permit more definitive measurements to be made, particularly on valuable lunar materials.

Since the time interval over which lunar igneous activity is presently observed to occur is rather restricted (4.00 to 3.20 eons from current data), the necessity for adequately precise data is apparent.

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8 October 1971

The comments of Wasserburg *et al.* are in part misleading and in part incorrect. (i) Only our report on ^{40}Ar-^{39}Ar dating is singled out, as though our work (*1*) is particularly poor in that we use a standard which is uncertain in age to a few percent. Our standard has an age of $2.61 \pm 0.06 \times 10^9$ years (*2*); in another case, Turner, Huneke, Podosek, and Wasserburg (*3*), a standard is used with an age of $1.062 \pm 0.020 \times 10^6$ years, an error of 1.9 percent compared to our error of 2.2 percent. (ii) The method used by Wasserburg *et al.* for computing the propagation of errors is incorrect. The combined error is not a simple arithmetic addition. What is even more important is that the $3.77 \pm 0.15 \times 10^9$ years age quoted in the abstract of our paper (*1*) is the mean age, and the error represents the spread in ages. As such the uncertainty due to the standard age hardly influences the results.

Finally, we would like to comment directly on the reliability and precision of the ^{40}Ar-^{39}Ar method as compared to the Rb-Sr method of age dating. At the present time, while the ^{40}Ar-^{39}Ar method of age dating is still relatively new, the results for lunar rocks agree well with the Rb-Sr method. We have only to quote Papanastassiou and Wasserburg (*4*): "The ^{40}K-^{40}Ar [that is, ^{40}Ar-^{39}Ar] ages determined on the same samples are in good agreement with the Rb-Sr results. There is thus clear evidence that these ages represent the true crystallization ages of these rocks."

The precision of the Rb-Sr method is now only slightly better than the ^{40}Ar-^{39}Ar method. This seems remarkable considering the relative newness of the ^{40}Ar-^{39}Ar method. It appears to us that with refinements such as better standards, and better understanding of the argon release patterns from different minerals, the ^{40}Ar-^{39}Ar method may well prove to be the best method for dating lunar rocks. It already possesses the distinct advantage of small sample requirement, milligram amounts. In addition, an important class of lunar rocks which appear to have high Sr contents and to have vanishingly low Rb contents, the anorthosites, are probably not datable by the Rb-Sr method.

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