that the moons are dark enough to be made of water-rich carbonaceous chondrite material, which probably could not have formed as close to the sun as Mars (although, points out Joseph Veverka of Cornell University, the color distinctions involved are subtle enough that earth's moon, by comparison with a carbonaceous chondrite, is considered "reddish").

Still stronger evidence may come early next year during Viking's post-solar-conjunction "extended mission," when flight officials hope to send one of the orbiters to within 30 kilometers of Phobos. The satellite's gravitational effects on the spacecraft's orbit should enable precise calculations of its density, revealing whether it is more like the 2.0 grams per cubic centimeter of a carbonaceous chondrite or the 3 to 3.5 grams of basalt.

If Phobos and Deimos were indeed formed elsewhere and captured, says Veverka, it is likely that they were captured while both were still part of a much larger object which later broke up, with the remaining fragments crashing into the planet or escaping into space. It would take a large object, he says, to produce strong enough tidal interactions with Mars to produce the present circular, equatorial-plane orbits that neither moon would be likely to have achieved on its own. If the two have different densities, however, it would suggest either two separate captures of larger objects or that circular, equatorial-plane capture is easier than now believed. □

Swine flu vaccine: Facts vs. fears

On Oct. 1, after extensive birth pains and controversy over its necessity, the swine flu vaccination program got underway throughout the United States. But its success was short-lived. On Oct. 11, three elderly persons died within 48 hours after receiving the vaccine at a Pittsburgh clinic. As a result, vaccination was suspended in a few states. By Oct. 13, some 35 older persons in 17 states had died within 48 hours of receiving the vaccine. The Center for Disease Control in Atlanta attempted to determine whether any of these deaths was due to the vaccine.

By Oct. 18, the CDC concluded that none of the deaths could be blamed on the vaccine, and the vaccination program moved ahead full tilt once again. However, many Americans, particularly older persons, have remained skeptical about the safety of the vaccine. Precisely what are the scientific facts behind the scare?

Although some 35 persons age 65 or older died within 48 hours after getting the vaccine between Oct. 1 and 13, there were almost a million other older Americans who also got the vaccine during that period and suffered no serious effects. Statistics from CDC show that 116 elderly Americans out of one million usually die every 24 hours under normal circumstances, suggesting that there was no connection between the vaccine and the deaths. In fact, the statistics suggest that there were considerably fewer deaths among those older persons getting the vaccine than among those who did not get it. Or in the words of Robert Webster, a flu vaccine scientist at St. Jude's Children's Research Hospital in Memphis, "If you want to play the numbers game, you can play it the other way around, that is, that the flu vaccine protects you from dying."

Webster doesn't really believe that, though. Then why were there actually fewer deaths among older vaccine recipients than among older nonrecipients? "Because the people who are really sick and in bed are not going to receive the vaccine," Webster suggests.

There is other evidence to exonerate the vaccine. Of the 35 deaths, 20 were the result of heart attacks; seven were the result of miscellaneous cardiovascular problems, and the others the result of diabetes, respiratory failure, lung embolism and lung hemorrhage. None of them were diagnosed as the result of flu, especially swine flu. These findings do not surprise flu vaccine scientists. All the flu vaccines that have ever been commercially available in the United States, including the swine flu vaccine, are made from killed flu viruses. None has ever been known to cause the disease it is supposed to guard against, attest both Webster and Robert Golasso, chief of the Infectious Disease Branch of the National Institute of Allergy and Infectious Diseases. The case is different for vaccines made from attenuated live viruses, such as the polio vaccine. Such vaccines have, on rare occasions, triggered the disease they were supposed to prevent (SN: 10/2/76, p. 213).

Although a killed virus vaccine cannot cause the disease it guards against, it might, of course, contain some chemical contaminant that could trigger disease. But CDC officials were not able to find any evidence of such material in vaccine batches. And whereas vaccines sometimes provoke allergic reactions in persons who are allergic to eggs or egg protein, autopies of the Pittsburgh vaccine recipients who died did not show evidence of such reactions. Also, allergic reactions to vaccines have never caused a death as far as Webster can recall.

Nor is it likely that the vaccine stressed older persons so badly that they died from the stress. As Robert M. Alden, a CDC spokesman points out, heart attack patients probably get more shots than healthy persons, so it is hard to imagine that a shot of vaccine would stress them anymore than, say, a shot of antibiotic. Golasso, however, concedes that traveling to a clinic for vaccination could be so stressful for sick, elderly people that it might have triggered some of the deaths that followed vaccination. Indeed, one elderly man died even before he was vaccinated—while reading a vaccination consent form. "No one has ever connected a heart attack with a vaccine," Golasso asserts. "Now stress, that's something else."

So taking these various factors into consideration, it is the consensus of the vaccine authorities both in and out of the CDC that the swine flu vaccine has not caused any deaths to date. □

Brain asymmetry present at birth

The intricate workings of the brain's 10 billion cells will not be explained in the near future, but during the past 10 years there has been an explosion of information relating the workings of the brain's two hemispheres to some basic human behaviors. It is now fairly well established that the left hemisphere functions predominately in language-oriented activities while the right hemisphere possesses superior spatial-perceptual capabilities. When and how does the brain develop this lateralization and specialization of hemispheric functioning? This was among the questions addressed this month at a conference on the evolution and lateralization of the brain sponsored by the New York Academy of Sciences.

In the early 1960s most of the evidence suggested that the two hemispheres are virtually equal in potential with regard to the acquisition of language, at least until the age of two. In other words, the hemispheres start out the same and then differentiate as language is acquired. Juhn A. Wada of the University of British Columbia in Vancouver now says, "It cannot be assumed that the two hemispheres are equally potential for speech at any time." Wada suggests instead that the left hemisphere is prepotent or predisposed for language development at least from birth. This conclusion is based on studies of both the structure and function of infant brains.

It has long been known that adult brains are morphologically asymmetrical, and Wada's examination of more than 100 infant brains now confirms similar asymmetry in infants, with the left side usually larger. These asymmetries are inborn, says Wada, and are not due to environmental or developmental factors after birth. They are present and visible at the twentieth week of gestational age and can be measured objectively by the twenty-ninth week.

What does such morphological asymmetry mean? Are the asymmetries coincidental? Do the larger areas represent underlying speech mechanisms or do they represent capabilities other than speech? "Unfortunately," says Wada, " the extent of our understanding of these perplexing problems is practically zero at this

moment. In my view, however, it is not of much value unless we know the microneuroanatomical basis of such gross morphological asymmetry and needless to say, such an understanding will require a carefully planned and sophisticated technical approach and expertise in order to gain insight into this problem."

In the absence of microneuroanatomical data and the techniques for obtaining them, researchers have relied in recent years on neuropsychological and electrophysiological techniques for determining hemispheric functioning. Most such studies have been concerned with responses to verbal and nonverbal stimuli. But if, as Wada suggests, functional asymmetry exists before the development of language, then it should be possible to identify hemispheric differences without using verbal stimuli. Wada and Alan E. Davis have studied hemispheric responses to flashes and clicks and now report electrophysiological evidence suggesting that functional brain asymmetry is present at or near birth.

The flash and click experiments were first performed with adults. As expected, the flash evoked activity in the right hemisphere and the click in the left hemisphere. An interesting finding with regard to handedness came out of these experiments. Handedness had no significant effect on the results. Both right- and left-handed subjects responded in the same way to the stimuli. "We believe," says Wada, "that handedness is not significantly related to cerebral speech dominance. In other words, the majority of the normal population is left speech dominant, regardless of their handedness." There does, however, appear to be some trend in left-handed individuals to show a greater degree of bilateral speech representation than in right-handed individuals. Only 10 percent of the right-handed population but 50 percent of the left-handed population displays bilateral representation.

When the flash and click experiments were conducted with 50 infants (mean age of 5 weeks) similar, but not identical, results with regard to asymmetry were found. "The functional implication of such a finding is not yet clear," says Wada, "although intriguing alternative possibilities could be entertained. . . . It is suggested that language is only a part of much more fundamental asymmetries which include the processing of both auditory and visual information. Our results and those of others have shown changing hemispheric asymmetries with speech *versus* nonspeech sounds, verbal *versus* nonverbal visual stimuli, and nonspeech stimuli in different modalities. These results are consistent with the assumption that the left hemisphere is more able to relate stimuli to past experience, either short- or long-term, while the right hemisphere is more able to process stimuli which are not easily identifiable or referable. These capabilities would not be based on language, and hence would be expected to develop independently and possibly before speech."

"Finally," concludes Wada, "I believe that it is now absolutely imperative to make a very serious and concerted effort in terms of microneuroanatomical exploration of both adult and infant brains in order to gain better insight into the underlying fundamental mechanisms of brain asymmetry which exists at or before birth." □

The sound-centered brain of the bat

The mustache bat of Panama emits a 61-kilohertz signal to locate its insect prey. The hearing system of these bats is specialized to accurately detect and analyze echoes of this sound. In the auditory portion of the bat brain, a disproportionately large area is occupied by nerve cells processing these echoes, researchers report in the Oct. 29 SCIENCE.

Research on other parts of the brain suggested that the extent of the areas processing sensory input depends on the importance of the sensory information to the animal's survival. In the visual cortex of primates, for example, disproportionately high numbers of cells receive input from the center of the visual field. In the processing of touch, the brain area receiving input from hands of primates is large compared with the areas receiving input from other body surfaces.

The predominance in the bat of brain neurons tuned to 61 to 63 kilohertz, reported by Nobuo Suga and Philip H.-S. Jen of Washington University in St. Louis, is the first observation of disproportionate representation in the brain auditory region.

To determine the most effective tone for stimulating particular brain cells, Suga and Jen penetrated the brain auditory area with a wire electrode. They then recorded the electrical activity in response to sounds from a loudspeaker. They could examine up to 90 brain locations in a single bat.

On a map of the brain, Suga and Jen charted the most effective frequencies for stimulating cells. In the simplest auditory area, there was an orderly representation of different tones from 24 to 100 kilohertz. As described in other mammals, the brain cells sensitive to the highest frequencies were located in bands toward the front of the brain and those sensitive to low frequencies toward the back.

The central third of the auditory area was found to contain only neurons responsive to frequencies of 60.5 to 63 kilohertz. This region was arranged differently from the ends of the auditory area. Neurons sensitive to 60.5 kilohertz were surrounded by rings of nerve cells tuned to higher and higher frequencies.

The constant tone of 61 kilohertz emitted by the bat is sometimes preceded by a faint sound of increasing frequency and is followed by a short sound in which the frequency sweeps downward. The bats use the constant tone, Suga explains, to determine how fast a target is moving, while the modulated sounds locate and identify insects.

Suga and Jen determined that the brain cells processing the frequency modulated signals were located in an area separate from the cells responsive to the constant-frequency tones. Within this second area, the cells were again arranged according to their most effective frequencies.

Studies with a second species of bat, the little brown bat, support the proposed relationship between brain organization and biological significance. In contrast to the mustache bat, the little brown bat uses no constant frequency signal, but only modulated sounds with a broad band of frequencies.

Suga and Jen found that the cells in the auditory cortex of this bat were also organized in bands ranging from those sensitive to the highest frequency to those sensitive to the lowest frequency. For the little brown bat, however, there was no disproportionate representation of cells responsive to sounds with any particular frequencies. □

NSF: Projecting R&D

The National Science Foundation has released its projections on the growth of research and development for the next decade. Growth is expected to be steady but unspectacular, with R&D receiving an ever smaller share of the gross national product. (All figures in terms of constant 1972 dollars. Any real growth would reverse the 1.2 percent average annual decrease since 1968.)

Total R&D expenditures are projected to reach more than $38 billion in 1985, representing a 3.0 percent annual real growth. But the proportion of the GNP devoted to research will decline from 2.2 percent at present to roughly 2.0 percent. Such a decline has been experienced since 1964.

Federal R&D expenditures are expected to increase 2.6 percent a year, to $19.3 billion in 1985, while industrial R&D spending is projected to rise more quickly, at 3.5 percent a year. Much of the industrial increase would result from swift growth of the chemical industry. Defense spending is expected to account for much of the growth in federal R&D spending.

Universities, colleges and other nonprofit institutions are expected to increase their spending by only 1.0 percent a year for the period. Such a leveling off will mean that by 1985, such institutions will account for only about 2.9 percent of the nation's research spending. □