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 non-profit 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. □