monkeys may react to the same sound quite differently.

The vervets are not absolutely consistent about what intruder triggers an alarm call, so the scientists in the field kept track of the "mistakes." They found that the adult monkeys seldom err, juveniles err more frequently and infants err most frequently of all. The juveniles, for instance, give the eagle call on occasion at the sight of an innocuous bird such as a stork or a spoonbill. Infants carry their caution even further; one gave the eagle alarm at the sight of an airborne leaf.

"Although they make mistakes, there is an order to the errors," Marler says. The young monkeys, for instance, may give an eagle call at the sight of a pigeon, but they never mistakenly give the eagle call in response to a leopard. "It's as though they have a generally preordained mechanism, which specifies that the eagle alarm call should be given to something that may be defined as 'moving up above' of a certain size and with a certain trajectory," he proposes. Initially for the young monkey, many stimuli satisfy that requirement. Gradually, however, the animals' perception becomes more discriminating, like children sharpening their semantic sense, Marler says.

Marler suggests that these animal studies offer a glimmer of hope for experimental elucidation of the process by which a child brings "innate knowledge" to the task of developing understanding. "We blind ourselves to the prospect of new discoveries if we insist on treating animals as though they were automata. The knowledge they have of companions and their surroundings is probably as intricate and complex as our own, though with an emphasis that is unique to each species," Marler says. In other work Marler observes among songbirds a complex mix of innate tendency, imitation, modification and invention (see p. 362). In discussion at the recent meeting in Atlanta of the Society for Neuroscience, James L. Gould of Princeton University challenged the idea that complexity of a behavior necessarily implies cognition. He says that what appears to be animal awareness and intentions may just be preordained, preprogrammed learning routines combined with scientists' ignorance of how complicated such programs can get. His work with bees (SN:11/17/79, p. 342) indicates that apparently complicated feats of communication can be described by simple rules that could be genetically determined.

Donald R. Griffin of Rockefeller University emphasizes the importance of gathering information about whether nonhuman animals have intentions or are aware of themselves in relation to their surroundings. "A cognitive ethology can thus hope to illuminate the fundamental dimensions of those attributes we loosely call thinking and which, in their most versatile manifestations, are the sources of our most pro-

Fluoride: Prevents caries longer

Tooth decay may not be the most serious or painful health problem in the United States, but is probably the most common and certainly the most enduring. Most — but not all — dental researchers consider fluoridation the most effective means of preventing dental caries (SN: 9/1/79, p. 152). Now, in the most recent follow-up of a clinical study started in 1969, it looks as if fluoride's protective effects continue after treatment with fluoride tablets ceases. A year and a half after treatments were discontinued, the children in the Wayne County, North Carolina Public Health Service study who had received one or two fluoride tablets daily for six school years had fewer dental caries than those who had received a flavored placebo tablet. Both during and after treatment, the fluoride group had between 32 and 35 percent fewer caries than the control group.

The study — conducted by William S. Driscoll, Stanley B. Heifetz and Janet A. Brunelle of the National Institute of Dental Research — started in 1969 when the 1,064 children were in first or second grade. After the original check-up, they were re-examined at intervals of 30 months, 55 months and six years. Following the six-year check-up, the fluoride/placebo treatments were stopped. Then in 1977, after one and a half treatment-free years, 354 children who had also been checked after six years were re-examined. This examination showed that "... cariostatic [anti-caries] benefits continue to be apparent for both [one and two] tablet treatment procedures at the end of seven and one half years.... Thus, the caries preventive benefit did not diminish as a result of discontinuing such treatment."

The study examined not only the protective effects of fluoride tablets, but also looked at the cost-effectiveness of using the treatment on large numbers of children. Overall, the fluoride treatments cost about $25 per child for six school years and — if the post-treatment period is included — prevented 3.65 "decayed, missing or filled" tooth surfaces from occurring in each child during seven and a half years. This means that it cost about $7 to prevent each decay, compared with the $10 to $20 it costs to have a decayed tooth filled. □

Dean justifies psychic research

Many respectable scientists, from Einstein on down, have speculated on the credibility of so-called "psychic" phenomena and on how they can be studied scientifically. Generally such efforts to legitimize this study have been thwarted by the obvious presence of charlatans and fools among reputed psychics and by open hostility from the scientific community at large. Perhaps worst of all, few new theoretical or experimental approaches to the subject have been generated.

Now a fresh set of "psi" experiments involving sophisticated technology has been designed by Princeton University's dean of Engineering and Applied Science, Robert G. Jahn, and his co-workers. Although Jahn is not yet ready to publish any conclusive results, he has offered some thoughts on a theoretical approach to psychic phenomena and has concluded that "once the overburden of illegitimate activity and irresponsible criticism is removed, there is sufficient residue of valid evidence to justify continued research."

Jahn, best known for his pioneering work with plasma discharges, summarized his two-year experience with psychic research during a recent science writers' meeting in Palo Alto.

Traditional psychic research has amounted to little more than the collection of anecdotes of spontaneous events, which tend to be spectacular but unverifi-

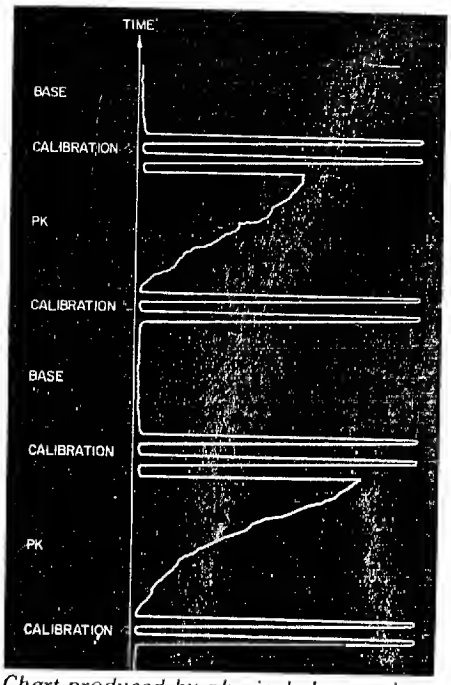


Chart produced by physical changes in a Fabry-Perot interferometer clearly shows different effects when a subject just relaxed (base) or tried to influence the instrument through psychokinesis (PK).

experiments, results of which can be scrutinized but not clearly interpreted. What the Princeton researchers have tried to do is design experiments in which the [illegible] to statistical analysis.

The work started when an undergraduate, Carol K. Curry, asked Jahn to supervise

data processing skills. The researchers began with some simple extrasensory perception exercises to see if they were indeed capable of generating effects to study"—then moved on to designing equipment to measure psychokinesis — a palpable disturbance of a physical system by thought alone.

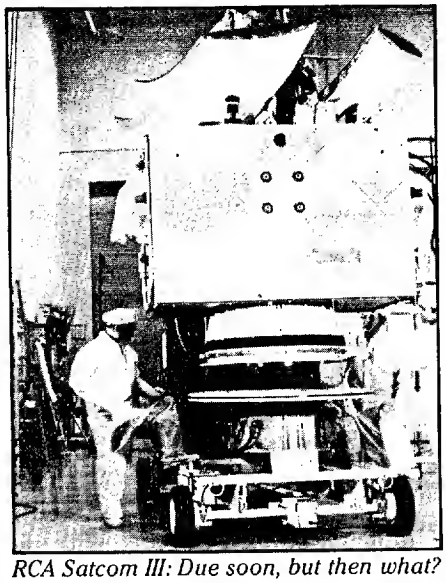
The psychokinesis experiments illustrate well why such research can be both fascinating and frustrating. Rather than try to reproduce spectacular, "macroscopic" effects, such as spinning a compass without touching it (which has been reported in poorly documented studies), Jahn and Curry concentrated on easily observed "microscopic" phenomena. In one experiment, a subject was to raise the temperature of a thermistor by a few thousandths of a degree. In another, the goal was to change the separation of two mirrors in a Fabry-Perot interferometer by a hundred-thousandth of a centimeter. The observations were specific and even dramatic. Subjects did, indeed, seem capable at times of raising the thermistor temperature or changing the optical pathlength of the interferometer at will. But neither experiment was fully "reproducible" in the scientifically accepted sense: The effects varied unpredictably from person to person and from day to day. Because of this unpredictability, Jahn prefers to call the results of work so far "tutorial" rather than technically conclusive. That is, they should be used as models for more extensive research rather than as any sort of "proof" of the validity of psychic phenomena. Nevertheless, analysis of these experiments has offered two important insights that can be further tested in future research.

First, the ability to produce measurable psychic effects appears to be trainable. Neither Jahn nor Curry was aware of any initial psychic ability and both got better as they went along. An important element in such training appears to be feedback that is "visible and attractive," Jahn says.

Second, Jahn speculates that psychic phenomena may have an *inherently* statistical nature. If so, theories dealing with such phenomena are likely to involve abstruse concepts related to the formalism of quantum mechanics or statistical mechanics, rather than some easily grasped intuitive explanation. In particular, psychokinesis appears to involve a reduction of entropy—a statistical measure of disorder—and the equivalence of physical "information" and energy.

An ad hoc committee of the university has established a charter for Jahn's work on psychic phenomena to proceed and he has brought in developmental psychologist Brenda Dunne to work full time on the program. In an interview Dunne said that a growing number of reputable scientists are becoming active in psychic research, but that "the field as a whole is struggling for recognition as a legitimate science." □

NASA back into satellite R&D



NASA

RCA Satcom III: Due soon, but then what?

Satellite communications, more intimately woven into contemporary life than perhaps any other aspect of Space Age technology, owes much of its solid footing to years of research and development by the National Aeronautics and Space Administration, which was ultimately able to pass on most of the effort to private industry as a self-sustaining enterprise. In 1973, prompted by tight budgets, NASA virtually dropped its R and D program in the field.

Now NASA is back in the game, with a five-year program "aimed at retaining U.S. world leadership in satellite communications research and technology."

Several factors have contributed to the restored effort: Early in 1977, a special committee of the National Research Council's Space Applications Board strongly recommended just such action (SN: 4/9/77, p. 231). A year later, President Jimmy Carter's reorganization plans produced the National Telecommunications and Information Administration, charged in part with easing the way for NASA communications experiments into commercial use. Further support came from various federal agencies and industries in the form of responses to a questionnaire from the White House's Office of Science and Technology Policy. The satellite-allocated portions of the communications spectrum have become increasingly crowded, and, NASA points out, the U.S. is facing more foreign technology competition.

The new NASA effort, based at the agency's Lewis Research Center in Cleveland, is concentrated on the high-frequency, 20-to-30-gigahertz portion of the spectrum known as the Ka band. Lower frequencies are fast approaching saturation, and, says NASA's Donald K. Dement, "this Ka-band allocation is the last potential opportunity for significant new capacity to be developed power levels." But, he adds, "this band has been inadequately explored, and technology [illegible] in the United States." The agency will be studying multi-beam antennas, on-board signal-switching and other technologies, but there is far more to the satellite communications problem than the opening of additional frequencies.

As the SAB committee's report emphasized, there are many potential satellite communications users who are too small or widely scattered to form a feasible commercial market. The Ka band is primarily relevant to large-scale, wide-band traffic, while the small users often can use narrow-band, lower-frequency equipment — which is also less costly. Some of NASA's new technologies will be applicable there, but much of the small-user activity is being studied amid a thicket of other agencies and organizations. The matter is thorny — and far from solved. □

Lasker Awards: DNA and the brain

The 1979 Albert Lasker Basic Medical Research Awards were presented to three scientists whose basic research has potential for clinical as well as laboratory use. Roger W. Sperry of the California Institute of Technology received a $15,000 award for his investigations into the workings of the brain's hemispheres, and Walter Gilbert of Harvard University and Frederick Sanger of the Laboratory of Molecular Biology in Cambridge, England shared another $15,000 for their independent development of new methods of rapid sequencing of DNA.

In 1953, Sperry developed the technique of "split brain" research, in which he severed the bundle of nerve fibers that connects the two halves of the brain. He discovered that the two hemispheres function independently in this situation; the right brain does not know what the left brain is learning. Sperry found that the two halves of the brain govern two sets of activities; there is no one "dominant" hemisphere for all mental processes.

The second Basic Research Award was presented jointly to Sanger and Gilbert (a 1949 Westinghouse Science Talent Search winner), whose rapid sequencing techniques will allow molecular biologists to discover the sequence of DNA components in a few days, instead of months. Gilbert's method uses chemical reagents to break the DNA molecules into fragments, and Sanger's employs an enzymatic reaction in its sequencing procedure.

The Lasker Special Public Service Award was presented to Sir John Wilson, President of the International Agency for the Prevention of Blindness. □