

# Human Aggression Linked to Chemical Balance

In the first reported study of its kind with human beings, federal researchers say they have evidence that "human aggression ... may have a biological component to it." The component appears to revolve around the critical balance of two or three key brain chemical neurotransmitters.

The findings are consistent with previous animal studies indicating that aggression seems to be mediated by the production levels of serotonin and norepinephrine. Animal results also indicate that dopamine may be related to aggression, but that was not corroborated in the human study, says Frederick K. Goodwin, chief of the National Institute of Mental Health's clinical psychobiology branch.

The results are additionally significant because the research subjects — 26 Navy enlisted men — had no apparent psychiatric problems. This means that in addition to influencing the occurrence of various mental illnesses, "a biological variable ... can also play a role in determining a range of behaviors considered reasonably normal," Goodwin told SCIENCE NEWS.

Goodwin and his colleagues first evaluated the aggression levels of the volunteers, each of whom "had some difficulty adjusting to service life." Their ratings were based on interviews, records of past behavior and on a 10-item aggression scale that included nonspecific fighting, specific assaults, temper tantrums, antisocial behavior not involving police, school discipline, loss of jobs, difficulty with police, difficulty with military judicial system, difficulty with military discipline and separation from military service because of pre-existing personality disorder.

The men had a wide range of aggression scores among themselves — but their mean score was nearly five times higher than that of a control group of "normal" subjects (employees at the National Naval Medical Center in Bethesda, Md.). In general, the 26 enlisted men were considered to have poor control over impulsive behavior, high levels of anger and aggression and poor judgment.

But an initial analysis of the volunteers' cerebrospinal fluid also showed a wide man-to-man variability in metabolite levels of serotonin. "Serotonin is known to be an inhibitory, modulatory influence" in animal aggression levels, Goodwin says (SN: 12/4/76, p. 362). "Animal studies have suggested that a decrease in serotonin level coincides with a rise in aggressiveness." Similar work also indicates that increases in norepinephrine and dopamine correlate with increased aggression.

Subsequent, more detailed, studies of the men's spinal fluid yielded a "very high correlation between behavior and chemi-

cal levels," Goodwin says. The men with the lowest aggression scores almost invariably had the highest levels of serotonin — up to five times higher than those at the opposite end of the scale. And those who were most aggressive had the highest levels of norepinephrine. Dopamine levels, however, did not correlate with aggressiveness as they had in animal studies. "This was an interesting aspect," Goodwin says. "It may signal some kind of difference between species."

Comparison of the results with various control groups revealed that the chemical-behavior relationship in aggressive personalities is essentially unique, contrasting sharply with correlations among nonpatients, manics, depressives and alcoholics. Particularly noteworthy among these comparisons was the clear chemical difference between depressed patients and those aggressive personalities who had attempted suicide. The results suggest that attempted suicide may not always be an act of desperation by a depressed person, but may constitute "an

aggressive act motivated by anger, rage and usually the desire on the patient's part to manipulate a person, a situation or an institution," Goodwin says.

Goodwin, who presented the report at the recent meeting of the American Psychiatric Association, says the chemical-behavior link "doesn't have to be genetic. Environment, particularly early life experiences, can have an influence" on biochemical balance. The treatment implications are obvious, he says. "There may be medications which could alter such [aggressive] conditions. ... Lithium has been seen to have beneficial effects on aggressive prisoners," he says.

Lithium has also been shown to boost serotonin levels in animals, Goodwin says. There are indications that other drugs for depression might do the same thing and help counteract aggression, he says. "Of course there are ethical issues, but to me this is just a question of common sense ... as long as you make sure the subjects are volunteers." This is the "first direct measure" of such metabolites in men, he says. □

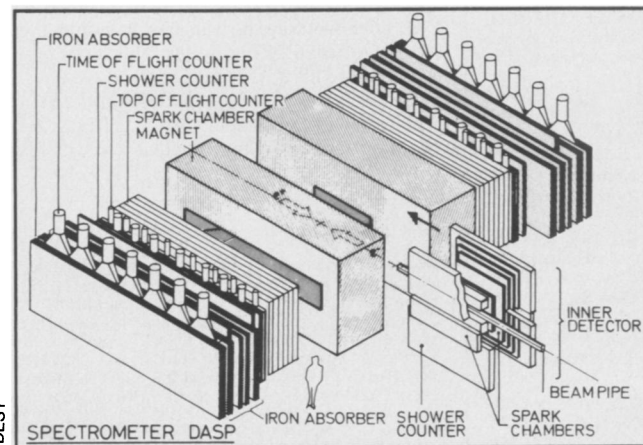
## Beautifying the quark theory

The most massive subatomic particle yet found by physicists is the *upsilon*, which weighs in at about 9.5 billion electron-volts (9.5 GeV). It was first discovered last summer at the Fermi National Accelerator Laboratory in Illinois (SN: 8/6/77, p. 87; SN: 8/13/77, p. 100). Few laboratories in the world are able to put that much energy at the disposal of the forces that create new particles, so there was and is a difficulty concerning confirming experiments. A number of independent confirming experiments would be desirable, especially some confirmations in which the *upsilon* is produced in different ways.

The Fermilab experiment struck very energetic protons against atomic nuclei to

produce the *upsilon*. Another, very elegant, way of making new particles is through the annihilation of matter and antimatter in the collisions of electrons and positrons (anti-electrons). The electrons and positrons are energized in apparatus called storage rings and then collided head on. There are a few such installations around the world, but none of them had the requisite energy to make an *upsilon*. At the Deutsches Elektronen-Synchrotron (DESY) in Hamburg they decided to push for it, and they have made it.

DESY possesses the electron-positron apparatus called DORIS (Doppel-Ring Speicher). DORIS was designed to collide electrons of maximum energy of 3.5 GeV



DASP is one of two detectors that found the *upsilon* particle in DORIS's electron-proton collisions.

with positrons of the same maximum energy, making a maximum total energy of 7 GeV. Modifications to the radiofrequency units that accelerate the particles, the magnets that bend and focus their paths and the operating procedure, yielded total energies up to 10 GeV.

The improvements were completed in April and the  $\epsilon$  search began. In the changed arrangement DORIS operates as a single ring, rather than a double ring. One bunch of electrons and one of positrons circulate (in opposite directions) in a single ring and collide at two "interaction points." So two detectors, PLUTO and DASP, were set up. Success came quickly enough that Burton K. Richter of the Stanford Linear Accelerator Center in California could mention it in his talk on electron-positron facilities at the American Physical Society meeting in Washington at the end of April. Now further data are available, and an announcement from DESY states that the  $\epsilon$  "has now been produced for the first time in electron-positron collisions, where it can be studied much better [than in proton-nucleus collisions]."

The "PLUTO collaboration" (Ch. Berger of the Technical University of Aachen and 46 others) and the operators of DASP (C. W. Darden of DESY and the University of South Carolina and 14 others) are publishing separate papers in PHYSICS LETTERS. This does not quite amount to two independent experiments; it's more like one and a half. But the detectors provided data, which, when interpreted by the two groups, yielded identical values for the  $\epsilon$ 's mass:  $9.46 \pm 0.01$  GeV.

The interpretation placed on the  $\epsilon$  up to now, namely that it is a bound state composed of a new variety of quark and its complementary antiquark, is supported by the DESY results. Quarks are the objects out of which most of the subatomic particles are believed to be built. Nobody has yet seen direct evidence for a quark, but there is enough indirect evidence for them that their existence commands widespread respect, and the particle physics game nowadays is largely motivated by a desire to find out how many quarks there are and whether they behave as theory says they should.

Until the  $\epsilon$  appeared, there was experimental evidence for four kinds of quark. Each kind is named for a particular property (quantum number) of particles that it represents in the Shivaistic dance of combinations and recombinations that builds up the individual kinds of particles. The four are up, down, strange and charmed. Theory right now envisions six, and to those four it adds a t quark (prosaically called "top," but the more philosophically inclined say "truth") and a b quark ("bottom" or "beauty"). The DESY interpretation agrees with that of the Fermilab discoverers in calling the  $\epsilon$  a bound state of b and anti-b, although in Hamburg they say beauty, in Illinois bottom. □

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## Spelling out a plant disease agent

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Big problems can come in little packages, or in no package at all. Viroids, which cause seven economically important plant diseases, are the absolute minimum among infectious agents. Each viroid is a naked ring of single-stranded RNA. Unlike a true virus, a viroid doesn't even have a protein coat.

The exact nucleotide sequence of a viroid, the one that causes potato spindle tuber disease, is reported in the May 18 NATURE. It has 359 subunits (only one-tenth as many RNA nucleotides as the three-gene bacterial virus analyzed previously by Belgian scientists [SN: 3/5/77, p.148]). Within that short sequence must be all the information for the survival and propagation of the viroid.

The newly elucidated sequence indicates the structure, if not the workings, of the viroid. Earlier experiments, including electron microscopy, showed rod-like shapes. Heinz L. Sanger of Justus-Liebig University in Giessen and Hans J. Gross and colleagues at the Max Planck Institute in Munich, West Germany, now predict that structure from their sequence data. They first arrange the RNA ring to give the maximum number of stable pairs between nucleotides (as nucleotides pair in a double-stranded helix), and then they ad-

just their model to expose known sites where enzymes break the ring. The result is a rod in which 68 percent of the nucleotides are paired in double helical sections linked with short single-stranded loops.

So far, solving the sequence gives few clues to the enigma of how viroids work. One feature that may be important is a string of 18 purines, mainly adenosines. Gross has found similar sequences in other viroids.

Virus genetic material contains information for virus-specific proteins, but the researchers do not yet know whether viroid RNA codes for any protein. AUG, the most common "start" signal for peptide or protein production, is absent from the viroid RNA, although there are seven possible GUG start signals and six possible stop signals.

The researchers also find several aspects of the viroid structure that seem to preclude its instructing protein production. They suggest that viroids, instead, may depend entirely on plant enzymes for their replication and cause disease by directly interfering with the operation of plant components. Somewhere in the sequence of the viroid RNA are the sites for those interactions. □

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## Infant formulas: Threat to Third World?

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Are infant formulas replacing breast feeding in the developing countries? Is such a replacement harming infants in those nations? Is the trend toward formulas in those countries due to heavy promotion of formulas by the companies who make them? The answer to all three questions is yes, according to doctors and nurses testifying last week before the Senate health and scientific research subcommittee, chaired by Edward M. Kennedy (D-Mass.). The answer to all three questions is no, according to formula manufacturers who also testified.

Ten million cases of malnutrition and diarrhea in developing countries can be attributed to inadequate bottle feeding, and most of these cases could be avoided by a return to breast feeding, charged Derrick B. Jelliffe, former director of the Caribbean Food and Nutrition Institute in Jamaica and now with the University of California at Los Angeles. One reason infant formulas can cause malnutrition among infants in developing countries, Allan Jackson of the University of West Indies in Kingston, Jamaica, explained, is that many parents in those countries cannot afford formula and overdilute it to make it last longer. One reason formulas cause diarrhea among infants in those countries, Fatina Petal, a nurse from Lima, Peru, explained, is that mothers often add

polluted water to formula rather than go into the jungle, chop wood, bring it back and start a fire to boil the water. As for formula use in developing countries, it is definitely due to overpromotion by formula manufacturers, charged Navidad Clavano, a physician from the Philippines. Such companies offer cocktail parties and company plane flights to medical officers in developing countries, he said.

There is no proof that the use of infant formulas has led to a decline in breast feeding in the developing countries, countered David O. Cox, president of the Ross Division of Abbott Laboratories, which has about 10 percent of the formula market in developing countries. There is also no proof, he asserted, that formulas worsen problems presented by dirty water and unsanitary conditions. And as for formula overpromotion, Cox said his company has adopted a code of marketing ethics for developing countries designed to restrict promotion to health care officials and to affirm the superiority of breast milk for most infant feedings. Bristol-Myers Co. and American Home Products Corp., makers of infant formulas, reported similar practices.

Obviously hard scientific evidence, rather than allegations like those above, will be needed to clarify the impact of formulas on developing countries. □