of asphyxia after the inhalation of nonhalogenated hydrocarbons have never been determined. Although respiratory arrest is often described as a cause of acute deaths due to inhalation of hydrocarbons (*3, 8*), it is possible that many decedents first had cardiac arrest, for which they were not examined, but which stopped their breathing. If respiration fails first, the resulting hypoxemia and hypercapnia may induce arrhythmias faster than usual in the heart sensitized by hydrocarbons.

We postulate that some humans who sniff glue or solvent vapors die suddenly from ventricular fibrillation, sinus bradycardia, AV block, or acute ventricular failure, alone or in combination. It must be remembered that often, though not always, complete AV block ends with ventricular fibrillation. Regardless of whether ventricular fibrillation or arrest is present, external cardiac massage and vigorous mouth-to-mouth respiration, by eliminating these volatile hydrocarbons and alleviating asphyxia, may have special efficacy in acute deaths due to inhalation of solvents. Defibrillation or pacing may then return the cardiac rhythm to normal. The reviver should not inhale the victim's expired air. Prompt resuscitation might have benefited one young boy who inhaled glue fumes, cried out that his heart had stopped, and then died (*1*). Of public health importance is the possibility that in susceptible people, such as those with ischemia or other disease of cardiac pacemaking or conduction tissue, unintentional exposure to environmental hydrocarbons may lead to cardiac arrhythmias causing syncope or sudden death.

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References and Notes

1. M. Bass, *J. Amer. Med. Ass.* **212**, 2075 (1970).
2. J. Tauber, *J. Occup. Med.* **12**, 91 (1970).
3. L. Goodman and A. Gilman, *The Pharmacological Basis of Therapeutics* (Macmillan, New York, 1970), chaps. 6, 7, and 44.
4. L. Nahum and H. Hoff, *J. Pharmacol. Exp. Ther.* **50**, 336 (1934); M. Chenoweth, *J. Ind. Hyg. Toxicol.* **28**, 151 (1946); B. Rennick, S. Malton, G. Moe, M. Seevers, *Fed. Proc.* **8**, 327 (1949); W. Meek, H. Hathaway, O. Orth, *J. Pharmacol. Exp. Ther.* **61**, 240 (1937); W. Meek, *Physiol. Rev.* **21**, 324 (1941).
5. H. Price, A. Lurie, R. Jones, H. Linde, *J. Pharmacol. Exp. Ther.* **122**, 63A (1958).
6. H. Price, A. Lurie, G. Black, P. Sechzer, A. Linde, M. Price, *Ann. Surg.* **152**, 1071 (1960); R. Matteo, R. Katz, E. Papper, *Anesthesiology* **24**, 327 (1963); *ibid.* **23**, 360 (1962).
7. A. Goldberg, in *Halothane*, N. M. Green, Ed. (Davis, Philadelphia, 1968), pp. 24–60; G. Black, *Acta Anaesthesiol. Scand.* **11**, 103 (1967); I. Purchase, *Brit. J. Anaesth.* **38**, 80 (1966); N. Andersen and S. Johnson, *Anesthesiology* **24**, 51 (1963).
8. J. Svirbely, R. Dunn, W. von Oettingen, *J. Ind. Hyg. Toxicol.* **25**, 366 (1943).
9. We thank S. M. Wells for her assistance. Supported in part by an American Heart Association grant, a grant from the University of Illinois Graduate College Research Board, a General Research Support grant, and NIH grant No. 1 T12-HE-05879.

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Sexual Behavior of Male Cats after Administration of Parachlorophenylalanine

Abstract. *The behavior of 12 male cats was observed before and after six or eight daily injections of parachlorophenylalanine. Sexual performance was either unchanged or diminished; aggressive behavior was not seen. Serotonin concentrations in the brains were uniformly lowered.*

After it was shown that parachlorophenylalanine (PCPA), a tryptophan hydroxylase inhibitor, lowers serotonin concentrations in the brains of rats (*1*), a number of studies appeared dealing with the effects of this drug on various aspects of animal behavior. These included reports of increased mounting activity by male (*2*) and female (*3*) rats, as well as a rise in aggressivity (*3*); other investigators failed to find an increase in heterosexual behavior by male rats (*4*). Pronounced changes in the behavior of cats after three to five daily injections of PCPA have also been described (*5*). These included manifestations of "hypersexuality" in 15 of 26 animals, rage and vicious behavior in most of the animals, and disturbances in activity and perception. Hypersexuality was defined as the tendency to mount and attempt to copulate with another male cat. Such behavior had not been seen previously in that laboratory in untreated animals.

We studied the effects of PCPA on copulatory behavior in the male cat with the use of quantitative measures of behavior shown in standard test situations with receptive females (*6*). Observations were also made of the responses of the experimental animals to stimulus objects other than a receptive female and of any alterations in physical appearance and qualitative changes in general behavior after treatment.

Twelve healthy mature male cats (3.5 to 5.9 kg) obtained from a commercial animal dealer were housed individually under natural lighting in rooms (2.7 by 2.1 m) with one outside screen wall. Observation alcoves between adjoining rooms had sliding windows, which permitted introduction of stimulus animals for sex tests and an unobstructed view of the test area. Receptivity was induced in stimulus females by injections of 0.3 mg of estradiol benzoate every 4 to 5 days.

During a preliminary period of several weeks, each experimental male was tested several times per week in his room with a receptive female until mating performance had stabilized, as indicated by consistent latency and frequency scores. (Latency refers to the interval between the start of the test and the display of a particular behavior such as neck grip, mount, or intromission.) Thereafter each cat received a minimum of three 15- or 20-minute "standard" base-line tests as well as a 90-minute test ("extended"). Intervals between tests, generally 48 hours, were the same for each animal during base-line and drug tests. All elements of the male's sexual pattern were noted and timed so that information on frequencies, latencies, and durations was obtained. The normal sexual patterns of male and female cats, and testing procedures similar to those used, have been described (*7*). The number of intromissions achieved by male cats with the same female varies little from test to test (*7*). In additional tests, each cat was also exposed to a male cat, an anesthetized male cat, and a stuffed toy cat until mounting or attempted mounting occurred in three 15-minute tests. No attempt was made to induce mounting by manipulating the stimulus animal or toy.

After base-line data were obtained, the experimental animals received six or eight daily subcutaneous injections of PCPA (150 mg/kg) suspended in a neutral citric acid–phosphate buffer. Sex tests were then run on eight cats including the one that received two separate courses of PCPA treatment with a 6-week interval between each series. The four remaining animals were tested with receptive females after three to five PCPA injections, but scoring was limited to the latencies for the first grip, mount, and intromission. Testing was begun after the third injection in all animals because of the reported 3- to 5-day delay before the change in behavior of cats treated with PCPA (*5*). Each cat received either one or two standard tests. An extended test was run after the fifth (six animals) or sixth (two animals) injection. Each male was tested with the same female used in his pretreatment tests.

All 12 males copulated with a receptive female within a few hours to several weeks after being brought to the field station. Also, before treatment with PCPA, ten cats mounted or attempted to mount unanesthetized males. Mounts lasted from a few seconds to several minutes. The duration of this behavior usually depended on how quickly the stimulus male fought off the experimental animal. The ten cats that mounted or tried to mount intact males also mounted anesthetized males in tests before drug treatment. Mounting of the anesthetized animals was accompanied by the treading and pelvic thrusts which are part of the normal copulatory pattern. The ten cats that displayed this behavior before injection of PCPA did so after drug administration. The two cats that did not mount other males before treatment failed to do so under the influence of the drug. No cat mounted the stuffed toy either before or after treatment with PCPA.

In standard tests six cats showed essentially no change in intromission frequencies and two animals exhibited some decrease after treatment with PCPA (Table 1). The difference in group averages was not statistically significant (*t*-test for differences). In 90-minute tests, seven of eight males achieved fewer intromissions after treatment with PCPA. The difference between pretreatment and treatment means was reliable ($P < .05$).

Table 1. Intromission frequencies before and after PCPA. The duration of the standard test was 15 or 20 minutes, that of the extended test was 90 minutes.

Cat No.	Injections (No.)	Mean for standard tests: Before PCPA, Tests (No.)	Before PCPA, Mean	After PCPA, Tests (No.)	After PCPA, Mean	Extended tests: Before PCPA	Extended tests: After PCPA
171	6	3	4.0	2	3.0	10	7
115	6	3	2.3	2	2.5	9	4
114	6	3	3.7	2	2.5	8	2
114	8					10	9
119	6	3	2.7	2	2.5	7	9
118	8	3	1.0	2	1.0	3	2
173	8	3	0.7	2	0.5	1	1
151	8	3	2.0	1	2.0	5	5
150	8	3	2.0	1	2.0	8	7
Mean			2.3*		2.0*	6.8†	5.1†

* Not significant. † $P < .05$.

Other measures of sexual activity, such as time before the first grip, mount, or intromission, were not significantly altered by PCPA in any of the 12 cats. There was no noticeable difference in general behavior in the test situation, and reactions to the female, in terms of approaches or attempts to mount, failed to indicate any heightened sexual interest as a result of treatment.

None of the treated cats displayed any signs of rage or vicious behavior toward either the experimenter or any of the stimulus animals. This is in contrast with the data of Ferguson *et al.* (*5*), who also reported that restlessness occurred 2 to 3 days after the first injection of PCPA, at the time when the sleep and the EEG pattern were altered. We did not observe this restlessness, nor was there any indication of the perceptual disturbances that Ferguson *et al.* reported as a reaction to PCPA. Our animals were under observation for only part of each day, however, and a 24-hour watch might have revealed behavioral changes not detected under these conditions. In addition there were marked differences in housing and handling of the animals and in testing procedures between this and the previous study.

Seven of the 12 cats appeared less active after five to seven injections. The vocalizations of these animals were softer and occurred less frequently. The group affected included two cats which had substantially lower intromission scores in extended tests after PCPA (cats No. 115 and 171). Ferguson *et al.* (*5*) reported a decline in activity in their cats after long-term administration of PCPA, as well as the deaths of a number of animals, which they presumed were due to toxic effects of the drug. Locomotor activity and vocalization were normal within 1 week after the eighth PCPA injection in three of our animals who had shown some change in these functions.

Brain serotonin concentrations were determined in six cats (*8*) and were reduced in these animals in the five areas of the brain assayed. Comparisons were with controls done in the same laboratory. Serotonin in the midbrain of two cats that received six PCPA injections was reduced 78 and 89 percent. In the four animals that had each received eight treatments, reduction ranged from 90 to 97 percent. Three cats with marked reduction of serotonin, including two that had received eight injections, had seemed normal in appearance, activity, and behavior. The concentrations and turnover of neuroregulators other than serotonin are altered in rats treated with PCPA (*9*) and are particularly sensitive to stress in treated animals (*10*). Differential changes in these substances may account for some of the behavioral differences in animals with equal reduction of serotonin.

One of us has previously emphasized the need for methodological care in studies of sexual behavior in animals (*11*). Interpretation of the effects of any experimental variable on the sexual activity of a particular species must include consideration of the varied behavior of which that species normally is capable and the multiplicity of factors that can elicit the behavioral display. For example, the percentage of male cats that will copulate in the laboratory increases with adaptation to the surroundings and with continued testing (*12–14*). Homosexual behavior by normal males has been described (*13, 14*). The mounting of inanimate objects and of members of other species, an activity that has been used as a criterion for hypersexuality following rhinencephalic lesions (*13, 15*), can also be readily induced in a large percentage of normal male cats (*16*).

Stable and sensitive base-line measures of the full range of sexual activity of the male cat are needed, therefore, to permit the accurate assessment of the effect of a particular variable on such behavior.

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References and Notes

1. B. K. Koe and A. Weissman, *J. Pharmacol. Exp. Ther.* **154**, 499 (1966).
2. E. E. Shillito, *Brit. J. Pharmacol.* **36**, 193 (P) (1969); A. Tagliamonte, P. Tagliamonte, G. Gessa, B. Brodie, *Science* **166**, 1433 (1969).
3. M. Sheard, *Brain Res.* **15**, 524 (1969).
4. R. E. Whalen and W. G. Luttge, *Science* **169**, 1000 (1970).
5. J. Ferguson, S. Henricksen, H. Cohen, G. Mitchell, J. Barchas, W. Dement, *ibid.* **168**, 499 (1970).
6. All observations were made at the Field Station for Animal Behavior Research, University of California, Berkeley. Brain serotonin assays were done in the laboratory of J. Barchas at Stanford.
7. F. A. Beach, A. Zitrin, J. Jaynes, *J. Comp. Physiol. Psychol.* **49**, 321 (1956); J. S. Rosenblatt and L. R. Aronson, *Behaviour* **12**, 285 (1958); R. E. Whalen, *ibid.* **20**, 321 (1963).
8. Serotonin was assayed fluorimetrically after adsorption on an IRC-50 resin (J. Barchas, E. Erdelyi, P. Angwin, in preparation).
9. J. Stolk, J. Barchas, W. Dement, S. Shanberg, *Pharmacologist* **11**, 288 (1969).
10. ———, in preparation.
11. F. A. Beach, in *Social Behavior and Organization among Vertebrates*, W. Etkin, Ed. (Univ. of Chicago Press, Chicago, 1964), p. 117.
12. A. Zitrin and F. A. Beach, *Ann. N.Y. Acad. Sci.* **46**, 42 (1945).

J. D. Green, C. D. Clemente, J. DeGroot, *J. Comp. Neurol.* **108**, 505 (1957).

14. R. P. Michael, *Behaviour* **18**, 1 (1961).
15. L. Shreiner and A. Kling, *J. Neurophysiol.* **16**, 643 (1953).
16. W. D. Hagamen and E. K. Zitzmann, *Anat. Rec.* **133**, 388 (1959).
17. Supported in part by PHS research grant MH 04000 to F.A.B. and NASA (NGR05-020-168) and PHS research career development award MH 24,161 to J.D.B. We thank Steven Henricksen for his valuable technical assistance. A supply of parachlorophenylalanine was provided by Nathan Belcher, Chas. Pfizer Co., Inc., to whom we are grateful. The estradiol benzoate used in the experiment was supplied by Dr. P. L. Perlman, Schering Corporation.

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Arsenic and Water Pollution Hazard

Undue speculation in the press, scare headlines, and the drawing of widesweeping conclusions about alleged hazards to consumers have resulted from the report by Angino *et al.* (*1*). The full set of facts for evaluation should include the following.

1) Arsenic in trace amounts ranging up to a maximum of 70 to 80 parts per million (ppm) is introduced into detergent products as a constituent of the phosphate builder. Arsenic in trace quantities is also widely found in both animate and inanimate nature. For example, an average of 5 ppm in soils has been reported, with soils of volcanic origin having as much as 20 ppm. Arsenic occurs in most plants and animals, especially in fish and shellfish (amounts considerably higher than anything found in washing products have been reported in some seafoods; for example, 174 ppm in prawns, 42 ppm in shrimp, and 40 ppm in bass have been noted in local areas). A survey of arsenic in food that had been purchased in New England chain stores showed detectable amounts in most of the items (*2*).

2) Schroeder and Balassa (*2*) state, "pentavalent arsenic as arsenate is nontoxic in normal concentrations, is excreted rapidly largely through the kidneys, probably does not accumulate in human tissues, is a normal constituent of food, and may perform some unknown physiological function."

3) Arsenic exists in detergents in the pentavalent state (arsenate) and not in the highly toxic trivalent form (arsenite) that is prepared commercially for pesticide use. Moreover, any human exposure to arsenic due to the trace amount in washing products is negligible in terms of the normal dietary intake. Even at the highest level reported by Angino *et al.*, the quantity is far too small to have a measurable effect on the acute toxicity of the product itself or to have any effect as a result of chronic ingestion. Typical wash water, even with the product that contained 80 ppm (the highest level detected) would contain only about 0.15 ppm arsenic, about one-fourth the amount estimated in the average diet. The skin effects of arsenic in detergents are equally negligible, both because of the valence form of the material and the exceedingly low concentration in which it would contact the skin.

4) Angino *et al.* have attempted to show that arsenic found in trace quantities in some detergents constitutes a potential threat to water quality. However, in only 4 out of 27 combinations (dilutions made in containers of different sizes) did the concentration of arsenic in wash water exceed drinking water standards. Angino *et al.* also measured the arsenic concentration of water and sewage in Lawrence, Kansas. The concentration in the raw drinking water ranged between 2.6 and 3.6 parts per billion (ppb), and in the finished water (after cold lime softening) arsenic ranged between 0.4 and 0.5 ppb. It was noted that 0.4 ppb is at the lower limit of detection for the analytical procedure used. The highest amount found, 0.5 ppb, is 100 times below the Public Health Service's mandatory limit. Arsenic in raw sewage in Lawrence ranged between 2.0 and 3.4 ppb and averaged 2.7 ppb. After treatment, the range was from 1.5 to 2.1 ppb and averaged 1.8 ppb. Treated sewage thus contained a maximum of 1/25th of the arsenic permitted in drinking water. A single determination made in the Kansas River at Lawrence indicated an arsenic concentration of 3.3 ppb and 8.0 ppb in the same river at Topeka. If these data are accurate (particularly that for Lawrence), it is obvious that a major input of arsenic to the Kansas River comes from a source other than Lawrence sewage.

5) The USPHS Drinking Water Standards (1962) set a recommended arsenic limit of 10 ppb (10 μg/liter) and considers amounts in excess of 50 ppb grounds for rejection of a water supply. These standards are legally applicable only to water supplies subject to federal quarantine regulations (such as interstate common carriers) but have been generally adopted by most state departments of health or sanitation commissions as their individual standards. Generally speaking, the USPHS standards are predicated on the assumption that the daily intake of water over a lifetime is 2 liters per day.

Under no circumstances (whether examining raw and treated sewage, raw and treated drinking water, and river water) were Angino *et al.* able to present data that indicated that arsenic concentrations remotely approached those that would disqualify these waters as water supplies. Moreover, finding traces of arsenic in wash water (which is certainly not recommended for drinking, in any case) likewise does not constitute a threat. Angino *et al.* made no apparent effort to evaluate the impact of the use of farm insecticides (arsenicals) or industrial and municipal discharges on the one river they studied (the Kansas River). In fact, all they demonstrated was that arsenic, in trace quantities, is a ubiquitous material found widely in nature and that it does not constitute a hazard to water quality at the concentrations they reported.

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References

1. E. E. Angino, L. M. Magnuson, T. C. Waugh, O. K. Galle, J. Bredfeldt, *Science* **168**, 389 (1970).
2. H. A. Schroeder and J. J. Balassa, *J. Chron. Dis.* **19**, 85 (1966).

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