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An Ethologic Search for Self-Administration of Hallucinogens*

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It is well-known that *Homo sapiens* voluntarily learns to self-administer psychoactive drugs without additional reinforcement. The primary societal use of these self-administrations is social (Blum et al., 1969), while the motivation to repeatedly self-administer is considered a major factor in human drug abuse (cf. Weeks, 1971). Among the many drugs used in this way by man are the hallucinogens. Indeed, it is a traditional, albeit tacit, assumption of psychopharmacological thinking that *Homo sapiens* is the only species that will self-administer hallucinogens without additional rewards. Often, it is further assumed that the human use of hallucinogens is primarily social in nature (e.g., Linn, 1971; Smith, 1970) and is even related to increased social intimacy and closeness (Cheek, Sarett, and

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Newell, 1969; Hamburger, 1969). Such assumptions have led investigators to restrict the use of infrahuman species to the formulation of biochemical and physiological models of hallucinogen use since, *a priori*, these animals don't self-administer hallucinogens. The recent increases in nonmedical drug use in Western societies have made these assumptions more explicit, leading to a myriad of studies and analyses of man's social–pharmacological behavior. The resulting research has generated a number of hypotheses regarding population social behavior with drugs, but these are not practically, morally, or legally verifiable by systematic empirical research. The urgent need for a firmly grounded theory of drugs and population social behavior prompts a revaluation of the basic assumptions stated above.

The present paper examines these assumptions in light of recent ethological, laboratory, anthropological, and sociological findings. This examination takes the form of an ethologic search guided by existing observations and fostered by some speculation. Several hundred ethological reports were originally collected and examined in this search. Many reports were purely anecdotal, lacking identification of active pharmacological principles as well as adequate behavioral study, and instances of these are cited below as miscellaneous examples. Only those reports which were supported by substantial observations and/or controlled studies are discussed in detail. However, some speculation on these reports is allowed as the search for infrahuman organisms which self-administer hallucinogens may uncover new areas and models for the study of drug dependence. Such infrahuman models would have the advantage over others of greater experimental control over biological, environmental, and pharmacological variables without the addition of "untestable mentalistic constructs" (Schuster and Thompson, 1969).

The findings of this search (discussed below) challenge the traditional assumptions and indicate that (1) several infrahuman species self-administer psychoactive substances in natural states; (2) hallucinogens are prominent among those substances included in (1); and, (3) social isolation may be associated with the use of hallucinogens and can be partially considered as a psychopharmacological effect.

ETHOLOGICAL EXAMPLES

Folklore and Self-Administrations

The notion of animals self-administering drugs in natural states is not a new idea. The history of pharmacology is rich with many examples of primitive peoples learning the rudiments of medicine by observing which plants were used by animals suffering from wounds, fever, or infection. In India, folklore maintains that the mongoose, when bitten by a cobra, retires to the jungle to look for a plant known as Mungo root (*Ophiorrhiza Mungos*) which it eats as an antidote to the venom. Mongooses have also been reported to pretreat themselves by rubbing the root over the head and body parts which the snake might bite. This treatment usually results in a "drugged sleep" from which the animal quickly recovers (Hinton and Dunn, 1967). Natives of Northern Rhodesia observed cobras peeling and eating the bark of the common creeper *Strophanthus welsitschii-Mimbapanda*. This naturally enough evolved as a charm against snake bites as did the Mungo root (Gilges, 1955). However, while infusion teas of the roots of both plants have been used as treatment for gonorrhea and scabies, there is no evidence to indicate they are effective against snake bites.

In Australia, the eucalypts are popular foods among many animals. The leaves are the exclusive diet of *Phascolartos cinereus Goldfuss*, a marsupial known as the koala (Barrett, 1943). Local folklore claims that the koala is a "drug addict," feeding only on the eucalypts, which have a "narcotic effect," and produce long periods of sleep. While such behaviors can be more easily explained in terms of the koala's metabolism and biological rhythms, the Australian aborigines adopted the custom of using eucalyptus leaves to sooth and heal their wounds (Mathison, 1958). Nonetheless, later analysis of the leaves revealed high concentrations of various oils which have local anesthetic properties as well as marked germicidal effects (Penfold and Willis, 1961).

Accidental Self-Administrations

Early man also learned about drugs by observing the effects of accidental self-administrations in animals. The legendary discovery of coffee was purportedly around 900 A.D. by an Abyssinian tending his herd of goats. The herder noticed that his animals became abnormally "frisky" after eating the bright red fruit of a tree which was later isolated and identified as coffee (Taylor, 1965). In Australia, the aborigines knew of leaves which dropped into water holes and killed both the fish and emu in the area. For centuries the natives ate these animals without ill effects. Later, expeditions to the area revealed that the leaves of the plant (*Duboisia*) contain the alkaloids atropine and scopolamine (Taylor, 1965).

Reliable ethological reports of animals self-administering psychoactive drugs in general, and hallucinogens in particular, are rare. Many such reports, like some of the above, are based on accidental administrations and lack the support of controlled observational or laboratory studies. There are occasional journalistic reports of domesticated house pets repeatedly self-administering cannabis (e.g., Schaefer, 1971), as well as several studies of accidental cannabis poisoning in grazing horses and mules and in domesticated dogs (Clarke, Greatorex, and Potter, 1971). Even when accidental ingestion of the drug does not result in death, there is only scant evidence that the animals are "intoxicated" and no evidence that the behavior is repeated. The most common instance of such accidents is found in the etiology of loco weed disease. This disease affects cattle, horses, and sheep on the Great Plains of the western United States and is caused by ingestion of loco weed (*Astragulus*). Loco weed disease (which means "cracked-brain") is characterized by paresis, ataxia, dullness, and a tendency of the animals to isolate themselves from social groupings. The active principle appears to be selenium, which the plants absorb from surrounding soil. Selenium is currently used for the prevention and treatment of white muscle disease in calves and lamb, and exudative diathesis in chicks. However, there are no suitable studies of individual animals in nature repeating the selenium ingestion.

Quasi-Accidental Self-Administrations

There are several other examples of animals self-administering psychoactive compounds and abundant observational reports confirming that this behavior is often repeated by the same individuals. However, since controlled psychopharmacological studies are still lacking here, these examples are classified as quasi-accidental self-administrations.

Several reports indicate that elephants ingest a variety of drugs. Some drugs, such as tobacco, are probably accidentally self-administered (Van Proosdy, 1960), while others such as *Sansevieria* leaves are probably used for their moisture rather than their cathartic effects (Sikes, 1971). However, Carrington (1959) reviews evidence suggesting that African elephants have a "passion" for alcohol. The usually graceful movements of the animals are marked by awkward and inappropriate behaviors. Drummond describes this phenomenon:

> They (the elephants) frequent, as I have mentioned, the country from the Pongolo northward, during the summer season, retiring to their fortresses in the interior at the approach of winter. The time of their arrival is simultaneous

> with the ripening of the umganu-tree, of which they are passionately fond, and doubtless come in search of. This fruit is capable of being made into a strong intoxicating drink, and the elephants after eating it become quite tipsy, staggering about, playing huge antics, screaming so as to be heard miles off, and not seldom having tremendous fights. (Drummond, 1875; in Carrington, 1959, p. 68)

In a more controlled study, Sikes (1971) notes that the migratory patterns of African elephants span a life of some 70 years and are marked by special areas with favored foods that are revisited at "appropriate times" when the *Borassus* palm fruits ferment. When the fruits ripen, fall to the ground, and ferment, hunters in the African bush can scent these fruits in the early stages of fermentation and seek them out for refreshment. Sikes maintains that elephants also detect the scent and repeatedly self-administer the fruits. However, it remains possible that highly "attractive" olfactory cues and not the subsequent psychoactive effects reinforce and maintain this behavior.

Several members of the cat family (*Felidae*) repeatedly self-administer catnip (*Nepeta cataria*). Catnip, a member of the mint family, has been used by man as a treatment for amenorrhea, chlorosis, and flatulent colic in infants. Recently, it has been used by man as an hallucinogen with effects similar to cannabis (Jackson and Reed, 1969). Catnip contains nepetalactone oils (Waller, Price, and Mitchell, 1969) and sensitivity to these oils is a genetically inherited response among the *Felidae* (Todd, 1963). The catnip response is characterized by sniffing, licking, chewing with head shaking, chin and cheek rubbing, and headover and body rolls accompanied by some salivation. Hatch (1972) describes frequent signs of apparent hallucinations such as "phantom butterflies" above the cat and "phantom mice" in the cat's cage as indicated by the cat's behavior. In the domestic cat, *Nepeta* induces EEG changes similar to those found following tetrahydrocannabinol administration. Since the behavioral changes are virtually identical to the oestrous behavior cycle and catnip-like activity has been found in urine extracts from tomcats, it has been argued that catnip mimics a pheromone produced to reinforce or release courtship behavior (Palen and Goddard, 1966; Todd, 1963). Sensitive *Felidae* probably do not self-administer *Nepeta* in natural environments as there is no correlation between the distribution of plants having catnip-like activity and that of cats which are sensitive to them. Nonetheless, domesticated male and female cats which possess the autosomal dominant ger for the catnip response will readily self-administer catnip without ad tional reinforcement. Since tolerance develops rapidly without concommitant increases in dose, it is difficult to assess the frequency of such self-administrations (Todd, 1963).

Miscellaneous Self-Administrations

There are several other examples of animals self-administering substances which lack identification of the active pharmacological principle as well as adequate behavioral study. For example, certain varieties of ants live in symbiotic relationship with *Myrmecophilous Pselaphid* beetles. Such beetles are referred to as symphiles or myrmoxenes ("true guests") and are accepted to some extent by their hosts as though they were members of the colony. Park (1964) describes cases in which worker ants licked the trichomes of adult beetles for long periods of time, after which they were "so overwhelmed by this trichome stimulant that they became temporarily disoriented and less sure of their footing" (p. 133). Wilson (1971) summarizes evidence relating to the narcotizing effect of symphilic substances in several different ants. *Hypoclinea biturberculata*, an abundant ant of Southeast Asia, licks an intoxicating attractant from trichome secretions of the bug *Ptilocerus ochraceus* and becomes overtaken by paralysis. Many such symphiles are repeatedly licked by their host ants, which self-administer the secretions and in turn provide regurgitated food for them. Indeed, Bejerot (1972) notes that in times of danger, the *Lasius flavus* ant tends to its symphile beetle larvae (*Lomechusa*) before it removes its own eggs to safety. However, Bejerot incorrectly cites such evidence as proof of drug addiction in these insects.

There are other reports of self-administrations in animals in which it is only speculated that the plant and animal toxins which cause hallucinations in man also cause similar psychoactive effects in the animals which regularly ingest them. For example, it is claimed that domesticated horses and cattle may develop "cravings" for and "addictions" to a variety of poisonous plants, many of which cause psychoactive effects in man (Forsyth, 1954). Some mongooses in the West Indies and the Hawiian Islands apparently ingest *Bufo marinus* toads, which contain the hallucinogen bufotenine. This phenomenon is something of a mystery, since other toads as well as other natural prey are more abundant in these regions. While it is not known if there are psychoactive effects resulting from such ingestions, the mongoose goes out of its way to ingest a variety of psychoactive compounds and poisons including the poison bulb of scorpions and the sting, "which it seems to consider a *bonne bouche*" (Hinton and Dunn, 1967, p. 20). Bees are naturally attracted to male cannabis plants, and their honey, when collected and assayed, has been shown to contain traces of tetrahydrocannabinol (Mendell, 1969). While some writers in the "undergound press" have speculated about "stoned bees," there are no studies of individual bees demonstrating psychoactive behavioral effects or repeating that particular pattern of behavior. The bug *Oxythris Canabensis* is a natural enemy of cannabis plants in Rumania but, again, there are no behavioral studies on this relationship (Addiction Research Foundation, 1972). Similarly, it is rumored that the natural predators of the South Pacific goat fish may become intoxicated after eating their prey. Such stories are probably based on the "fantastic nightmares" and hallucinations produced in man by ingestion of this fish (Halstead, 1965).

Intentional Self-Administrations

Hemp seeds (*Cannabis sativa*) and avians have enjoyed a long historical association. Many birds, including the pigeon (*Columba livia*), eat hemp seeds, and until recently such seeds were available in commercial bird feeds (Levi, 1957; Schorger, 1955). It has been reported that wild mourning doves and pheasants eat hemp seeds in areas of Illinois and Iowa (Haney and Bazzaz, 1970; Hanson and Kossack, 1963; McClure, 1943). Hemp seeds can contain small quantities of cannabinoids, including tetrahydrocannabinol (Commission of Inquiry, 1972). In addition, the average seeds nearly always contain some green gummy calyx, and this caylx may contain additional amounts of cannabinoids (cf. Levi, 1957; Vaughan, 1970). Levi discusses the historical uses of hemp seed as a source of pigeon food and summarizes evidence from breeders who refer to hemp seed as "pigeon candy" and use it as a stimulant and delicacy for their birds. Hemp seed is repeatedly self-administered by the same individuals and an "optimal" frequency of three feedings per week is noted. The following account illustrates the behavioral effects:

> Its (hemp seed) feeding has a decided beneficial psychological effect upon the bird's happiness. Pigeons fed sparingly with a little hemp in the middle of the day during the moulting season take a new interest in life which is almost inconceivable. In general, scattering any feed upon the ground of the flypen is dangerous because of possible contamination and infection. An exception to this rule is the feeding of hempseed in such fashion. When some hemp is fed out on the dry ground of the flypen, every bird comes out for its share. The avidity with which the seed is devoured has to be seen to be believed. Even after the portion of hemp has been consumed, many of the birds may be seen for hours diligently searching for a possible additional

> grain. . . . It (hemp seed) is of great assistance in taming birds and in training them for shows, as all fears seem to be set aside when they know that hemp-seed is being offered. (Levi, 1957, p. 499)

In an effort to confirm these observations, the following experiment was conducted. Thirty-six loft-reared homing pigeons were individually housed in laboratory cages. The animals were given free access to water and grit as well as Purina Pigeon Feed. The Purina Feed contains a mixture of five major types of seeds: black seeds, 7.1%; maize, 33.1%; big peas, 3.5%; small peas, 22.6%; and mixed grain, 33.7%. One group of 12 pigeons (Group A) was deprived of all food for 48 hours and then given a mixture containing five grams of each of these seeds and allowed access to this mixture for five hours. A second group of 12 pigeons (Group B) was deprived of all food for 48 hours and then given a five hour access to an experimental mixture containing five grams of each of these seeds plus five grams of hemp seeds (United Nations Office, Division of Narcotic Drugs). Thus, the experimental mixture contained 16.6% (by weight) of each seed type, including hemp. The third group of 12 pigeons (Group C) was given a single five hour access to the experimental mixture without any food deprivation. The results of this study are presented in Table 1 in terms of the number of birds in each group which preferred each type of seed as first choice (based on weight of each type eaten by each bird). The results clearly indicate that the pigeons preferred hemp to all other seed types provided. Even when deprived of all food for 48 hours, some birds in Group B ate less food in order to keep their seed preferences constant. While the present study lacks controls for the morphological characteristics of the seeds, bill shape, and genetic variables, the results lend some support to Levi's observations.

Reindeer offer another example of intentional self-administration. An almost symbiotic relationship exists between the primitive peoples and reindeer of the Asian forest and tundra regions:

Table 1

Number of Pigeons in Each Group and Their First Choice Seed Preference [a]

	SEED TYPE					
	Black seeds	Maize	Big peas	Small peas	Grain	Hemp
Group A	2	0	6	3	1	—
Group B	1	0	4	2	0	5
Group C	1	0	3	0	0	8

[a] Based on weight of each type eaten by each bird.

> Reindeer manifest two addictions, two passions, one to urine, especially human urine, and the other to mushrooms including the fly-agaric (the hallucinogenic *Amanita muscaria*). When human urine or mushrooms are in the vicinity, the half-domesticated beasts become unmanageable. All reindeer folk know of these two addictions. . . . Reindeer, like men, suffer (or enjoy) profound mental disturbances after eating the fly-agaric. (Wasson, 1968, pp. 75–76)

The natural diet of the reindeer is composed almost exclusively of lichens. Nonetheless, Wasson (1968) summarizes evidence which suggests that reindeer develop special preferences for fly-agaric mushrooms or human urine, which contains the active metabolites of fly-agaric. The native Chukchi people self-administer fly-agaric, and other native groups (e.g., the Karyaks) will drink their own urine for additional intoxications when the supply of mushrooms is exhausted. Such intoxications are marked by elation, sedation, colored visions, and hallucinations and are presumably caused by the active principle muscimol (Waser, 1967; Wasson, 1967). Several observational reports indicate that the same reindeer will also repeatedly ingest these mushrooms or urine. The behavior of the reindeer appears similar to that of the people:

> The fluid (human urine) has the same effect on the reindeer as intoxicating drink has on people who have fallen victim to the drinking habit. The reindeer become just as drunk and have just as great a thirst. At night they are noisy and keep running around the tents in the expectation of being given the longed-for fluid. And when some is spilled out into the snow, they start quarreling, tearing away from each other the clumps of snow moistened with it. Every Chukchi saves his urine in a sealskin container which is especially made for the purpose and from which he gives his reindeer to drink. Whenever he wants to round up his animals, he only has to set this container on the ground and slowly call out "Girach, Girach!", and they promptly come running toward him from afar. (Wasson, 1968, p. 243)

Like elephants in search of fermented fruit, the reindeer have acute olfactory receptors, which detect the human urine and attract them to human communities (Wasson, 1968). Indeed, one report stresses that the passion of the reindeer for human urine is so intense that "it is likely to make it dangerous to relieve oneself in the open when there are reindeer around" (Wasson, 1968, p. 161). Wasson recounts some scant evidence that the intoxicated reindeer isolate themselves from the herd. However, it is well-known that other conditions such as insect plagues and hunger may cause individual animals to leave the herd groupings (Leeds, 1965). Indeed, when reindeer are afflicted by insects in their nostrils they are driven into a frenzy which appears behaviorally similar to that following mushroom ingestion. It is interesting to note in passing that the shamans of the Chukchi have come to believe that psychic disturbances are caused by insects and they treat their patients with rituals based on ridding the head of these insects (Wasson, 1968).

LABORATORY EXAMPLES

Definitions

When a drug serves as a controlling consequence for the behavior leading to its administration, that drug is defined as a reinforcer (Schuster and Thompson, 1969). Thus, drugs can be either positive (rewarding) or negative (punishing) reinforcers and animals can learn to approach (and self-administer) or avoid them. For example, in the laboratory examples cited below some infrahuman species will learn to self-administer psychoactive drugs such as morphine. Such learning will often occur after considerable delays in the reinforcement effect, even after oral ingestion, and can be controlled by a variety of stimulus properties of the drugs (see Revusky and Garcia, 1970; Thompson and Pickens, 1971). This delay-of-reinforcement effect could partially account for many of the ethological examples provided above, which indicate that certain infrahuman species self-administer psychoactive substances through repeated oral ingestions.

Studies with Individuals

With varying reinforcing efficacy, several infrahuman organisms, in laboratory environments, have self-administered psychoactive drugs which are self-administered by man. Monkeys have been shown to self-administer barbiturates, caffeine, cocaine, codeine, ethyl alcohol, methylphenidate, morphine, nicotine (tobacco), phenmetrazine, pipradrol, as well as volatile organic solvents (Deneau, Yanagita, and Seevers, 1969; Hoffmeister and Schlichting, 1972; Jarvik, 1967; Thompson and Schuster, 1964; Wilson, Hitomi, and Schuster, 1971; Yanagita, Haga, and Sato, 1969). Such studies have usually employed considerable restraints on the physical movements of the animals. However, unrestrained monkeys have been shown to self-administer morphine but not the hallucinogen mescaline (Thompson, Bigelow, and Pickens, 1969; Schuster and Thompson, 1969). Similarly, rats have self-administered chlordiazepoxide, meprobamate, morphine, and nicotinic acid, but not LSD, mescaline, or quinine (Harris, Claghorn, and Schoolar, 1967; Schuster and Thompson, 1969; Stolerman and Kumar, 1970). Taken together, these studies indicate that infrahuman organisms can self-administer many psychoactive compounds in the laboratory but they do not readily self-administer hallucinogens.* One explanation of these findings is that the self-administration of hallucinogens may involve a negative reinforcement or punishing component which is detectable only in appropriate behavioral situations. Indeed, aversive taste conditioning has been demonstrated in rats with high doses of amphetamine, mescaline, and THC. But it is not clear whether these drugs are actually aversive to the animal or simply novel substances (either novel in taste or some other stimulus property) to which the animals may adapt over time (cf. Cappell and LeBlanc, 1971; Elsmore and Fletcher, 1972). The degree of aversion is probably dose-related and not noticeable in low doses, since a number of investigators have recently been able to train monkeys to smoke cannabis with low doses of THC in order to gain access to water or food reinforcement (e.g., Jarvik, 1972). Interestingly, it has been argued that such hallucinogen-induced "aversion" supports the notion that the naturally occurring plant hallucinogens are evolutionarily justified in terms of the maladaptive effects that they could have on herbivores (Bever, 1970; Eisner and Halpern, 1971). For example, the plant henbane (*Hyoscyamus niger*) contains the active principles hyoscyamine, hyoscine, and atropine, and it induces hallucinations in man (Cohen, 1969). However, henbane has a strongly nauseating odor and taste which animals and men actively avoid—but accidentally ingest—in natural environments (Forsyth, 1954; Taylor, 1965).

It should be noted that these findings of the laboratory are restricted to the species and drugs studied. While monkeys and rats are the most common animals used in self-administration studies, the present search failed to find evidence that these species self-administer psychoactive drugs in natural states—although it remains possible that they do so. Conversely, there is substantial evidence presented above which indicates that other species may self-administer psychoactive drugs including hallucinogens, which interestingly were not the hallucinogens tested in these laboratory studies!

Studies with Groups

Elsmore and Fletcher (1972) describe the THC-induced aversive effects in rats as similar to a drug-induced "illness" or "sickness." The behavioral

* Pickens and Thompson (1972) have recently reported that one monkey in their laboratory self-administered hashish on a FR10 and FR20 operant schedule without additional reinforcement.

consequences of such a state may vary with social groupings, as well as with dose and route of administration. Typically, low doses of hallucinogens lower spontaneous activity in rodents and induce hypothermia, hypersensitivity, and ataxia, while higher doses induce more profound ataxia and sedation. In the single animal studies noted above, such "sick" or "intoxicated" behavior may have few consequences. In groups of two to four animals, hallucinogens diminish aggressiveness and fighting behavior in mice and inhibit dominance behavior of rats competing for food (Santos, Sampaio, Fernandes, and Carlini, 1966; Silverman, 1966; Uyeno, 1966a, 1966b; Uyeno and Benson, 1965). In larger social groupings such as herds, it has been noted that animals suffering from loco weed disease or fly-agaric intoxication tend to isolate themselves from others. Similar observations have been made on "drunk" elephants (Carrington, 1959), sick eland and kudu (Davis, Karstad, and Trainer, 1970), as well as sick reindeer (Davis and Anderson, 1971). In nearly all such cases, the sick or intoxicated animals behave in strange and socially inappropriate ways and either leave the herd or are segregated by the herd (Davis, Karstad, and Trainer, 1970). Much of this behavior is understandable in view of Ardrey's (1970) argument that a basic force of animal social structure is animal xenophobia, or the fear and avoidance of strangers. Ardrey argues that groups of animals or men reject the strange, whether strangely behaving or the actual stranger.

A series of laboratory studies has indicated that hallucinogens induced strange and dramatic changes in the social behavior of fish (*Hyphessobrycon innesie*), pigeons, and mice (Siegel, 1971a, 1971b; Siegel and Poole, 1969). Treatment of large populations ($n = 50$–120) of these animals with LSD, bufotenine, cannabis, or THC induced hypersensitivity in the members. When treated fish, pigeons, or mice were placed in populations of untreated or placebo-treated animals, they tended to avoid interaction with these members. For example, Siegel (1971b) notes that each time drugged mice were approached by undrugged colony members they would squeal, squeak, and retreat from the investigation. Drugged mice exhibited typical hallucinogenic patterns of head-twitches, increases in flight postures, and decreases in social postures such as nosing, sniffing, and licking. Futhermore, drugged animals actively avoided investigating mice and escaped to areas occupied only by nonaggressive and quiescent drugged animals. This escape–avoidance pattern of behavior was marked by drugged animals literally hopping over the others or engaging in sham fighting, and the behavior resulted in aggregation of drugged individuals among themselves.

When the entire populations were treated with hallucinogens, inhabitants appeared to actively avoid social groupings by dispersing among themselves.

ANTHROPOLOGICAL AND SOCIOLOGICAL EXAMPLES

Comparison of an aggregated group of hallucinogen-treated animals with groups of *Homo sapiens* drug users may prove to be conceptually useful in the development of a general theory of hallucinogens and social behavior. Perhaps the best *Homo sapiens* analog of this animal model is found in the "mushroom madness" of the New Guinea highlands (Reay, 1960, 1965). The native peoples of this area regularly ingest mushrooms, but variations in climatic conditions apparently render the mushrooms hallucinogenic for about only two days every year. Despite the fact that the social behavior is strongly controlled by a patrilineal clan system, the behavior of at least half of the intoxicated individuals severely disrupts everyday activities. The behavior is marked by shaking, shivering, dancing, delusions, and hallucinations. The men run wildly about, escaping and avoiding others, until they eventually run away from the group's territory. The following account illustrates the striking similarity of this behavior to that seen in the animal model:

> He (the intoxicated individual) begins to run, often stumbling because his vision is affected. The direction he takes initially, while he is still capable of rudimentary control over his actions, is out of his group's territory. . . . A man can often rush out (from) his own group's territory only to rush into the territory of a neighboring group. . . . A man who blunders into a tree or other obstacle, continues compulsively in whatever direction he is facing after the contact. . . . He is irritated by a constant, strange noise, which has begun so suddenly that he believes later a bush demon boxed his ears . . . he is likely to encounter at least one other Komugl man in his compulsive rush. At first, they appear to each other simply as moving objects that must be immobilized. . . . Each thinks the other a danger to him and believes he must defend himself. He struggles to disarm the other . . . (a sham fight ensues and the men escape from each other). . . . After prowling about in a dazed and indecisive manner, he eventually comes to rest (alone), exhausted and thirsty. (Reay, 1965, pp. 25–28)

While the Komugl man becomes hypersensitive and seeks to escape and avoid social interaction, the particular cultural conditions and population density of this area may not be conducive to the aggregation phenomenon. Conversely, in modern Western societies, Goode (1969) has commented that marijuana users form special social groupings and that users are more likely to identify and interact with other users than with someone who does not smoke marijuana; even at "... large parties where marijuana is smoked, small cliques will form ..." (p. 54). Siegel (1971b) observed that such small groups formed within larger groups of people using LSD or cannabis in a living-room setting. At the societal level, such groups take on the appearance of a subculture, with sociological, anthropological, enthographical, and social psychological identities (Goode, 1969, Scherer and Mukherjee, 1971). Individual members of this subculture may manifest aggregation in any one of these dimensions:

> It remains possible that the physical limitations of space in the mice cages, fish tanks, pigeon loft, or the living-room may have restricted the drugged subjects in their behavior, thereby channelling random ambulations to unpopulated or quiet areas where aggregations soon formed. Similarly, current legal and social sanctions may also prevent individuals from using psychedelics in any other than such clandestine aggregations. It is not surprising, therefore, that recent observations in North American cities find that continued use of marihuana involves participation in small intimate groups which actively avoid interaction with strangers (Goode, 1969). While high doses of hallucinogens can produce ataxia and disorientation and thus block any avoidance behavior (cf. Fuller, 1968), more than one social theorist has maintained that psychedelic drug users continue to "avoid" social interaction by embracing attitudes and ideologies of lessened commitment to institutional goals and rules. (Siegel, 1971b, pp. 317–318)

These phenomena are rarely observed in non-Western cultures that use hallucinogens. Previous ethnographic and ethnopharmacologic searches have agreed that the hallucinogens, unlike other psychoactive drugs, are rarely used socially in non-Western societies, but rather for mind-altering, religious-magical, or medicinal purposes (Blum et al., 1969; Efron, 1967). Blum (1971) notes that "the hallucinogen user is generally internally preoccupied, experiencing inner sensations, and ordinarily is not primed for social action or personal interaction" (p. 97). Attempts to use hallucinogens in social groups have indicated profound effects on activity, communication, decision-making processes, and interpersonal cohesiveness (Battegary, 1971; Cappell, Hicks, Miles, and Pliner, 1971; Cheek and Holstein, 1971). Therefore, it is not surprising that in Western societies such drug-taking behavior typically begins around the minimum school-leaving age and is marked by lessened family structure and relationships (Crockett, 1972), psychological alienation (Keniston, 1966), and sociological isolation (Soskin, 1967).

CONCLUSIONS

The ethologic search has found that *Homo sapiens* is not alone in the self-administration of hallucinogens. Either by accident or design, numerous infrahuman species also self-administer these drugs. Table 2 shows some ethologic examples of the self-administration of various types of drugs as described in this paper. The drug types and their naturally occurring substances are listed together with the animals which self-administer them, pattern of self-administration as discussed in this paper, animals which self-administer the same or similar substances in the laboratory, and the human use of these substances. Of the 14 drugs listed in Table 2, four are hallucinogens and four others are known to have hallucinogenic effects in man. Many of the examples cited here need further controlled psychopharmacological study in order to identify the biological, environmental, and pharmacological variables which reinforce and maintain self-administration. Nonetheless, it is clear that the consequences of such administrations dramatically affect the social behavior of these animals. Whether "sick," "ill," "intoxicated," "poisoned," "hypersensitive," "genetically guided," "narcotized," or "addicted," hallucinogen-treated animals tend to isolate themselves from social groups.

This behavior may be related to hallucinogen-induced states of central nervous system excitation (Winters and Wallach, 1970) and sympathetic nervous system arousal marked by a behavioral "turning inward toward a mental dimension at the expense of the physical" (Fischer, 1971, p. 897). Consequently, this excitation and arousal may contribute to the tendency of a variety of social species to isolate themselves from further stimulation after such stimulus bombardment (cf. Walters, 1968). In more cognitive terms, Keniston (1966) refers to the "stimulus flooding" effects of modern Western industrial society and the resultant "psychological numbing" of the individual. Accordingly, the self-administration of hallucinogens provides a means whereby the "numbed" individual can achieve desired states of arousal and stimulation. While this stimulus-seeking is but a manifestation of man's basic motivational drives, the coupling of continued hallucinogen use with such a search is associated with sociological isolation and psychological alienation. In that isolation and estrangement from self and others, the hallucinogen user seeks meaning and individuation in his life (Keniston, 1966). He is on a search for freedom and liberation in a sensual and affectual way (Miller, 1971). In effect, the ethologic search *for* hallucinogens has found man on an existential search *with* hallucinogens. Like his counterparts in nature, man does so alone.

Table 2

Ethologic Examples of Self-Administration of Various Types of Drugs

Drug type	Animal	Pattern of use	Laboratory animal	Human use
Hallucinogens				
Amanita Muscaria (fly-agaric; muscimol)	Reindeer	Intentional		Hallucinogen
Bufo marinus (toad; bufotenine)	Mongoose	Miscellaneous		Hallucinogen
Cannabis sativa (seeds; cannabinoids)	Pigeon	Intentional	Monkey, pigeon	Hallucinogen
Nepeta cataria (catnip; nepetalactones)	Cat	Quasi-accidental	Cat	Hallucinogen
Anesthetics				
Borassus (palm fruit; ethyl alcohol)	Elephant	Quasi-accidental	Monkey, man	Beverage, topical antiseptic can cause hallucinosis
Antimuscarinics				
Duboisia (atropine and scopolamine)	Fish, emu	Accidental		Anticholinergic can cause hallucinations
Hyoscyamus niger (Henbane; hyoscyamine, hyoscine, atropine)	Grazing animals	Accidental		Anticholinergic can cause hallucinations
Stimulants				
Coffee (caffeine)	Goat	Folklore	Monkey, man	Stimulant
Nicotiana tobacum (tobacco; nicotine)	Elephant	Accidental	Monkey, man	Stimulant, harman alkaloids in smoke may be related to hallucinogen harmaline
Miscellaneous				
Astragulus (loco weed; selenium)	Cow, horse, sheep	Accidental		Metallic base in industry, can cause hallucinations
Eucalypts (cineole and other oils)	Koala	Folklore		Expectorant, vermifuge, local anesthetic and antiseptic
Ophiorrhiza Mungos (Mungo root)	Mongoose	Folklore		Treatment for gonorrhea and scabies
Sansevieria	Elephant	Quasi-accidental		
Strophanthus welsitschii-Mimbapanda	Mongoose	Folklore		Treatment for gonorrhea and scabies

[a] Examples are listed with the ANIMAL which self-administers them, the PATTERN OF USE as defined in the text, the LABORATORY ANIMAL which self-administers the substance or its active principle, and the related HUMAN USE.

Summary

The traditional assumption that *Homo sapiens* is the only species which self-administers psychoactive drugs, including the hallucinogens, is examined in light of recent ethological, laboratory, anthropological, and sociological findings. Several examples of infrahuman organisms in natural environments self-administering hallucinogens by accident or on purpose are presented. The need for controlled studies to identify the biological, environmental, and pharmacological variables is discussed. Evidence for hallucinogen-induced changes in the social behavior of human and infrahuman populations is reviewed and it is concluded that the primary ethologic effect in all species is social isolation.

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