CROWDING INTO THE BEHAVIORAL SINK

Calhoun, J. B. (1962). Population density and social pathology. *Scientific American, 206*(3), 139-148.

The effects of crowding on our behavior is something that has interested psychologists for decades. You have probably noticed how your emotions and behavior change when you are in a situation that you perceive as very crowded. You may withdraw into yourself and try to become invisible; you might look for an escape; or you may find yourself becoming irritable and aggressive. How you react to crowding depends on many factors.

You will notice that the title of the article of discussion in this chapter uses the phrase *population density* rather than *crowding*. While these may seem very similar, psychologists draw a clear distinction between them. Density refers to the number of individuals in a given amount of space. If 20 people occupy a 12-by-12-foot room, the room would probably be seen as densely populated. Crowding, however, refers to the subjective psychological experience created by density. That is, if you are trying to concentrate on a difficult task in that room with 20 people, you may experience extreme crowding. Conversely, if you are at a party with 20 friends in that same room, you might not feel crowded at all.

One way behavioral scientists can study the effects of density and crowding on people is to observe places where crowding already exists, such as Manhattan, Mexico City, some housing projects, prisons, and so on. The problem with this method is that all these places contain many factors that can influence behavior. For example, if we find high crime rates in a crowded inner-city neighborhood, there's no way to know for sure that crowding is the cause of the crime. Maybe it's the fact that people there are poor, or that there's a higher rate of drug abuse, or perhaps all these factors combine with crowded conditions to produce the high crime rates. 250

Another way to study crowding is to put human subjects into high-density conditions for relatively short periods of time and study their reactions. While this method offers more control and allows us to isolate crowding as a cause of behavior, it is not very realistic in terms of real-life crowded environments, since they usually exist over extended periods of time. It should be pointed out, however, that both of these methods have yielded some interesting findings about crowding that will be discussed later in this chapter.

Since it would be ethically impossible (because of the stress and other potential damaging effects) to place humans in crowded conditions over long periods of time simply to do research on them, there is a third way of addressing the effects of density: Do research using animal subjects. One of the earliest and most classic series of studies of this type was conducted by John B. Calhoun (1917-1995) in 1962. Calhoun allowed groups of white rats to increase in population to twice the number that would normally be found in a space the size of a 10-by-14-foot room and observed their "social" behavior for 16 months.

THEORETICAL PROPOSITIONS

Calhoun especially wanted to explore the effects of high density on social behavior. It may seem strange to you to think of rats as social animals, but they do socialize in various ways in their natural environment.

To appreciate what led Calhoun to the study being discussed in this chapter, it is necessary to back up several years to an earlier project he conducted. Calhoun had confined a population of rats to a quarter-acre of enclosed, protected outdoor space. Plenty of food was available; there were ideal protected nesting areas; there were no predators; and all disease was kept to a minimum. In other words, this was a rat's paradise. The point of Calhoun's early study was simply to study the population growth rate of the rats in a setting free from the usual natural controls on overpopulation (predators, disease, etc.). After 27 months, the population consisted of only 150 adult rats. This was very surprising since with the low mortality rate of adult rats in this ideal setting, and considering the usual rate of reproduction, there should have been 5,000 adults in this period of time! The reason for this small population was an extremely high infant mortality rate. Apparently, reproductive and maternal behavior had been severely altered by the stress of social interaction among the 150 rats, and very few young rats survived to reach adulthood. Even though this number of rats (150 in a quarter-acre) does not seem to be particularly dense, it was obviously crowded enough to produce extreme behavioral changes.

These findings prompted Calhoun to design a more controlled and observable situation inside the lab in order to study more closely what sorts of changes occur in the rats when they are faced with high population density. In other words, he had observed what happened, and now he wanted to find out why.

METHOD

In a series of three studies, either 32 or 56 rats were placed in a 10-by-14-foot laboratory room that was divided into four sections or pens (see Figure 1). There were ramps that allowed the rats to cross from pen 1 to pen 2,

from pen 2 to pen 3, and from pen 3 to pen 4. It was not possible for the rats to cross directly between pen 1 and pen 4. Therefore, these were end-pens. If a rat wanted to go from 1 to 4, it would have to go through 2 and 3. The partitions dividing the pens were electrified, so the rats quickly learned that they could not climb over them.

These pens consisted of feeders and waterers and enclosures for nests. The rats were supplied with plenty of food, water, and materials for building nests. In order to observe and record the rats' behavior there was a viewing window in the ceiling of the room.

From his years of studying rats, Calhoun was aware that this particular strain normally is found in colonies of 12 adults. Therefore, the observation room was of a size to accommodate 12 rats per pen, or a total of 48. After the groups were placed in the room, they were allowed to multiply until this normal density was nearly doubled to 80. Once the population level of 80 was reached, young rats that survived past weaning were removed so that the number of rats remained constant.

With this arrangement in place, all that was left was to observe these crowded animals for an extended period of time and record their behavior. These observations went on for 16 months.

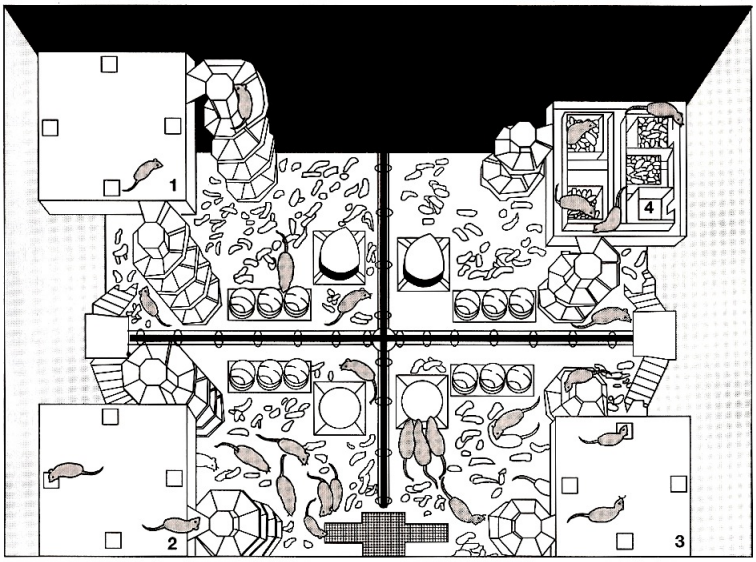

FIGURE 1 Diagram of laboratory room as arranged in Calhoun's study of crowding.

RESULTS

It is important to keep in mind that the density of the rats was not extreme; in fact, it was quite moderate. If the rats wanted to spread out, there would only have to be 20 or so per pen. But this is not what happened. When the male rats reached maturity, they began to fight with each other for social status as they do naturally. These fights took place in all the pens, but the outcome was not the same for all of them. If you think about the arrangement of the room, the two end-pens only had one way in and out. So when a rat won a battle for dominance in one of these pens, he could hold his position and territory (the whole pen) simply by guarding the entrance and attacking any other male that ventured over the ramp. As it turned out, only one male rat ended up in charge of each of the end-pens. However, he was not alone. The female rats distributed themselves more or less equally over all four pens. Therefore, the masters of pens 1 and 4 each had a harem of 8 to 12 females all to themselves. And they didn't take any chances. In order to prevent infiltration, the males took to sleeping directly at the foot of the ramp and were always on guard.

On occasion, there were a few other male rats in the end-pens, but they were extremely submissive. They spent most of their time in the nesting burrows with the females and only came out to feed. They did not attempt to mate with the females. The females in these pens functioned well as mothers. They built comfortable nests and nurtured and protected their offspring. In other words, life for most of the rats in these end-pens was relatively normal and reproductive behavior was successful. About half of the infant rats in those pens survived to adulthood.

The rest of the 60 or so rats crowded into the middle two pens. Since these two pens each had central feeding and watering devices, there were many opportunities for the rats to come in contact with each other. The kinds of behaviors observed among the rats in pens 2 and 3 demonstrate a phenomenon that Calhoun termed the *behavioral sink*. A behavioral sink is "the outcome of any behavioral process that collects animals together in

unusually great numbers. The unhealthy connotations of the term are not accidental: A behavioral sink does act to aggravate all forms of pathology that can be found within a group" (p. 144). Let's examine some of the extreme and pathological behaviors he observed:

1. *Aggression*. Normally in the wild, male rats will fight other male rats for dominant positions in the social hierarchy. These fights were observed among the more aggressive rats in this study as well. The difference was that here, unlike in their natural environments, top-ranking males were required to fight frequently in order to maintain their positions and often the fights involved several rats in a general brawl. Nevertheless, the strongest males were observed to be the most normal within the center pens. However, even those animals would sometimes exhibit "signs of pathology; going berserk; attacking females, juveniles, and less active males; and showing a particular predilection—which rats do not normally display—for biting other rats on the tail" (p. 146).

2. *Submissiveness*. Contrary to this extreme aggression, other groups of male rats ignored and avoided battles for dominance. One of these groups consisted of the most healthy-looking rats in the pens. They were fat and their fur was full, without the usual bare spots from fighting. However, these rats were complete social misfits. They moved through the pens as if asleep or in some sort of hypnotic trance, ignoring all others, and were, in turn, ignored by the rest. They were completely uninterested in sexual activity and made no advances, even toward females in heat.

   Another group of rats engaged in extreme activity and were always on the prowl for receptive females. Calhoun termed them probers. Often, they were attacked by the more dominant males, but were never interested in fighting for status. They were hypersexual and many of them even became cannibalistic!

3. *Sexual deviance*. These probers also refused to participate in the natural rituals of mating. Normally, a male rat will pursue a female in heat until she escapes into her burrow. Then, the male will wait patiently and even perform a courtship dance directly outside her *door*. Finally, she emerges from the burrow and the mating takes place. In Calhoun's study, this ritual was adhered to by most of the sexually active males except the probers. They completely refused to wait and followed the female right into her burrow. Sometimes the nests inside the burrow contained young that had failed to survive, and it was here that late in the study the probers turned cannibalistic.

   Another group of male rats was termed *the pansexuals* because they attempted to mate with any and all other rats indiscriminately. They sexually approached other males, juveniles, and females that were not in heat. This was a submissive group that was often attacked by the more dominant male rats, but did not fight for dominance.

4. *Reproductive abnormalities*. Rats have a natural instinct for nest building. In this study, small strips of paper were provided in unlimited quantities as nest material. The females are normally extremely active in the process of building nests as the time for giving birth approaches. They gather the material and pile it up so that it forms a cushion. Then they arrange the nest so that it has a small indentation in the middle to hold the young. However, the females in the behavioral sink gradually lost their ability (or inclination) to build adequate nests. At first they failed to form the indentation in the middle. Then, as time went on, they collected fewer and fewer strips of paper so that eventually the infants were born directly on the sawdust that covered the pen's floor.

The mother rats also lost their maternal ability to transport their young from one place to another if they felt the presence of danger. They would move some of the litter and forget the rest, or simply drop them onto the floor as they were moving them. Usually these infants were abandoned and died where they were dropped. They were then eaten by the adults. The infant mortality rate in the middle pens was extremely high, ranging from 80% to 96%.

In addition to these maternal deficits, the female rats in the middle pens, when in heat, were chased by large groups of males until they were finally unable to escape. These females experienced high rates of complications in pregnancy and delivery. By the end of the study, almost half of them had died.

DISCUSSION

You might expect that a logical extension of these findings would be to apply them to humans in high-density environments. However, for reasons to be discussed shortly, Calhoun did not draw any such conclusions. In fact, he discussed his findings very little—probably assuming, and logically so, that his results spoke volumes for themselves. He did comment on one clear result: that the natural social and survival behaviors of the rats were severely altered by the stresses associated with living in a high-population-density environment. In addition, he noted that through additional research, with improved methods and refined interpretation of the findings, his studies and others like them may contribute to our understanding of similar issues facing human beings.

SIGNIFICANCE OF FINDINGS

As with many of the studies in this book, one of the most important aspects of Calhoun's studies was that they sparked a great deal of related research on the effects on humans of high-density living. It would be impossible to examine this large body of research in detail here, but perhaps a few examples should be mentioned.

One environment where the equivalent of a behavioral sink might exist for humans is in extremely overcrowded prisons. A study funded by the National Institute of Justice examined prisons where inmates averaged only 50 square feet each (or an area about 7-by-7 feet), compared with less crowded prisons. It was found that in the crowded prisons there were significantly higher rates of mortality, homicide, suicide, illness, and disciplinary problems (McCain, Cox, & Paulus, 1980). Again, however, remember that other factors besides crowding could be influencing these behaviors.

Another interesting finding has been that crowding produces negative effects on problem-solving abilities. One study placed people in small, extremely crowded rooms (only 3 square feet per person) or in larger, less crowded rooms. The subjects were asked to complete rather complex tasks, such as placing various shapes into various categories while listening to a story on which they were to be tested later. Those in the crowded conditions performed significantly worse than those who were not crowded (Evans, 1979).

Finally, what do you suppose happens to you physiologically in crowded circumstances? Research has determined that your blood pressure and heart rate increase. Along with those effects, you tend to feel that other people are more hostile and that time seems to pass more slowly as density increases (Evans, 1979).

CRITICISMS

Calhoun's results with animals have been supported by later animal research (see Marsden, 1972). However, as has been mentioned before in this book, we must always be careful in applying animal research to humans. Just as substances that may be shown to cause illness in rats may not have the same effect on human physical health, environmental factors influencing rats' social behaviors may not be directly applicable to people. At best, animals can only represent certain aspects of humans. Sometimes animal research can be very useful and revealing and lead the way for more definitive research with people. At other times, it can be a dead end.

In 1975, a study was undertaken in New York City that attempted to replicate with people some of Calhoun's findings (Freedman, Heshka, & Levy, 1975). Data were collected for areas of varying population density on death rates, fertility rates (birth rates), aggressive behavior (court records), psychopathology (admissions to mental hospitals), and so on. When all the data were analyzed, no significant relationships were found between population density and any form of social pathology.

Nevertheless, Calhoun's work in the early 1960s focused a great deal of attention on the psychological and behavioral effects of crowding. This line of research, as it relates to humans, continues today.

RECENT APPLICATIONS

John Calhoun died on September 7,1995, and left behind a legacy of insightful and historically meaningful research. The kinds of social problems discussed by Calhoun in his 1962 article are increasingly relevant to the human condition. Consequently, when scientists undertake research to better understand and intervene in such problems as aggression, infertility, mental illness, or various forms of social conflict, it is not unusual for them to make reference to Calhoun's research on crowding and behavioral pathology.

An interesting study citing Calhoun's work, examined changes in animal behavior that accompany domestication (Price, 1999). This author contended that species of animals that are domesticated, that is, kept as pets, have undergone genetic and developmental changes over many generations that have altered their

behaviors in ways that allow them to share a common living environment with humans. Basically, what Price is suggesting is that as wild animals have become domesticated over centuries, they have had to adapt to human settings that are very different from their original habitats. This usually includes living in peaceful harmony (most of the time, at least) with others of their own species, other animal species, and humans, usually in relatively crowded conditions. This is accomplished, the author contends, through the evolution of increased response thresholds, meaning it takes a lot more provocation for a domesticated animal to become territorial and aggressive. In other words, dogs, cats, and humans are all able to live together in a relatively small space without running away or tearing each other to pieces as would occur among nondomesticated animals in the wild.

In a different direction, an article by Torrey and Yolken (1998) incorporated Calhoun's study in examining the association between growing up in crowded conditions and the development of schizophrenia and bipolar disorder (manic-depression): Many studies have found that people who are raised in high-density urban environments are at increased risk for these psychological disorders later in life. Numerous factors are present in crowded, urban settings that may account for such increased risks. However, the authors of this study hypothesized that it is not the increased density of living conditions in the neighborhood, but rather in the individual homes (more people occupying less space) that may explain the higher rates of mental illness later in life. Why? This study contended that exposure to a larger number of infectious agents may account for this association.

Finally, a related study found a possible key difference in human reactions to population density compared to animals. In animal studies, pathology appears to increase in a linear way as a direct result of increased density: as one increases the other increases. However, a study by Regoeczi (2002) found that for humans, the effect of household population density on social withdrawal and aggression actually *decreased* as the number of people in a single household increased. However, this effect was only observed until the number of people exceeded the total number of rooms; very much beyond that, the antisocial effects begin to appear with increasing density. In other words when living conditions are such that, say, 5 people occupy a 3-room apartment or 7 people are squeezed into a 4-room house, the tendency for people to withdraw and/or display more aggression increases. Two possible causes may be at work here. Either density is causing the pathology, or people who are more withdrawn or more aggressive end up in less crowded living situations, by choice or by ostracism, respectively.

These studies demonstrate how social scientists are continuing to explore and refine the effects of density and crowding. The causes of social pathology are many and complex. The impact of population density, first brought to our attention by Calhoun over 40 years ago, is only one, but a very crucial, piece of the puzzle.

Evans, G. W. (1979). Behavioral and psychological consequences of crowding in humans. *Journal of Applied Social Psychology, 9*, 27-46.

Freedman, J. L., Heshka, S., & Levy, A. (1975). Population density and social pathology: Is there a relationship? *Journal of Experimental Social Psychology, 11*, 539-.552.

Marsden, H. M. (1972). Crowding and animal behavior. In J. F. Wohlhill & D. H. Carson (Eds.), *Environment and the social sciences*. Washington, DC: American Psychological Association.

McCain, G., Cox, V. C., & Paulus, P. B. (1980). The relationship between illness, complaints, and degree of crowding in a prison environment. *Environment and Behavior, 8*, 283-290.

Price, E. (1999). Behavioral development in animals undergoing domestication. *Applied Animal Behavior Research, 65*(3), 245-271.

Regoeczi, W. (2002). The impact of density: The importance of nonlinearity and selection on flight and fight responses. *Social Forces, 81*, 505-530.

Torrey, E., & Yolken, R. (1998). At issue: Is household crowding a risk factor for schizophrenia and bipolar disorder? *Schizophrenia Bulletin, 24*(3), 321-324.