

**POPULATION GROWTH** has been thought, since the time of Thomas Malthus, to produce dire consequences such as disease, scarcity and social deviancy. This dark view seemed confirmed by rodent studies. Yet little evidence suggests that people are similarly affected: we seem to handle large crowds quite well for the most part.



# Coping with **CROWDING**

by Frans B. M. de Waal, Filippo Aureli and Peter G. Judge



BRIAN PETERSON/ISTOCK

In 1962 this magazine published a seminal paper by experimental psychologist John B. Calhoun entitled “Population Density and Social Pathology.” The article opened dramatically with an observation by the late-18th-century English demographer Thomas Malthus that human population growth is automatically followed by increased vice and misery. Calhoun went on to note that although we know overpopulation causes disease and food shortage, we understand virtually nothing about its behavioral impact.

This reflection had inspired Calhoun to conduct a nightmarish experiment. He placed an expanding rat population in a crammed room and observed that the rats soon set about killing, sexually assaulting and, eventually, cannibalizing one another. Much of this activity happened among the occupants of a central feeding section. Despite the presence of food elsewhere in the room, the rats were irresistibly drawn to the social stimulation—even though many of them could not reach the central food dispensers. This pathological togetherness, as Calhoun described it, as well as the attendant chaos and behavioral deviancy, led him to coin the phrase “behavioral sink.”

In no time, popularizers were comparing politically motivated street riots to rat packs, inner cities to behavioral sinks and urban areas to zoos. Warning that society was heading for either anarchy or dictatorship, Robert Ardrey, an American science journalist, remarked in 1970 on the voluntary nature of human crowding: “Just as Calhoun’s rats freely chose to eat in the middle pens, we freely enter the city.” Calhoun’s views soon became a central tenet of the voluminous literature on aggression.

In extrapolating from rodents to people, however, these thinkers and writers were making a gigantic leap of faith. A look at human populations suggests why such a simple extrapolation is so problematic. Compare, for instance, per capita murder rates with the number of people per square kilometer in different nations—as we did, using data from the United Nations’s 1996 *Demographic Yearbook*. If things were straightforward, the two ought to vary in tandem. Instead there is no statistically meaningful relation.

But, one could argue, perhaps such a relation is obscured by variation in national income level, political organization or some other variable. Apparently not, at least for income. We divided the nations into three categories—free-market, former East Block and Third World—and did the analysis again. This time we did find one significant correlation, but it was in the other direction: it showed more violent crime in the least crowded countries of the former East Block. A similar trend existed for free-market nations, among which the U.S. had by far the highest homicide rate despite its low overall population density. The Netherlands had a population density 13 times as high, but its homicide rate was eight times lower.

Knowing that crime is generally more common in urban areas than it is in the countryside, we factored in the proportion of each nation’s population that lives in large cities and controlled for it. But this correction did nothing to bring about a positive correlation between population density and homicide. Perhaps because of the overriding effects of history and culture, the link between available space and human aggression—if it exists at all—is decidedly not clear-cut.

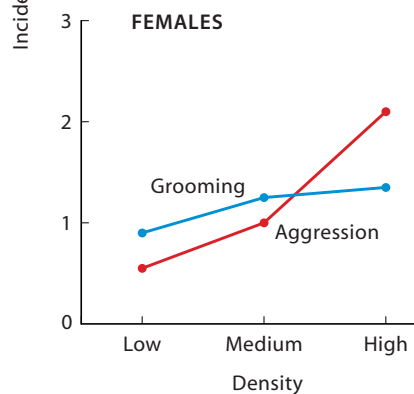
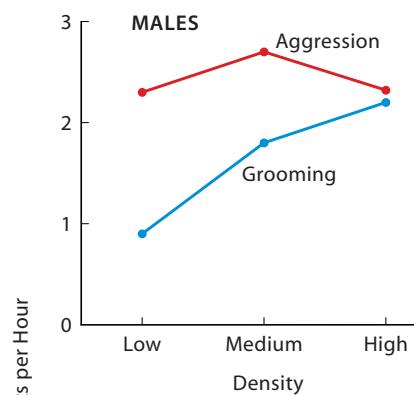
Even if we look at small-scale human experiments, we find no supporting evidence. Crowding of children and college students, for instance, sometimes produced irritation and mild aggression, but in general, people seemed adept at avoiding conflict. Andrew S. Baum and his co-workers in the psychiatry department at the Uniformed Services University found that dormitory residents who shared facilities with many people spent less time socializing and kept the doors to their rooms closed more often than did students who had more space. Baum concluded that the effects of crowding are not nearly as overwhelming as originally presumed. Published in the 1980s, these and other findings began to undermine, at least in the scientific community, the idea that people and rats react in the same ways to being packed together. In modern society, people commonly assemble in large masses—during their daily commute to work or during holiday-season shopping expeditions—and most of the time

*A persistent and popular view holds that high population density inevitably leads to violence. This myth, which is based on rat research, applies neither to us nor to other primates*



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**RHESUS MONKEYS** from three different settings show different rates of grooming—that is, of calming one another. The monkeys seem to adapt to crowded conditions by grooming more frequently. Among the males, grooming of each other and of females was more common when they lived in crowded conditions than when they lived in more spacious quarters. Among female nonkin, aggression was common and increased further with crowding but was accompanied by increased grooming, which served to reduce conflicts.



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SOURCE: Peter G. Judge and Frans B. M. de Waal

they control their behavior extraordinarily well.

Calhoun's model, we must conclude, does not generally apply to human behavior. Is this because our culture and intelligence make us unique, or is the management of crowding part of an older heritage? To answer this question, we turn to the primates.

### Primates Are Not Rats

Primate research initially appeared to support the harrowing scenario that had been presented for rats. In the 1960s scientists reported that city-dwelling monkeys in India were more aggressive than were those living in forests. Others claimed that monkeys in zoos were excessively violent. Those monkeys were apparently ruled by terrifying bullies who dominated a social hierarchy that was considered an artifact of captivity—in other words, in the wild, peace and egalitarianism prevailed. Borrowing from the hyperbole of popularizers, one study of crowding in small captive groups of baboons even went so far as to report a “ghetto riot.”

As research progressed, however, conflicting evidence accumulated. Higher

population density seemed to increase aggression occasionally—but the opposite was also true. One report, for instance, described intense fighting and killing when a group of macaques were released into a corral 73 times larger than their previous quarters had been. Then, after two and a half years in the corral, a similar increase in aggression occurred when the monkeys were crowded back into a small pen.

Whereas the macaque study manipulated population density through environmental change, other early research did so by adding new monkeys to existing groups. Given the xenophobic nature of monkeys, these tests mainly measured their hostile attitude toward strangers, which is quite different from the effect of density. The better controlled the studies became, the less clear-cut the picture turned out to be. Increased population density led to increased aggression in only 11 of the 17 best-designed studies of the past few decades.

In the meantime, the view of wild primates was changing. They were no longer the purely peaceful, egalitarian creatures people had presumed them to be. In the 1970s field-workers began reporting sporadic but lethal violence in a

wide range of species—from macaques to chimpanzees—as well as strict and well-defined hierarchies that remained stable for decades. This view of an often anxiety-filled existence was confirmed when researchers found high levels of the stress hormone cortisol in the blood of wild monkeys [see “Stress in the Wild,” by Robert M. Sapolsky; *SCIENTIFIC AMERICAN*, January 1990].

As the view of primates became more complex, and as the rat scenario was weakened by counterexamples, researchers began to wonder whether primates had developed a means to reduce conflict in crowded situations. We saw the first hint of this possibility in a study of the world's largest zoo colony of chimpanzees in Arnhem, the Netherlands. The apes lived on a spacious, forested island in the summer but were packed together in a heated building during the winter. Despite a 20-fold reduction in space, aggression increased only slightly. In fact, the effect of crowding was not entirely negative: friendly grooming and greetings, such as kissing and submissive bowing, increased as well.

We wondered if this conciliatory behavior mitigated tension and proposed a way to test this possibility. Without ig-

noring the fact that crowding increases the potential for conflict, we predicted that primates employ counterstrategies—including avoiding potential aggressors and offering appeasement or reassuring body contact. Because some of the skills involved are probably acquired, the most effective coping responses would be expected in animals who have experienced high density for a long time. Perhaps they develop a different “social culture” in the same way that people in different places have varying standards of privacy and interpersonal comfort zones. For example, studies show that white North Americans and the British keep greater distances from others during conversations than Latin Americans and Arabs do.

### Coping Culture

**W**e set about finding several populations of monkeys that were of the same species but that had been living in different conditions to see if their

behavior varied in discernible ways. We collected detailed data on 122 individual rhesus monkeys at three different sites in the U.S.: in relatively cramped outdoor pens at the Wisconsin primate center in Madison, in large open corrals at the Yerkes primate center in Atlanta and on Morgan Island off the coast of South Carolina. These last monkeys had approximately 2,000 times more space per individual than the highest-density groups. All three groups had lived together for many years, often for generations, and included individuals of both sexes. All the groups had also been in human care, receiving food and veterinary treatment, making them comparable in that regard as well.

Rhesus society typically consists of a number of subgroups, known as matriline, of related females and their offspring. Females remain together for life, whereas males leave their natal group at puberty. Rhesus monkeys make a sharp distinction between kin and non-kin: by far the most friendly contact, such as grooming, takes place within the matriline. Females of

one matriline also fiercely support one another in fights against other matriline. Because of their strict hierarchy and pugnacious temperament, rhesus seemed to be ideal subjects. We figured that if this aggressive primate showed coping responses, our hypothesis would have withstood its most rigorous test.

Our first finding was, surprisingly, that density did not affect male aggressiveness. Adult males increasingly engaged in friendly contact under crowded conditions. They groomed females more, and likewise the females groomed the males more frequently. (Grooming is a calming behavior. In another study, we demonstrated that a monkey’s heart rate slows down when it is being groomed.) Females also bared their teeth more often to the males—the rhesus way of communicating low status and appeasing potentially aggressive dominant monkeys.

Females showed a different response with other females, however. Within their own matriline they fought more but did not change the already high level of friendly interaction. In their dealings with other matriline, they also showed more aggression—but here it was cou-

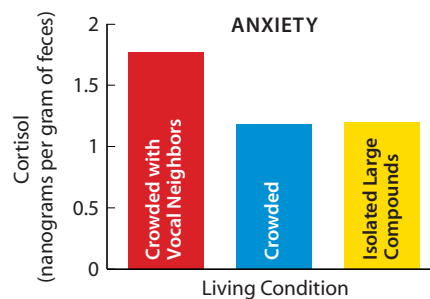
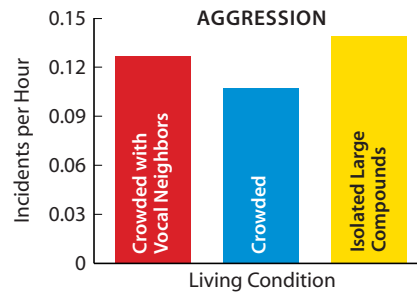


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**CHIMPANZEES IN THE WILD** have hostile territorial relations with other groups, and in captivity they are bothered by the presence of noisy neighboring chimps. By examining apes under three conditions—those living in a crowded space and able to hear their neighbors, those living in a crowded space without such worrisome sounds, and those living in isolated large compounds (*photograph below*)—we were able to measure the association between aggression, space and stress. Aggression (*photograph at left*) remained the same, but stress varied with neighbors’ noise. Chimpanzees in small spaces exposed to vocalizations from other groups showed the highest levels of the stress hormone cortisol.



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SOURCE: Filippo Aureli and Frans B. M. de Waal

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pled with more grooming and submissive grinning.

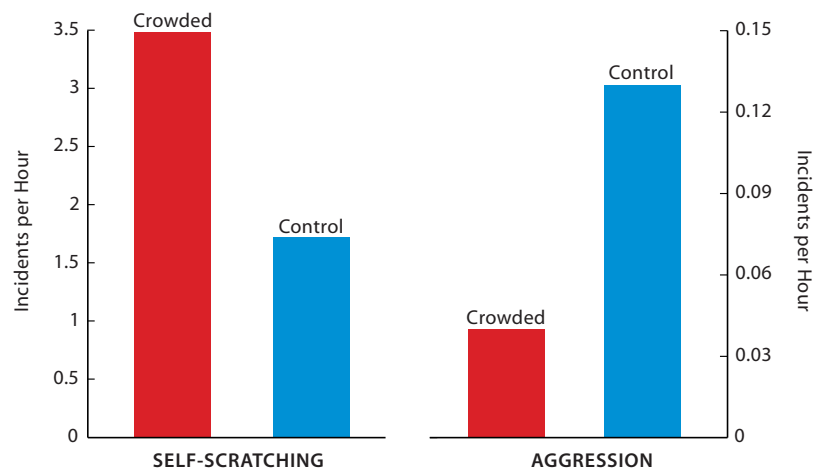
These findings make sense in light of the differences between kin and non-kin relationships. Related females—such as sisters and mothers and daughters—are so strongly bonded that their relationships are unlikely to be disrupted by antagonism. Rhesus monkeys are used to managing intrafamilial conflict, cycling through fights and reconciliations, followed by comforting contact. Crowding does little to change this, except that they may have to repair frayed family ties more often. Between matriline, on the other hand, crowding poses a serious challenge. Normally, friendly contact between matriline is rare and antagonism common. But reduced escape opportunities make the risk of escalated conflict greater in a confined space. And our data indicated that female rhesus monkeys make a concerted effort at improving these potentially volatile relationships.

### Emotions in Check

In a second project, we turned our attention to chimpanzees. As our closest animal relatives, chimpanzees resemble us in appearance, psychology and cognition. Their social organization is also humanlike, with well-developed male bonding—which is rare in nature—reciprocal exchange and a long dependency of offspring on the mother. In the wild, male chimpanzees are extremely territorial, sometimes invading neighboring territories and killing enemy males. In captivity such encounters are, of course, prevented.

We collected data on more than 100 chimpanzees in various groups at the Yerkes primate center. Although some groups had only a tenth the space of others, cramped quarters had no measurable impact on aggression. In contrast to the monkeys, chimpanzees maintained their grooming and appeasement behavior—no matter the situation. If crowding did induce social tensions, our chimpanzees seemed to control them directly.

We usually do not think of animals as holding in their emotions, but chimpanzees may be different. These apes are known for deceptive behavior—for instance, they will hide hostile intentions behind a friendly face until an adversary has come within reach. In our study, emotional control was reflected in the way chimpanzees responded to the vocalizations of neighboring groups. Such noises commonly provoke hooting



SOURCE: Filippo Aureli and Frans B. M. de Waal

and charging displays, which in wild chimpanzees serve to ward off territorial intrusion.

In a confined space, however, excited reactions trigger turmoil within the group. We found that chimpanzees in the most crowded situations had a three times *lower* tendency to react to neighbors' vocalizations than chimpanzees with more space did. Chimpanzees may be smart enough to suppress responses to external stimuli if those tend to get them into trouble. Indeed, field-workers report that chimpanzee males on territorial patrol suppress all noise if being detected by their neighbors is to their disadvantage.

The inhibition of natural responses is not without cost. We know that continuous stress has the potential to suppress the immune system and therefore has important implications for health and longevity. We developed two noninvasive techniques to measure stress in our chimpanzees. One was to record the rate of self-scratching. Just as with college students who scratch their heads when faced with a tough exam question, self-scratching indicates anxiety in other primates. Our second technique was to collect fecal samples and analyze them for cortisol. Both measures showed that groups of chimpanzees who had little



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**ELEVATOR EFFECT** helps to explain how chimpanzees, and people, deal with crowding. During brief periods of crowding, people often limit social interaction—a way of avoiding any conflict (*photograph at left*). Chimpanzees do the same, reducing their aggressive interactions (*photograph above and chart at left*). This doesn't mean that crowded situations do not induce anxiety. Chimpanzees packed together tend to scratch themselves more often—a sign of stress.

space and heard neighbors' vocalizations experienced more stress. Space by itself was not a negative factor, because in the absence of noisy neighbors, chimpanzees in small spaces showed the same stress level as those with a good deal of space.

So even though chimpanzees fail to show a rise in aggression when crowded, this does not necessarily mean that they are happy and relaxed. They may be working hard to maintain the peace.

Given a choice, they would prefer more room. Every spring, when the chimpanzees at the Arnhem zoo hear the door to their outdoor island being opened for the first time, they fill the building with a chorus of ecstasy. They then rush outside to engage in a pandemonium in which all of the apes, young and old, embrace and kiss and thump one another excitedly on the back.

The picture is even more complex if

we also consider short periods of acute crowding. This is a daily experience in human society, whether we find ourselves on a city bus or in a movie theater. During acute crowding, rhesus monkeys show a rise in mild aggression, such as threats, but not violence. Threats serve to keep others at a distance, forestalling unwanted contact. The monkeys also avoid one another and limit active social engagement, as if they are trying to stay out of trouble by lying low.

Chimpanzees take this withdrawal tactic one step further: they are actually less aggressive when briefly crowded. Again, this reflects greater emotional restraint. Their reaction is reminiscent of people on an elevator, who reduce frictions by minimizing large body movements, eye contact and loud verbalizations. We speak of the elevator effect, therefore, as a way in which both people and other primates handle the risks of temporary closeness.

Our research leads us to conclude that we come from a long lineage of social animals capable of flexibly adjusting to all kinds of conditions, including unnatural ones such as crowded pens and city streets. The adjustment may not be without cost, but it is certainly preferable to the frightening alternative predicted on the basis of rodent studies.

We should add, though, that even the behavioral sink of Calhoun's rats may not have been entirely the product of crowding. Food competition seemed to play a role as well. This possibility contains a serious warning for our own species in an ever more populous world: the doomsayers who predict that crowding will inevitably rip the social fabric may have the wrong variable in mind. We have a natural, underappreciated talent to deal with crowding, but crowding combined with scarcity of resources is something else. SA

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FRANS B. M. DE WAAL, FILIPPO AURELI and PETER G. JUDGE share a research interest in the social relationships and behavioral strategies of nonhuman primates. Their work on aspects of this topic will appear in *Natural Conflict Resolution*, to be published by the University of California Press. De Waal, author of *Chimpanzee Politics* and *Good Natured*, worked for many years at the Arnhem zoo in the Netherlands before coming to the U.S., where he is now director of the Living Links Center at the Yerkes Regional Primate Research Center in Atlanta and professor of psychology at Emory University. Aureli is a senior lecturer in biological and earth sciences at Liverpool John Moores University in England. Judge is an assistant professor at Bloomsburg University in Pennsylvania and a research associate at Yerkes.

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