

# A GAME OF CAT AND HOUSE: SPATIAL PATTERNS AND BEHAVIOR OF 14 DOMESTIC CATS (*FELIS CATUS*) IN THE HOME

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## ABSTRACT:

*A descriptive study of the use of space and patterns of interaction of 14 unrelated, nonreproductive domestic cats (*Felis catus*) living together in a single-story house was undertaken, since these behaviors have rarely been described for cats in this common situation.*

*Within the house, the cats kept to overlapping but individually distinct home ranges. The home ranges of males tended to be slightly larger than those of females, a pattern similar to that found in studies of feral cats outdoors. Three male kittens showed dramatic reductions in home range at approximately one year of age.*

*Almost all individuals had favored spots where they could predictably be found within the rooms they frequented. While some individuals had unique spots that only they used, more com-*

*monly several individuals had the same favored spot within a room. Sharing of such spots was primarily the result of different individuals occupying the spots at different times, a kind of time-sharing rather than physical sharing. Time-sharing groups could be identified, some all female, some all male, some a mix.*

*Certain individuals were identified as dominant or subordinate by their ability to control access to resources and/or by others conceding resources to them. However, overt aggression was rare, and there was no clear hierarchy.*

*Tail positions could be identified and may have played an important role in helping this relatively large group occupy this relatively small home.*

*Density calculations completed at the end of the study indicated that the group was living at approximately 50 times the highest densities observed in most studies of cats outdoors, yet stable groupings were maintained.*

## INTRODUCTION

**A**lthough an estimated 60 million domestic cats (*Felis catus*) in the United States currently reside as pets in people's homes, little research has focused on how cats actually live and interact within this setting. We were able to gather basic information about cat behavior in the home by observing a group of fourteen domestic cats for three months, as they lived without restriction in the house of one of the authors of this study (Strack). This group provided a readily observable, closed, stable community in which we could explore questions that have been studied only rarely in this setting.

In this descriptive, preliminary study, we asked several basic questions about behavior and use of space by cats in this home setting.

First, we asked if we could identify home ranges within the house, areas of regular use by each cat, and whether there were

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male/female differences in use of space. Home range use has been described previously in many outdoor studies of domestic and feral cats (e.g. see summaries in Liberg and Sandell 1988; Bradshaw 1992) but not formally in indoor home situations.

Second, we wanted to examine special uses of space, primarily the use of "favored spots" by individual cats within each room. This is a behavior familiar to all cat owners but one which has only rarely been discussed in previous studies (e.g. Leyhausen 1965; Bradshaw 1992).

Third, we wondered if dominance played a role in organizing interactions within the group. We asked this question because it was Strack's impression that there were 1-2 dominant individuals in her group, because dominance plays such an important role in so many other very social animal groups, and because dominance has not apparently been studied formally in groups of cats in the home setting.

Fourth, we examined tail signaling, to see what patterns of signal/behavior combi-

nations cats utilized in this setting, and what role such signaling might play in interactions carried out in this situation. Long, visible tails have been shown to play a role in organizing behavioral interactions in other very social groups (e.g. Bernstein 1978, 1979; Bernstein et al. 1978), making this an obvious characteristic to examine.

Last, since ours was a fairly large group in a relatively small home, we wondered at what density the cats were actually living and how their situation compared with densities described in previous studies, all of which focused on cats outdoors (reviewed in Liberg and Sandell 1988).

## SUBJECTS AND METHODS

The 14 subjects in this study were unrelated individuals of both sexes, various ages, and several breeds of domestic short-haired and long-haired cats (Table 1). All had been neutered prior to or soon after the study began.

At the beginning of the study, subjects ranged in age from four months to thir-

**TABLE 1.**

Subjects of Study				
NAME	SEX	AGE	BREED	COLOR/PHENOTYPE
Daphne	F	13	Domestic	Tri-color Tabby
Julius*†	M	9	Domestic	White
Patti	F	9	Domestic	Silver Tabby & White
Melissa	F	8	Domestic	Brindle
Mrs. Kitty	F	6	Domestic	Black & White
Violet	F	6	Domestic	Silver Tabby
Tonto	M	5 1/2	Domestic	Black & White
Harry	M	5 1/2	Russian Blue	Blue-Gray
Lily*	F	4	Siamese	Sealpoint
Carly	F	2 1/2	Domestic Long Hair	Red Tabby & White
Leonard	M	2	Domestic	Sliver Tabby
Nijinsky*	M	1	Siamese	Sealpoint
Wojo**	M	6 mos.	Domestic	Orange/White Tabby
Dietrich**	M	6 mos.	Snowshoe	Sealpoint & White

\*declawed    \*\*altered during study    †died in second month of study

NOTE: Individuals are arranged in order by age at the start of this study; this is roughly similar to their length of time in the community with a few exceptions.

teen years and in length of residence from newly arrived to thirteen years (Table 1).

There were seven males at the start, including three male kittens. One male, Julius, became critically ill and died in the second month of the study, an event which triggered changes in the behavior and dynamics of the group.

There were seven females in the study. One female, Melissa, was chronically ill throughout and was much less active than the others, but did nonetheless play a role in the dynamics of the group.

The study area was a one-story ranch house approximately 124.5 sq. meters

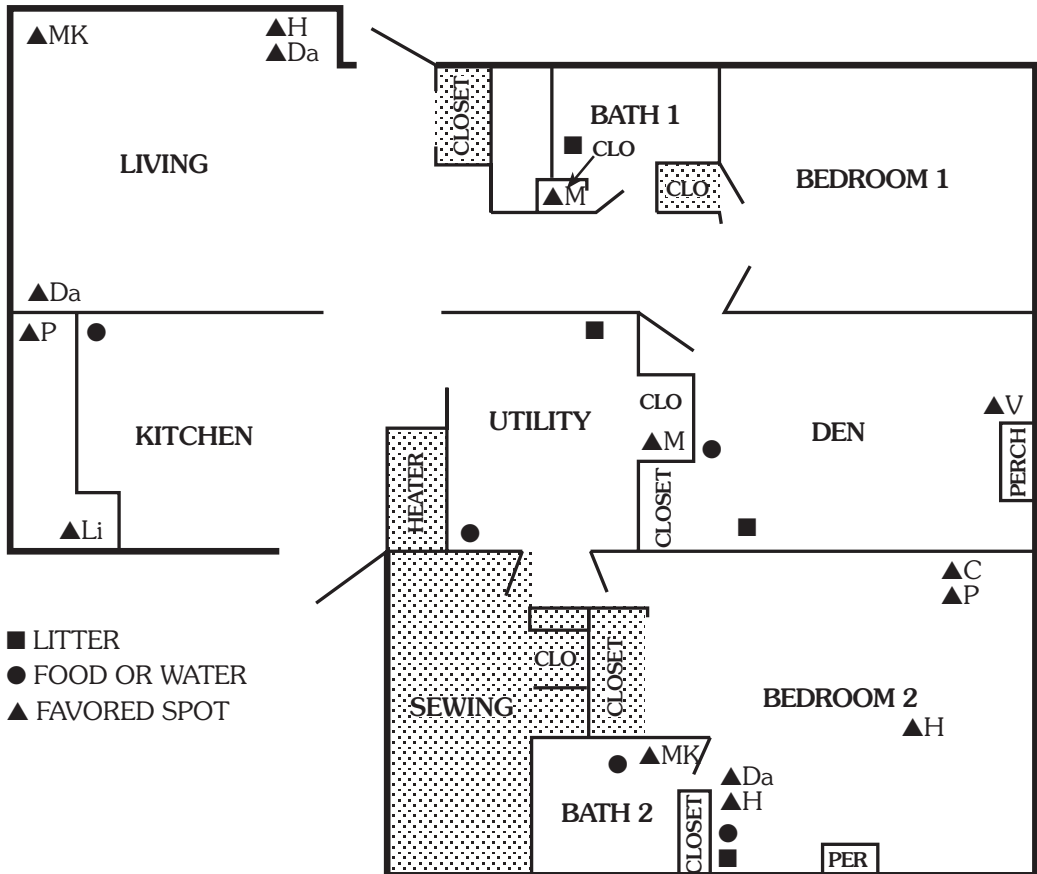
(1340 sq. feet) in area. There were seven rooms, several closets and two baths (Figs. 1a and b). Most closets and all rooms except the sewing room were open to all cats at all times; all cats essentially had free run of the house.

All cats were fed regularly: a bowl of canned food was provided for each cat in its own dish in the kitchen or in a preferred room (e.g. the ill cat, Melissa, was provided food in the utility room where she stayed most of the time) once a day, and dry food and water were available to all cats at all times. Litter pans, feeding stations for dry food, and window perches were distributed throughout the house

**FIGURE 1A.**

**“Favored Spots” at the Beginning of the Study**

“Favored spots” are indicated with an “▲”; initials indicate which individual used the spot. A stack of “▲’s” in an area indicates that the spot was time-shared (e.g. ▲H, HDa in the Living Room). Placement of food and litter boxes is also shown. Individuals who lacked favored spots were three adult males: Leonard, Tonto and Julius, and the three kittens: Nijinsky, Dietrich and Wojo.



as shown (Figs. 1a and b).

Two human adults also shared the house with the cats, were present throughout the study, and interacted freely with all of the cats. Those interactions were not systematically observed for this study and are not discussed in this paper.

Because of the layout of the house, the observer (Strack) was able to position herself in one spot and view most of the rooms at one time; she had only to move a short distance to view additional areas.

Strack formally observed the cats' behavior a minimum of four hours a day, seven days a week, from late January through April 1981, an approximate total of 336 hours. These formal observations were made pri-

marily in the hours just before and after morning or evening feeding, and recorded as detailed handwritten notes. Use of space, feeding areas, toys, window perches, sleeping spots, and the behaviors and interactions connected with these uses were noted.

Informal observations, like those of any cat owner, occurred regularly throughout the study and provided contextual information helpful in interpreting the results of the more formal study.

## RESULTS

### Use of Space - Home Ranges

In spite of the fact that the entire house was open to all of the cats at all times, it was evi-

FIGURE 1b.

### "Favored Spots" at the End of the Study

Only the adult male Leonard lacked a favored spot.

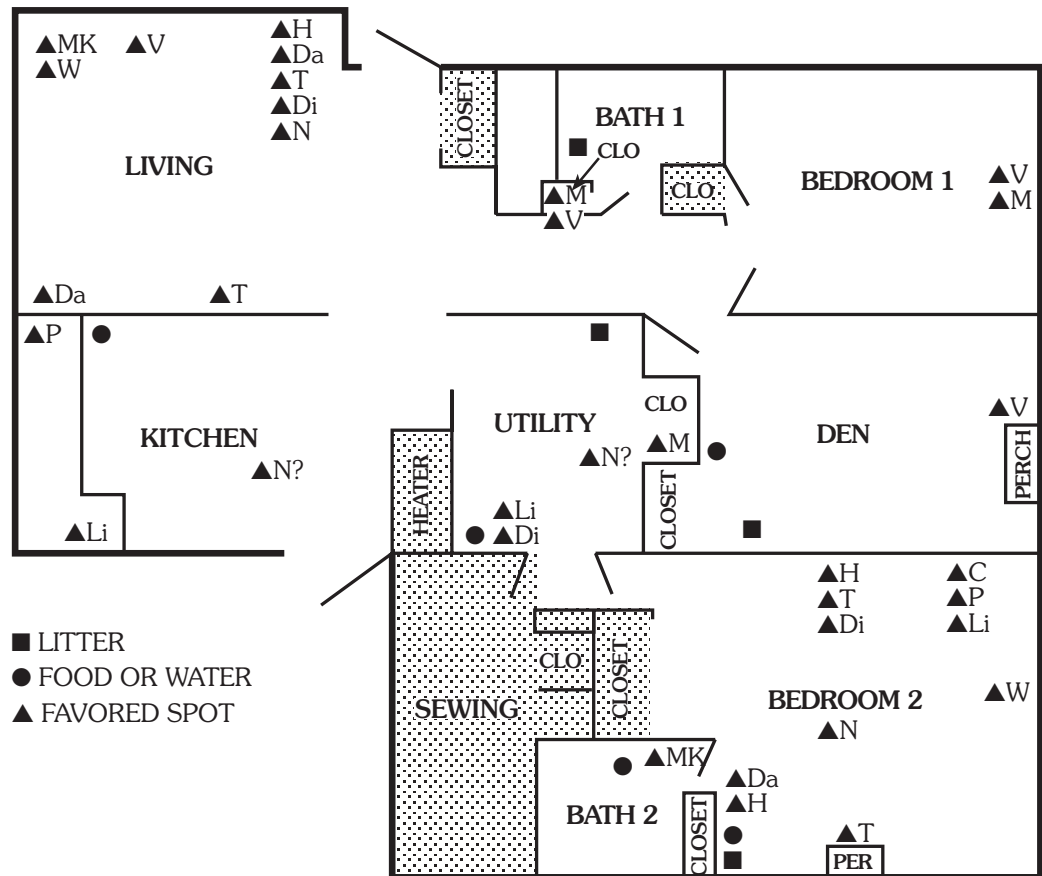


TABLE 2.

## Home Ranges as Numbers/Kinds of Rooms

CAT	LIVING	KIT	BR 1	BA 1	BA CL	BR 2	BA 2	DEN	UTIL	UT CL	BEG	END	CHG
Julius	x	x	x	x	x	x	x	x	x		9		
Harry	x	x				x	x		x		5	5	0
Leonard	x	x				x	x				4	4	0
Mrs. K.	x	x				x	x	x	x		4	4	0
Melissa					x			x	x	x	4	4	0
Daphne	x	x				x				x	3	3	0
Patti	x	x				x					3	3	0
Carly	x	x				x					3	3	0
Violet	x		x	x				x			3	4	+1
Tonto	x	x				x					2	3	+1
Lily	x	x				x				x	1	4	+3
Wojo	x	x	x	x	x	x	x	x	x	x	10	6	-4
Dietrich	x	x	x	x	x	x	x	x	x	x	10	5	-5
Nijinsky	x	x	x	x	x	x	x	x	x	x	10	3	-7
<b>Adults</b>	<b>7</b>	<b>9</b>	<b>2</b>	<b>1</b>	<b>2</b>	<b>7</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>1</b>	
<b>Kittens</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>3</b>	<b>0</b>	
<b>Total</b>	<b>10</b>	<b>12</b>	<b>5</b>	<b>3</b>	<b>5</b>	<b>10</b>	<b>7</b>	<b>4</b>	<b>6</b>	<b>4</b>	<b>4</b>	<b>1</b>	

NOTES: Use of space by each cat. The first column under a room indicates use at the beginning of this study, the second column, use at the end. An "x" indicates the room was used on a regular basis; blanks indicate the room was used only rarely or not at all by that individual. The chart shows the ten areas—six rooms, two bathrooms and two closets—that were available for the cats to use. Totals are shown for each room and for each individual at the beginning and end of the study. Changes (Chg) in the number of rooms used by each individual at the beginning vs. end are also shown.

dent from the beginning of the study that individuals limited their living areas. For each individual we could identify a home range, or area of habitual use. We characterized this, basically, by the number of rooms and the specific rooms each individual utilized on a regular basis. There was some degree of overlap among ranges, some degree of individuality, and some changes occurred during the course of the study (Tables 2 and 3, Figs. 1a and b).

**TABLE 3.**

Average Home Range Size by Age/Gender				
	BEGINNING (N)		END (N)	
Adult Males	5	(4)	4	(3)
Adult Females	3	(7)	3.6	(7)
Kittens	10	(3)	4.7	(3)
Grand Average	5	(14)	3.9	(13)

*NOTES: Summary of the average number of rooms used (out of 10) at the beginning versus end of the study by adult males, adult females and kittens. N=number of individuals per category.*

### Ranges - Beginning of Study

At the beginning of the study, there was great disparity in the size of home ranges. Julius, for example, was observed in every available area except the utility closet. His “home range,” therefore, included at least part of everyone else’s ranges. This “freedom” to move throughout the house was one of the reasons why we considered Julius to be a dominant cat (see “Dominance” below).

The three kittens were the only individuals who went everywhere in the house. In contrast, Lily was the most restricted individual, spending almost all of her time on top of the refrigerator in the kitchen.

The most popular rooms, where ranges showed the most overlap, were the kitchen, used regularly by 12 of the original 14 cats (including kittens), and the living room and bedroom 2, used by 10 of the 14.

### Ranges - End of Study

By the end of the study three adults had added rooms, increasing their home ranges. The three kittens, now 9-15 months old, were the only individuals who became more restricted in their use of space.

Lily showed perhaps the most dramatic change. She came down off the refrigerator after the death of Julius, and began spending time in four of the ten areas.

Violet and Tonto also made dramatic changes, mostly by beginning to utilize the living room, where most other cats also went. Previously they, Melissa (the ill cat), and Lily had been the only cats to avoid this room. At the end of the study, Melissa was the only individual who did not utilize the living room.

By the end of the study, 12 of the remaining 13 cats used the living room, 11 of 13 used the kitchen, and 10 of 13 used bedroom 2.

Size of home range, defined as number of rooms used, was compared for adult males, adult females, and kittens at the start and end of the study (Table 3). Adult males always utilized more rooms than adult females, despite there being nearly twice as many females as males. The kittens, when they were between 6-12 months old at the start of the study, had the largest ranges, overlapping with everyone else. But their ranges decreased as they grew older. Home ranges in general were smaller at the end of the study, after Julius died and the kittens became more restricted, than at the beginning.

### Use of Space - Favored Spots and Time-Sharing

We could identify “favored spots” within home ranges, places where a particular cat was likely to be found at particular times, and which were used repeatedly for sleeping, resting, and grooming (Table 4, Figs. 1a and b). Individuals were either unique in their choice of spot, using the spot alone, or they shared spots. Sharing involved either occupying the space together, a physical sharing, or using the area in temporal



**TABLE 4.**

<b>Favored Spots</b>			
<b>BEGINNING OF STUDY</b>			
CAT	UNIQUE	TIME-SHARED	NO OBVIOUS SPOT
Mrs. Kitty*	lr, ba2	Grp 1 Har-Dap lr, br2	Julius
Melissa*	ba cl, ut cl	Grp 2 Pat-Car br2	Leonard
Violet	den		Tonto
Lilly	kit		Wojo
Daphne*	lr		Dietrich
Patti*	kit		Nijinsky
Harry*	br2		
	<b>Total = 7 inds</b>	<b>Total = 2 grps, 4 inds</b>	<b>Total = 6 inds</b>
<b>END OF STUDY</b>			
CAT	UNIQUE	TIME-SHARED	NO OBVIOUS SPOT
Mrs. Kitty*	ba2	Grp 1 Har-Dap-Ton-Nij-Diet lr	Leonard
Melissa*	ba cl, ut cl	Sub a Har-Dap br2	
Violet*	den, lr	Sub b Har-Ton-Die br2	
Lily*	k	Sub c Nij-Dei lr	
Daphne*	lr	Grp 2 Pat-Car-Lil br2	
Patti*	k	Grp 3 Mrs. K-Woj lr	
Tonto*	lr, br2	Grp 4 Mel-Vio br1, ba cl	
Wojo*	br2	Grp 5 Lil-Die Ut	
Nijinsky*	br2, k?, Ut?		
	<b>Total = 9 inds</b>	<b>Total = 5 grps, 12 inds</b>	<b>Total = 1 ind</b>

\*indicates individuals who also time shared.

NOTE: Some individuals had unique spots they used alone; some had spots that were time-shared with others; some had both; some had no obvious spot where they could predictably be found.

sequence, a kind of time-sharing. Some individuals did not seem to have a favored spot, and were less predictably observed in any one area over another.

While all rooms except bathroom 1 had at least one favored spot, only some rooms had spots where individuals time-shared. It is not known from this study why only some rooms were utilized in this way and others not.

Which cats utilized spots in these rooms, and who shared spots, changed during the course of the study (Table 4, Figs. 1a and b). In general, at the start, a number of individuals had unique spots and did not time-share; several individuals had unique spots but also had spots they time-shared; and several indi-

viduals had no obvious favored spot—i.e., it was not possible to predict where they might be found at any given time.

By the end, all individuals time-shared at least one spot; and no individual maintained only unique spots. This was the result of changes in the behavior of a specific set of individuals who began to time-share spots that had previously been unique to other individuals. This group was basically the same set of individuals who showed changes in home range following the death of Julius, and included the three kittens: Tonto, a previously submissive individual (see "Dominance"); Lily, who expanded her home range and was becoming more dominant (see "Domi-

nance"); the ill cat Melissa; and a "shy" cat Violet. Only one individual, Leonard, still had no obvious spot of any kind.

Examining the details concerning favored spots and changes in them revealed three major patterns. First, individuals had 0-3 spots that they utilized regularly. Second, spots were rarely shared by more than 2-3 individuals. The exception was a spot in the living room, time-shared by five individuals by the end of the study.

Third, there were gender differences in utilization of spots. At the beginning of the study, females tended to be spread throughout the house in predictable and usually unique spots, while six of the seven males "roamed" the house and were not found predictably in any one spot. The remaining male was found predictably alone in a unique spot or in a spot time-shared with a female. By the end of the study, this specific picture had changed: more individuals formed time-sharing "groups" and only one still "roamed" without a spot. Gender still played a role in these groupings: three of the groups were all male, two were all female, and three were "mixed" (one male with one female). Two of these mixed groups involved a male kitten with an older adult female. The third seemed to have at least started as a similar situation; it involved an adult male time-sharing with an older adult female with whom he had begun time-sharing when he entered the community as a kitten nearly six years earlier.

In sum, individuals generally had 0-3 spots where they could predictably be found at various times of day. These spots were either unique or shared over time. Time-sharing involved individuals of the same gender, or individuals in unique relationships, possibly in maternal/kitten roles. Males were more likely than females to "roam" the house, without having a predictable spot.

## Dominance

Interaction within this group was usually peaceable. There was no actual fighting within the community. The most obvious

aggressive behavior was hissing, and occasionally there was swatting. Direct physical contact among the cats, when it occurred, included sniffing noses, sniffing tails, bumping/rubbing heads, wrestling, sleeping together, and allogrooming, all generally considered nonaggressive behaviors.

Because there was little overt aggression, we realized early in the study that dominance in this group must be developed and maintained in subtle ways, and that it would be difficult at our level of observing capability to document such subtleties. They would best be examined by focusing on dominance alone, and using continuous recording techniques that would allow detailed tracking and examination of interactions. We tried, then, to at least begin to characterize this aspect of the group in this indoor home situation.

We found we could classify cats as dominant or subordinate based on their ability to control access to resources and/or by others conceding resources to them, two commonly cited indicators of dominance (e.g. Alcock 1989; Grier 1984), as well as by outcomes of infrequent fighting. However, we found that other behaviors also seemed to indicate an ability to dominate or control a situation. These included behaviors such as who went where, who was avoided by others versus who avoided others, who seemed least and most wary, and who took over places that had been vacated versus who conceded places to others.

Based on these observations, certain individuals appeared to be dominant in the group. There was no evidence for a hierarchy below the one or two dominant cats, except for one cat who appeared submissive to all others at the beginning of the study. Julius, the oldest male, was the obviously dominant cat at the start of the study. Julius could go anywhere in the house, freely using nine of the ten available areas (Table 2); he controlled access to resources already in his possession, such as resting places; and all cats conceded feeding and resting places to him on his approach. Quantifying these lat-



ter data turned out to be trivial, since Julius was seen to supplant individuals one to several times a day, while supplanting done by others was a rare event—observed a total of only three to five times during the course of the entire three-month study.

The male Tonto seemed subordinate to all other cats at the start of the study, yielding his place to whichever cat approached. The rest of the population was not obviously engaged in either sorts of behavior, at least at our level of observation, so that a hierarchy could not be defined.

### Changes in Dominance

After Julius's death Harry, the oldest surviving male, seemed to be dominant; that is, he seemed to have free range of the house, utilized the most rooms (5, see Table 2), and seemed to move from place to place at will with no obvious hesitance or interference. However, it was not common to see cats conceding places to him, and there was no obvious supplanting.

Also after Julius's death, a subgroup formed, comprised of the three Siamese/half-Siamese (Snowshoe breed) cats. Lily, the oldest Siamese, assumed dominance of this group. Unlike Julius and Harry, however, Lily was actively challenged initially. Nijinsky, a pubescent male Siamese, had "staring-down" yowling matches with Lily during which she would stand her ground and swat at him until he retreated; Nijinsky at one point also urine-marked in Lily's sleeping territory during her absence. Nijinsky continued to face-off with Lily periodically during the remaining month of the study, Lily continued to swat him, and he continued to retreat. He also began to cheek and paw mark doorways, perches and people, behavior he had not exhibited before that time. His challenges and marking came at a time when he and the other kittens were beginning to restrict their living areas and choose "favored spots" (see "Use of Space — Favored Spots"). Harry and Lily, then, seemed to become "co-dominants." They were never observed to

challenge each other openly, however, and rarely interacted with one another.

The male Tonto, previously subordinate, now expanded his home range slightly, began to interact more readily with some of the older cats (including Harry, the new "dominant"), and was less likely to withdraw from others.

Food-getting ability was not a good predictor of dominance as it had been in some laboratory situations (e.g. Winslow 1938; Baron et al. 1957); overt aggression was never observed during feeding. However, older cats were sometimes observed "deferring" to younger ones, similar to findings of other laboratory studies (Chesler 1969).

### Box-Sharing

A simple "experiment" was undertaken to determine if our identification of "dominants" was correct. Strack had found previously that cats in her community liked to spend time investigating, marking and sitting in boxes, and that turn-taking for these behaviors seemed to follow a pattern, with the dominant (Julius, for example) taking the first turn in any newly introduced box. Near the end of the study, two similarly-sized boxes were introduced. As soon as the boxes were set on the floor, Lily and Harry each got into one. They occupied their respective boxes for long periods of time and were not obviously challenged by any of the other cats, although other cats remained nearby and observed them closely. When Harry and Lily left the boxes at any time, other cats got into them.

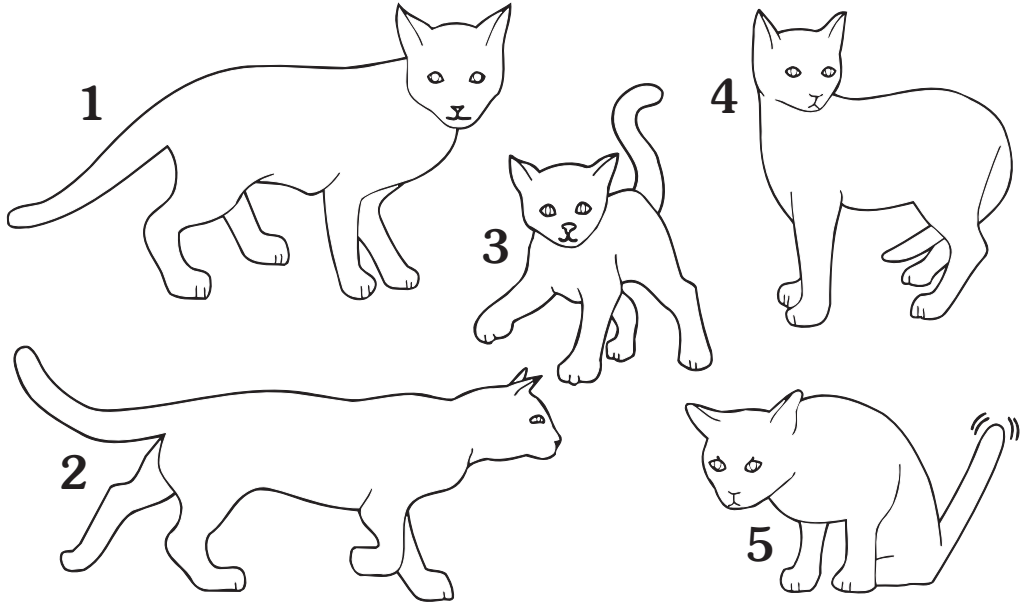
Lily and Harry continued to return to the boxes over the next several days, each returning to their original box, occupying them for several hours each day. In four or five days all of the cats lost interest in the boxes, as was typical in Strack's experience. New boxes were introduced, with the same general results.

### Tail Communication

It proved difficult to track the tail positions of so many different individuals at one

Figure 2.

Tail Positions Commonly Used in This Group



NOTE: Lines indicate motion.

time while also tracking other behaviors. While we could not obtain detail, we were able to characterize a range of tail positions and movements (Fig. 2) and identify a variety of behaviors with which they coincided, such that general patterns of use could be summarized.

In general, positions 1-3 were used when individuals were nonaggressive: gathering information, monitoring approaches by others, or beginning nonaggressive interactions. Position 4 occurred in situations where defense or escape were obvious options, and was often followed by escape or attempts to escape. Position 5, which involved a whipping movement of the entire tail, was observed just before aggressive behavior, such as biting or scratching, or defensive escape. These tail forms and the contexts in which they occurred are similar to those described by others (e.g. Kiley-Worthington 1976; Kiley-Worthington 1976 and S.L. Brown unpub., as cited in Bradshaw 1992, for unspecified numbers of cats in unspecified living situations).

Positions 4 and 5, most closely associated with agonistic situations, were rarely observed in our population. Position 4 was usually seen in response to the vacuum cleaner being run or at the approach of an "intruder" cat outdoors, rather than in response to other cats in the indoor community. Position 5 occurred when cats were being ruffled to examine them for fleas, or being sprayed with flea spray while being tightly held. Positions 1 and 2 were most common in our population, with 3 next. Since positions 4 and 5 were used so rarely, and primarily in non-cat situations, the cats in this population were using positions 1-3 almost exclusively; that is, they were mostly monitoring others and seeking further information, rather than being directly involved in attack/escape situations.

### Density

At the beginning of the study, 14 cats were occupying the 124.5 sq. meters of the house, a density of 0.1 cat per square meter. This density remained essentially unchanged

by the loss of Julius during the study.

This is an extremely high density when compared with data from most studies of cats outdoors where observed densities are measured per square kilometer and have ranged from a low of about one cat per square km to a high of about 2000 (reviewed in Liberg and Sandell 1988, see text and Table 7.1). The 13-14 cats in the home in the present study were living at a density equal to approximately 113,000 cats per square kilometer, about 50 times greater than the highest densities observed outdoors. Conversely, if the densities found outdoors had been maintained in Strack's home, less than one cat would have been expected there (ranging from 0.000124 to 0.124 cats).

One exceptional outdoor population consisted of 81 resident cats in a 2570 sq. meter plot within ancient Roman ruins (Natoli and DeVito 1988), equivalent to a density of approximately 30,000 cats per square kilometer. Even given this unusually high outdoor density, our population was still three to four times more dense; however, four cats would have been expected to live in Strack's home if these outdoor densities had been maintained, rather than a fraction of a cat.

## DISCUSSION

### Home Range

Patterns in home range were similar to those described for feral cats outdoors (e.g. Bradshaw 1992; Turner and Mertens 1986; Liberg and Sandell 1988). Dominant individuals, male and female, used the most rooms over the largest areas, and males tended to have larger home ranges than females. But differences in home range size in our population were much smaller than the average difference cited for outdoor feral cats (e.g. male ranges 3.5 times the size of female ranges, Liberg and Sandell 1988).

It was not clear why some individual home range sizes changed during the study. Changes seemed to correlate for the most part with changes in individual relationships,

but we could not demonstrate a cause and effect. For example, Lily and Tonto expanded their ranges after Julius died, but perhaps factors other than Julius' death played a role. The ranges of the three kittens became greatly reduced as they became older and their relationships to others changed; but with little overt aggression evident in the population, it was not clear if the kittens had merely scaled back their use of rooms themselves, or if others had begun to exclude them from areas. Again, how cats in the home actually formulate their home ranges remains to be investigated further.

It was clear that some rooms were preferred over others. While we did not investigate what variables might have been controlling these preferences, we can suggest that access to resources, such as food or warming sun, may have played a role in making the kitchen and living room popular, and that individual defense of areas may have made some rooms less accessible (e.g. Melissa, the ill cat, may have actively excluded others from the utility closet). Other room preferences may have depended on access to other, more subtle, resources (e.g. access to specific surface textures, or to humans or their scents) or on individual relationships.

### Favored Spots

Despite the fact that most individuals overlapped home ranges to some degree, they tended to segregate themselves within those areas, in favored spots, and gender seemed to play a role in this separation.

In feral cats outdoors, matrilineal groups seem to be the key grouping factor, with males separated from one another and spaced out between groups of related females (Kerby and MacDonald 1988; Liberg and Sandell 1988). Cats in our community, being unrelated, could not break into matrilineal groups. However, they did divide the house into home ranges and further into favored spots, where each could have some space near and yet apart from the others, mostly by sharing space in time. This division did not appear to be random,

and males seemed to “roam” among female spaces or “shared” spots between spaces “shared” by females. This sounds very much like the grouping arrangement described for outdoor feral cats, without the component of relatedness, and may be a basic aspect of cat spatial organization.

Why certain spots were chosen, and why spots were timeshared rather than each cat simply having its own unique spot, are open questions. With respect to sharing of spots, this study could not discriminate between a cooperative process—where each cat might be allowing others a fixed share of time on a resource—and a simpler process where cats simply did not challenge for possession, so that each cat would have exclusive use of the resource until it gave it up.

It would appear, however, from the non-random, patterned nature of the time-sharing that individuals were aware of who was using spots, and that time-sharing “groups” were an indication of positive associations and tolerance among individuals, rather than negative, although we cannot rule out avoidance playing a role.

We suspect that scent-marking played a role in these patterns, since body areas that are known to be used for marking, such as chin, cheek, ear, mouth, tail, and foot glands (Beaver 1992; Bradshaw 1992), and perhaps the fur itself, readily make contact with the spots being occupied. However, we did not track marking in this experiment, and we do not know if the cats actually rubbed glands on surfaces, depositing scent. Also, little is known about the function of the scents produced by these glands (Bradshaw 1992) and whether they actually provide individual identifying information.

## **Dominance**

Dominance does not seem well-defined for domestic cats, and there is little agreement on the phenomenon. On one hand, there are studies of cats in unrestricted outdoor populations (Natoli and De Vito 1991) as well as in confined laboratory situations (Winslow 1938; Baron et al. 1957; Cole and Shafer

1966; De Boer 1977) that describe agonistic threat behaviors and subordinate postures and find evidence for linear hierarchies, based primarily on actual fighting, and primarily in males. On the other hand, based on his review of the literature, Bradshaw (1992) states that 1) no pattern of submission has been identified in domestic cats, making it difficult to define a “hierarchy”; rather, cats tend to ward off aggressive approaches with defensive, rather than submissive, behaviors; and 2) although what appear to be hierarchies can sometimes be identified for feral male cats, feral females tend to show cooperation in groups, rather than competition, making overall characterization of domestic cats as a group difficult. Little formal research has examined the question for groups of cats in the home.

Borchelt (pers. comm.), based on his work with problem cats in the home, and Voith and Borchelt (1986) suggest that what appears to be “dominance” may better be explained as individual differences in approach/withdrawal behavior, play, defense, etc. which result in specific interpersonal relationships between individual pairs of cats. They cite lack of a hierarchy and frequent lack of overt aggression as indicators that something other than “dominance” is at work. Beaver (1992), in her review for veterinarians, also discusses the uniqueness of cat “social ordering.” Although she seems to accept the concept of one or more “dominant” individuals in a group, she too discusses the lack of a clear hierarchy and cites several studies that have indicated that time of day, place, presence of food, and past history may all influence agonistic behavior, making it difficult to predict outcomes of confrontations. Others (reviewed in Mendl and Harcourt 1988) also note the importance of context in individual behavior and the resulting interactions.

Our results show a similar mix of organization. We observed individuals who showed at least two of the most commonly cited general indicators of dominance (e.g. Alcock 1989; Grier 1984): 1) they had the

ability to control resources (e.g. the boxes, certain favored spots), and 2) other individuals were seen to concede resources to them. We are therefore not ready to rule out the concept "dominance" altogether with respect to cats in the home. However, we also observed the lack of a clear hierarchy and the fluid nature of some relationships based on place, individual histories, etc. (e.g. Tonto being submissive to all at the beginning of the study but less so after Julius's death). Perhaps the house was considered a "joint territory," as discussed by De Boer (1977), which somehow obviated the need for a hierarchy. Clearly, while there may be dominant individuals within cat social groups, it is not clear if a single "dominance hierarchy" label will work to describe cat social organization, or if that is even the appropriate way to look at such a mixed organization, especially in the home setting.

Box-sharing experiments show promise as a means for testing dominance in indoor house cat populations, but need further testing.

### Tail Positions

The view we formed of this community was of a constantly shifting set of individuals. Rather than seeing cats sitting or lying about in groups, we most often observed individuals moving through the house, stopping at spots as others vacated them, or remaining alone away from others.

To accomplish this shifting with so little overt aggression, the cats would need to be extremely aware of one another, an idea suggested by Leyhausen (1965), in order to maintain the dynamics of movement and non-movement in time and space. This constant adjustment of individuals with respect to their interaction possibilities is similar to what has been described for two very social groups, black-tailed prairie dogs (Bernstein 1978, 1979), and grivet/vervet monkeys (Bernstein et al. 1978) and may enable the cats to occupy the relatively small, enclosed space of the house with a minimum of overt interaction, particularly overt aggres-

sion. This may be a reason why time-sharing was observed more often in this community than physical sharing of space.

Tail positions may play a key role in this community by "tagging" individuals as being more or less likely to interact, and/or be aggressive. Since the tail can be seen at a distance, receivers could tailor their responses before contact was imminent, leading to the dynamic adjustments we observed. This was the case in the prairie dog and monkey groups above (Bernstein 1978, 1979; Bernstein et al. 1978).

In our population, it appears that individuals may have been so closely monitoring one another, as signaled by their tail positions, that they were able to respond at a distance in ways that reduced aggressive encounters. Such encounters were rare, as were the tail signals that went with them. A more quantitative testing of this idea in house cats remains an area for future research.

### Density

We were surprised by our findings concerning density. Nothing in the literature had prepared us for the large difference in densities between outdoor and indoor groups of cats. Little has been published regarding cat densities indoors, for either domestic or wild cats, and to our knowledge there have been no direct comparisons. Hediger (1955, 1964, 1969) and Price (1984) discuss density for "captive" animals (indoor, confined, in zoo or circus settings) in general terms, and emphasize that when animals are supplied with necessary resources (such as food, water, mates, nesting/birthing sites), an "artificial territory can perhaps be a thousand times smaller than a natural territory in the wild" (Hediger 1969).

Liberg and Sandell (1988), and to some extent Kerby and Macdonald (1988), demonstrate that densities of colonies of outdoor cats increase as resources, particularly food, become richer and more clumped. And Natoli and DeVito (1988) attribute the formation and maintenance of their dense group of feral cats to the rich, clumped nature of food



provided by people visiting the site every day. But we found no hard data actually comparing outdoor and indoor territory size and densities (although Hediger 1964 included outdoor territory data for many of the captive species he discussed).

We could find no studies for indoor house cats that investigated the effects different densities might have on social interaction. Most outdoor studies of cats would lead us to predict that most homes and apartments would be too small to house even one cat, much less the 14 observed in the present study. Only the Natoli and DeVito (1988) study provides evidence that cats could live within the small confines of most homes and apartments, given proper provisioning. Yet like other pets (e.g. dogs) and like so many zoo animals, cats can clearly manage stable groupings under an extremely wide range of

densities (see Liberg and Sandell 1988 and Kerby and Macdonald 1988 for feral cats outdoors), including the high densities artificially induced by confinement.

Cats in the home may provide the ideal test situation for studying just how well animals can adapt their social behavior to the compressed conditions of confinement, allowing us to more carefully explore the interaction between density and social organization in these situations. We are currently pursuing such a study.

## SUMMARY

In our study community, individuals seemed to be able to remain together by being able to maintain themselves apart, allowing for the primarily peaceful co-existence of individuals in this relatively large group within a relatively small home.

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