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Rubbing and Rolling Behavior in the Domestic Cat, *Felis catus*

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Abstract The frequency of rolling and rubbing and the relation between those who rub and those who are rubbed were studied in the domestic cat, *Felis catus*, under laboratory conditions. The removal of the mother motivated kittens to roll. Rubbing against other cats or observer was more frequent than rubbing against objects. Juveniles rubbed against an adult female, but came to rub against the observer after the adult female's death. The adult female rubbed against the observer and seldom rubbed against juveniles. Rubbing was a one-way behavior pattern by proteges. Rolling was observed more in the first half of observation periods, and seemed to be a compensation for the direct contact of rubbing. In group living conditions, younger cats emphasize their weakness and need for protection by rolling and rubbing.

Key words Cat, *Felis*, Rubbing, Rolling, Behavior

Introduction

Some animals rub the parts of their bodies which are near their scent glands against objects or other individuals (reviewed in Thiessen & Rice 1976). This rubbing behavior has been considered a kind of scent marking behavior since Kleiman (1966). Scent marking behavior includes marking with urine, feces, and saliva, in addition to rubbing. The function of scent marking is discussed as follows: 1) keeping territories, 2) detecting novelty, 3) orientating, 4) attracting mates (Gosling 1982; Fadem & Cole 1985; Randall 1987; Hurst 1987).

The function varies according to species. For example, there is no sexual dimorphism seen in rubbing of the bannertail kangaroo rat, *Dipodomys spectabilis*, the function is defense territories (Randall 1987). On the other hand, the frequent rubbing of the male grey short-tailed opossum, *Monodelphis domestica*, plays an important role in reproduction (Fadem & Cole 1985). Even in the same species, the function of scent marking can vary. The frequency of Indian gerbil, *Tatera indica*, marking behavior changes according to population densities (Idris & Prakash 1987).

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In the domestic cat, there are groups of special apocrine and sebaceous glands, which produce scents in certain areas, such as the chin, temples, and base of the tail (Wright & Walters 1980). Cats rub these areas against objects or other individuals; we define this as "rubbing". They often rub their backs against substrate, which we defined as "rolling". They also practice urine marking (Natoli 1985).

So far, there is little information on rubbing and rolling behavior in the domestic cat. Leyhausen (1979) reported that female cat frequently rub or roll when they come into heat and male cats rub their heads in the early stage of courtship. He also reported that cats display rolling and rubbing when they meet familiar humans. In both situations cats clearly display rolling and rubbing, but are these behaviors really instances of scent marking? Morris (1987) described rolling and rubbing against people as friendly greeting; Leyhausen (1979) also used the word "greeting".

It is indeed difficult to determine whether they use olfactory cues. Rubbing and rolling in domestic cats might have relevance to processes other than scent marking. Morris (1987) and Leyhausen (1979) have described these behaviors as greetings. The society of domestic cats ranges from solitary to socially (Corbett 1978; Liberg 1980). In high density populations, offspring cannot disperse away from their mother and stay with her for relatively longer periods. In contrast to other mammals, cats are more or less dependent on humans. In this study of captive domestic cats, the problems of "long stay offspring" and the relation between cats and humans will be discussed.

Materials and Methods

Object animals were domestic cats, *Felis catus*. In this study, 15 cats from 4 groups were observed.

Cats were kept in tow wire netting cages set on the roof of our laboratory building. Cage A was 360 × 240 × 240 cm. Cage B was 200 × 200 × 200 cm. Each cage contained a house where cats could sleep and be protected from rain and snow. Cat food (Oriental Yeast Co. Ltd.) and water were available *ad libitum*. Cage A was used by group A, consisting of MA (♀, 3 years old), BUL (♂, 9 month old), GREEN (♀, 9 month old), and MICH (♀, 11 month old), in spring 1983. Group B was brought into cage A in autumn 1983. Cage B was used by Group C in 1983 and by group D in 1984. Group C was removed before group D's entrance. Group C consisted of 1 mother, her 2 kittens, and 3 adopted kittens. Adopted kittens were raised in the same way as her own kittens (Ohkawa & Hidaka 1987). Group D consisted of 4 kittens from 2 litters. They were brought in cage B from private homes and kept without their mothers.

To examine the relationship in cats through rubbing and rolling behavior, the following 4 variables were recorded.

- 1) First rolling. The time of the first rolling was observed for cats of group B, C, and D.

- 2) Frequency of rolling and rubbing. The frequency of rolling and rubbing was observed for cats of group A. Each cat was active for 2-3 hours and inactive for the next 2-

3 hours, and that this activity pattern occurred almost simultaneously among cats in the same cage. There were about 4 active periods in a day.

We found that all cats in the same cage were active for at least 30 minutes during one active period. We observed cats for 30 minutes a day when all the cats were active during 2-3 active hours in the evenings. We chose evenings for observation because people (student of our university) seldom came to the cage and played with cats at that time.

We examined the frequency of rolling and rubbing behavior for 30 minutes periods in the following circumstances:

I One adult female and 3 juveniles (group A) were observed.

II An "alien" adult male was brought into the cage and kept there for a week. As this male did not introduced in the presence of an observer, a record of the frequency of the rolling of this male or rubbing against him could not be compiled.

III Three juveniles were observed after the adult female (MA) died. Observations were done for 3 weeks after her death.

IV Three juveniles were observed when the observer was not in the cage. Observation was made from the room 10 meters away. The cats were not aware of being observed. This observation was done within one month after MA's death.

V The difference between behavior patterns in the first and second halves of the observation periods of the three juveniles was examined. The observation periods were one hour. Observations were done within one month after MA's death.

3) Direction of rubbing behavior. It is not clear at whom cats direct rolling. But when cats rub, we can observe who or what is being rubbed. We investigated the relation between those who rub and those who are rubbed for cases I , II , and III .

4) Change of attitude in juveniles. Juveniles were observed after the adult female was removed.

All observation and recording of behavior was done by one person (the first author).

Results

First rolling

Table 1 shows the date when rolling was first observed. Groups B and D were brought into each cage, after being taken from their own mother. B-2 (individual no. 2 of group B) and B-3 were siblings. D-2, D-3, and D-4 were also siblings. Their ages at the time of introduction to the cages are shown in the "Separation from mother" column in Table 1. Group C consisted of a mother, her 2 own kittens, and 3 adopted kittens (of 2 litters). C-1, C-2, and C-3 were adopted kittens. To investigate attitudinal change among kittens, their mother was removed. The mother's kittens were 150 days old and the adopted kittens were 127 and 134 days old at that time. Since her own kittens showed the complex behavior of rubbing and rolling, we omitted their data (Rubbing sometimes blends into rolling. When cats rub against low objects, their cheeks, backs of necks, and backs may be rubbed; back rubbing requires rolling).

The average age when a cat began to roll was 105.9 days; standard deviation was

Table 1. First rolling.

Group	Individual No.	First rolling(A) age(days)	Separation from mother(B) age(days)	B-A (days)
B	1	116	79	37
	2	102	75	27
	3	95	75	20
	4	91	80	11
C	1	130	127	3
	2	157	134	23
	3	154	134	20
D	1	59	54	5
	2	87	67	20
	3	87	67	20
	4	87	67	20
mean \pm S.D.		105.9 \pm 29.0		16.5 \pm 9.2

Table 2. Frequencies of rolling for each case. The numbers are mean frequencies (\pm S.D.) of each cat during 30 minutes observation. GR and MI roll more in first half observation than in second half observation ($p < 0.05$ by U-test).

Name	I (n=4)	II (n=3)	III (n=7)	IV (n=3)	V (n=5)	
					first	second
MA	0.75 \pm 1.3	0.0 \pm 0.0	-	-	-	-
BU	1.5 \pm 1.1	1.7 \pm 2.4	5.4 \pm 5.0	0.0 \pm 0.0	2.4 \pm 1.4	1.0 \pm 1.1
GR	2.0 \pm 2.4	0.3 \pm 0.5	5.1 \pm 4.1	0.7 \pm 0.9	7.4 \pm 2.9	1.0 \pm 0.6
MI	2.2 \pm 3.1	0.3 \pm 0.5	7.9 \pm 7.0	0.0 \pm 0.0	13.2 \pm 2.9	2.2 \pm 0.4

Statistical analysis (Mann-Whitney U-test)

	I - II	I - III	III - IV	V
MA	n. s.	-	-	-
BU	n. s.	n. s.	n. s.	n. s.
GR	n. s.	n. s.	n. s.	P < 0.05
MI	n. s.	n. s.	n. s.	P < 0.05

BU=BUL, GR=GREEN, MI=MICH,
n. s. = not significant

29.0. There were significant differences among groups ($p < 0.05$ by Mann-Whitney U-test).

But significant differences among groups could not be detected for the number of days between separation from mother and first rolling. The average number of days from separation to first rolling was 16.5 and standard deviation was 9.2.

Frequency of rolling and rubbing

The frequency of rolling and rubbing was observed for 4 cats of group A. The result of the frequency of rolling is shown in Table 2. Table 3 shows the frequency of rubbing.

In Table 2, significant difference was detected in V of GREEN and MICH by U-test

Table 3. Frequencies of rubbing for each case. The numbers are mean frequencies (\pm S.D.) of each cat during 30 minutes observation. Abbreviations are showed in Table 2.

Name	I (n=4)	II (n=3)	III (n=7)	IV (n=3)	V (n=5)	
					first	second
MA	17.4 \pm 4.0	7.3 \pm 4.6	-	-	-	-
BU	11.6 \pm 6.5	7.0 \pm 2.8	4.0 \pm 3.7	0.0 \pm 0.0	5.2 \pm 3.7	4.4 \pm 1.9
GR	6.8 \pm 4.8	21.7 \pm 7.9	7.0 \pm 6.3	0.0 \pm 0.0	12.0 \pm 6.2	1.0 \pm 2.6
MI	0.4 \pm 0.5	0.0 \pm 0.0	11.4 \pm 10.0	0.0 \pm 0.0	13.0 \pm 6.6	11.4 \pm 6.6

Statistical analysis (Mann-Whitney U-test)

	I - II	I - III	III - IV	V
MA	P<0.05	-	-	-
BU	n. s.	P<0.05	P<0.05	n. s.
GR	n. s.	n. s.	P<0.05	n. s.
MI	n. s.	n. s.*	n. s.**	n. s.

* p=0.053 ** P=0.058

($p < 0.05$). The value of p by U-test for BUL's III and IV equals 0.058.

In table 3, significant difference was detected between MA's I and II, BUL's I and III, BUL's III and IV, GREEN's III and IV (by U-test, $p < 0.05$). The value of p of U-test for MICH's I and III equals 0.053 and that for MICH's III and IV equals 0.058.

From this, we could say as follows: 1) rolling was initiated by the appearance of an observer, 2) when an observer was not in a cage, cats seldom rubbed, 3) the presence of an alien cat did not affect the rolling or rubbing among juveniles, and 4) adult female rubbed less when adult male was present.

Direction of rubbing

Table 4 shows the relation between those who rub (A) and those who are rubbed (B). Ohkawa observed 30 minutes a day for 4 days for case I, 3 days for case II, and 7 days for case III. In the table, total frequencies were shown.

In case I, almost all of the rubbing of the adult female was directed at the observer. Juveniles rubbed themselves not against other juveniles but against adult female. When the adult female disappeared, cats rubbed themselves against the observer (case III). When a strange male was brought in (case II), distribution of rubbing was same as in case I.

Change of attitude in juveniles

Ohkawa observed how separation from the mother changed the attitudes of juveniles towards observer. The subject cats were members of group C: mother (TA), her own kittens (KAME and DOJI), and adopted kittens (NIYANYA, VEDANTA, and MIMANSA). These juveniles, except DOJI, were very timid, ran away when the observer or other humans came close to the cage. DOJI was not cautious about humans, but did not rub or roll for them. The mother was taken away from the cage on September 11th. The subsequent changes of the juveniles' attitudes are shown in Table 5.

Table 4. Directions of rubbing for case I , II , and III . "A" shows those who rub, "B" shows who are rubbed.

Case I		B						Total
		MA	BU	GR	MI	Observer	Object	
A	MA	-	0	1	0	69	0	70
	BU	18	-	0	0	10	8	36
	GR	30	0	-	0	7	2	39
	MI	2	0	0	-	0	0	2

Case II		B						Total
		MA	BU	GR	MI	Observer	Object	
A	MA	-	0	0	0	20	0	22
	BU	18	-	0	0	2	0	20
	GR	53	0	-	0	11	0	64
	MI	0	0	0	-	0	0	0

Case III		B					Total
		BU	GR	MI	Observer	Object	
A	BU	-	2	0	20	6	28
	GR	3	-	0	43	3	49
	MI	0	0	-	61	20	81

Table 5. Change of attitude in juveniles. The behavior of 5 kittens after removal of mother was observed. The numbers in the brackets shows days after removal of mother.

Cat	Sex	Behavior (days after removal of mother)
KAME	female	run away(1)→after 1 rubbing against observer, run away(3) → after 1 rubbing against observer, stay nearby observer(8) → bite observer softly(9) →considerably rub against observer(18)
DOJI	male	stay nearby observer(1) →rub against observer(3)
NIYANYA	male	threaten observer(1) →stop threatening(2) →after rubbing against cage's wire net, roll(3) →play with observer's clothes(6)
VEDANTA	female	threaten(1) →threaten(2) →stop threatening, but maintain distance from observer(3) →approach observer(6) →after sniffing observer, touch observer and show playful pawing(18) →roll(23)
MIMANSA	female	run into the house (6)→stare observer at the entrance of the house(9) →approach observer(14) →roll(20)

Discussion

Other papers dealing with rubbing behaviors (Johnston 1975; Idris & Prakash 1987; Randall 1987) focus on object rubbing. For example, hamsters, *Mesocricetus auratus*, rub flanks against a vertical surfaces (cage's corners) (Johnston 1975), and topi, *Damiliscus korrigum* males mark grass stems (Gosling 1987). In this study, the ratio of object rubbing was low, as Table 4 shows. We discuss mainly rubbing against other cats or humans.

Ohkawa observed that cats often sniffed marking spots when they rubbed against objects, but rarely sniffed when they rubbed against other cats or the observer. Fadem & Cole (1985) observed that grey-tailed opossum, *Monodelphis domestica*, sniffed, bit, or licked the object being marked, either before or after head rubbing. In other scent marking behaviors, animals often sniff. For example, red foxes sniff considerably before urine marking (Macdonald 1979). If cats do not make sure they deposit odours in rubbing against other cats and humans, this type of rubbing is just contacting behavior rather than scent marking behavior. On the other hand, when they make sure odours are being deposited, scent plays an important role in the context of discussions of object rubbing as practiced by other mammals.

The main known function of scent marking are keeping territories, orientation, detecting novelty, and attracting mates (Gosling 1982; Fadem & Cole 1985; Randall 1987; Hurst 1987). In this study, cats were kept in groups and in cages. The functions of keeping territories and orientation were not explored; fellow cats and "possessed" humans are not suitable subjects for territorial marking. Cats can show possession of other cats or humans in their territory by means of scent, but cats in this study did not equally mark other cats and the observer. Juveniles rubbed against the adult female. Juveniles who were deprived of the adult rubbed against the observer. The functions of attracting mates and detecting novelty are also not relevant to the understanding of rubbing. Rubbing against other cats or humans has, whether it is scent marking or not, another function.

When there was no observer, juvenile cats seldom rubbed. But when the adult female was present, juveniles rubbed on her and she rubbed against the observer. On the other hand, the adult female seldom rubbed against juveniles. When the alien male was brought into the cage, rubbing frequency of the adult female decreased; but juveniles' frequencies did not change. Since the male was very secretive and did not appear in the open in the daytime, it was not clear whether the adult female rubbed herself against him in the night. Juveniles chose whom they rubbed; similarly the adult female's preferences may not have changed in response to darkness or daylight. An observation done in spring showed that adult females' rubbing has some relation to oestrus (Leyhausen 1979). If MA was in oestrus during the experiment, her decrease of rubbing was understandable. Although the frequency decreased, it did not become zero. In MA's rubbing, some was related to oestrus and some was related to the presence of the observer. In juveniles, most rubbing was related to the presence of the adult female or the observer. And almost all of

the rubbing was one-way behavior. Those who rubbed might be someone relatively weak or young.

What about rolling? From Tables 1 and 5, the removal of the mother motivated juveniles to roll. What did this removal of mother elicit in juveniles? Cats are completely weaned by the age of 2 months (Scott 1970) and become independent at about 7-8 months (Izawa & Ono 1986). Juveniles in Table 1 were considered to be between weaning and independence. Since juveniles' rolling was not observed until after the removal of their mother, it appears that juveniles need not to roll when they are with their mother. But when they stayed with their mother after the age of 7-8 month, they rolled (case I of Table 2). Through rolling, older juveniles may be able to stay with their mother. Rolling might serve as buffer of imminent conflict between juveniles and mother which would occur when juveniles grow older and become competitors for food and space. In play situation rolling is also observed (West 1974; Caro 1980; Bateson & Young 1981). We also discussed rolling as a manifesto of no hostility in play-fights in which cats are old and strong enough to hurt playmates (Ohkawa & Hidaka 1999).

Case V in Table 2 suggested that the emergence of the observer enhanced frequencies of rolling. This type of rolling could be behavior directed at the observer. For cats humans are not companions but a potential source of danger. Particularly in the case of juveniles that are removed from their mother, getting along with humans is indispensable. Rolling with bellies up is a safe way for cats to show no hostility to other cats and humans.

What relation do rolling and rubbing have? The fact that the frequency of rolling was high in the first halves of observation periods indicate that cats at first will choose rolling, avoiding direct touch of rubbing. Rolling will develop into rubbing against objects and rubbing against objects will develop into rubbing against the observer. Rolling may be compensation for direct rubbing. Rolling and rubbing have essentially the same meaning or purpose.

Solitary cats are not close to each other except while courting. In cats living in groups in high density populations the dispersal of offspring is delayed (Corbett 1979; Olof 1980). A cat kept by humans is sometimes forced to join an unfamiliar cat group against his will. When previously solitary individuals are moved into groups, vertical, rather than horizontal, bonds seem to be formed. Horizontal bonds mean mutuality, vertical bonds means one-sided relations. The basic bond in solitary individuals would be the mother-offspring bond. This bond is the relation of protector and protege, so to speak a vertical bond. It is unique because there is only one mother for each cat. Solitary cats could not have horizontal bonding. When cats are made to live in groups, they want to form vertical bonds. Cats would choose only one "mother" (an adult female or a human), and emphasize that they are protege through rolling and rubbing.

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