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SHORT COMMUNICATION

Drinking from Tails: Social Learning of a Novel Behaviour in a Group of Ring-tailed Lemurs (*Lemur catta*)

GEOFFREY R. HOSEY, MARIE JACQUES, and ANGELA PITTS
Bolton Institute

ABSTRACT. Several examples have been documented of novel behaviours which have apparently arisen spontaneously in primate groups and then spread through the group by learning. Here we describe the first recorded instance of such an acquired behaviour in a prosimian. The behaviour, consisting of immersing the tail in water and then drinking from the wet tail, was observed in a group of semi free-ranging ring-tailed lemurs (*Lemur catta*). Seventeen of 28 animals showed the behaviour, including adult males. Several animals which did not show the behaviour were observed watching and sometimes sharing the wet tail of animals who did. Several incomplete sequences, notably of non-stimulus directed elements, were also seen in non-performers. It is likely that stimulus enhancement is the mechanism of spread of this behaviour through the group, although the presence of the incomplete sequences suggests that imitation is also a possibility.

Key Words: *Lemur catta*; Novel behaviour; Stimulus enhancement; Imitation.

INTRODUCTION

Primate societies are exemplified by the complexity of their social interactions, many of which, like alliance-formation, reconciliation, and kin recognition, imply the operation of complex learning and cognitive skills (BYRNE & WHITEN, 1988). Primate interactions with their environment, and notably their use of tools, are also suggestive of cognitive abilities (MCGREW, 1992; GIBSON & INGOLD, 1993). In some cases these interactions with the environment appear to arise spontaneously in one individual in a group, and subsequently spread to other group members. Probably the most famous example of this is the spread of potato-washing and later wheat-washing, in the sea by Japanese macaques (*Macaca fuscata*: KAWAI, 1965; NISHIDA, 1987). In another example, vervet monkeys (*Cercopithecus aethiops pygerythrus*) immersed *Acacia* seedpods into the exudate from the tree during a drought, presumably to facilitate obtaining the exudate (HAUSER, 1988). This behaviour arose spontaneously in one individual, and later spread to other members of the group.

There appear to be no records of the occurrence of such spontaneous behaviour or of their spread, in any group of prosimian primate, although KAPPELER (1987) has shown that a novel response to an artificial problem (flipping a dish over to obtain food concealed underneath) can be acquired and can spread through a group of ring-tailed lemurs (*Lemur catta*). Here we report what we believe to be the first recorded instance of a spontaneously occurring behaviour which has spread through a prosimian group. The behaviour is that of immersing the tail in water, and then drinking from the wet tail.

These behaviours are important for what they can tell us about primate learning abili-

ties. The spread of the novel behaviour is almost certainly through social learning, but it is unclear exactly what learning mechanism is involved. The learning of potato and wheat washing by the Japanese macaques has usually been attributed to imitation, but this explanation has recently been called into doubt.

For example, VISALBERGHI and FRAGASZY (1990a) have shown that in the laboratory tufted capuchins (*Cebus apella*) and crab-eating macaques (*Macaca fascicularis*) have a high tendency to immerse novel objects, both food and non-food, anyway. In fact, apparent examples of imitation in primates can generally be explained in terms of lower-order social learning mechanisms such as stimulus enhancement, where the attention of the observer is drawn to the stimulus, which can then facilitate learning of the novel behaviour through trial-and-error mechanisms (VISALBERGHI & FRAGASZY, 1990b). Imitation, where the observer learns about behaviour (responses), is considered a more complex cognitive task than other kinds of social learning, where the observer learns about stimuli, because it requires the observer to topographically transform visual information from observing another animal's motor pattern into kinaesthetic or proprioceptive stimulation of its own body (HEYES, 1993). Thus it is disappointing that primates apparently cannot imitate, whereas budgerigars and rats apparently can, but this is almost certainly a consequence of the experimental designs, which do not distinguish between the different social learning processes, since more recent experiments with chimpanzees, which do permit these processes to be distinguished, show some ability of the animals to imitate (WHITEN et al., 1996).

In the example given here, of social learning of a novel behaviour by ring-tailed lemurs, we cannot show unequivocally what learning mechanism is involved, but we argue that the varieties of the motor pattern shown by the animals are best explained as being due to imitation.

MATERIALS AND METHODS

The observations recorded here were made on a semi-free ranging group of ring-tailed lemurs living on a small island in Chester Zoo. The island, approximately 1,500m^2 in area, is surrounded by a 1-m deep moat, approximately 8m wide at its narrowest point. There are two cages with heated indoor quarters on the island, and the animals are confined to these during the winter. In the summer, the cages are left open so the lemurs have the run of the island, and can also move in and out of the cages. The lemurs are fed twice a day by keepers, with monkey chow in the morning, and with chopped fruit and vegetables in the afternoon. At the point where the keepers cross to the island there is a small wooden pier, about 2m long, and it is from here that the lemurs immerse their tails.

In July 1994, the group consisted of 28 animals: 6 adult (>2 yr) females; 12 adult males; 3 juvenile (1–2 yr) females; 2 juvenile males; 2 infant (<1 yr) females; and 3 infant males. Three male and two female infants were born in March–May 1995. All lemurs wore a collar with a numbered metal tag, which permitted individual identification. The ages, place of birth, and mother's identity were known for most of the lemurs in the group.

The lemurs were observed for other research projects by MJ and AP for over 300 hr between 1992 and 1995, and during this period observations of tail immersion were made opportunistically whenever the behaviour was seen. Video sequences were made where possible and condensed down to 2 hr of footage of just this behaviour. Motor patterns were described from the video records; identities of animals were recorded on the video soundtrack at the time. Although our earliest observations were from 1992, most of the

video sequences which provide the data for this paper were made between June 1994 and May 1995. A further ten days of observation in July/August 1996 (A. LYSAGHT, pers. comm.) provided further data on which individuals were showing the behaviour.

RESULTS

THE BEHAVIOUR

In its basic form, the behaviour occurred as follows: a lemur would walk towards the side of the pier, turn through 180° and climb backwards down one of the pier supports until its tail was in contact with the water of the moat. The animal would then ascend the support back up to the pier, and lick the water from its tail (Fig. 1). This whole motor pattern would characteristically be repeated, in some sequences up to eight or nine times. The motor pattern thus consisted of the following elements:

Turning the body: This was done by all the lemurs who immersed their tails, but also by several who did not. For example:

June 30, 1994. Unidentified lemur circles several times, as if unsure what to do, starts to descend then comes back up to the pier without immersing its tail.

Descending to the water: This element was necessary when lemurs used the pier to immerse their tails. However, in at least one instance a lemur attempted to immerse its tail from the bank of the moat.

Tail immersion: There are two variants of this element. Either the tail would be dipped into the water, so that the whole of the end of the tail (about 20 – 30 cm) was wet, or the lemur would hold its tail in such a position that it appeared to float on the water, so that only the fur on the underside of the tail was wet. Most lemurs who immersed their tails either dipped or floated, but several animals showed both variants. The tail was left dipping or floating for 1 – 2 seconds.

Ascending to the pier: This element was sometimes omitted. For example, in one observation an adult male, *Ziggy*, floated his tail and then licked it 13 times while holding on to the pier support, before finally ascending back up to the pier.

Licking: The motor patterns here superficially resembled those of autogrooming, which in lemurs is done with the mouth, not the hands. However, it was clear that the lemurs were licking the water from their fur and not using the tooth-comb, which is used in grooming.

DISTRIBUTION OF THE BEHAVIOUR

In our records, 17 of the 28 animals in the group were seen to tail immerse on at least one occasion. There was no association between age/sex class and likelihood of showing the behaviour (Chi-square = 2.49, 5 *df*, n.s., see Table 1). The only group in which we have not seen any animals immerse their tails is infant males. For those animals whose mother is known, there was no association between mothers and offspring in whether or not they

Table 1. Distribution of the tail immersion behaviour between age/sex classes of the lemurs in the group.

	Infants (<1 yr)		Juveniles (1–2 yrs)		Adults (>2 yrs)	
	Male	Female	Male	Female	Male	Female
No. of animals seen tail immersing	0	1	2	2	8	4
No. of animals in group	3	2	2	3	12	6

immersed ($\chi^2=1.4$, 1. *df*). The lemurs do not necessarily learn tail immersion from their mother.

WATCHING AND SHARING

Tail immersion occurred within the context of a social group, and often several animals would simultaneously be engaged in the behaviour. More interestingly, the immersers were often accompanied by individuals who have not been seen to do the behaviour, but who became involved to a greater or lesser extent because of their proximity.

Sharing: Both successful and unsuccessful attempts by non-immersers to share the wet tails of immersers have been observed on a number of occasions. Attempts by lemurs to lick the wet tails of other lemurs were often resisted; those we have seen to allow sharing have all been adult males and females. With one exception (an adult male) all of the non-immerser lemurs we have seen attempting to share have been infants or juveniles.

Watching: The lemurs often watched other lemurs doing the tail immersion, sometimes (or so it seemed to us) pointedly so. For example, on June 23, 1994, an adult male (*Kirk*) was tail immersing, watched by another adult male (*Oscar*) who has not been seen to immerse. After several attempts by *Oscar* to lick from *Kirk*'s tail, in which *Kirk* repulsed him, *Oscar* was eventually allowed to lick from *Kirk*'s tail. Similarly, on May 9, 1995, *Jimmy*, an adult male non-immerser, watched *Neely*, an adult female immerser, for several minutes, and then licked water from the spot where *Neely* had been sitting when she had moved away.

Trying the behaviour: There were several occasions where lemurs who had not previously been seen to do the tail immersion behaviour were observed in what appeared to be an unsuccessful attempt to perform the behaviour. The example has already been given of the lemur who repeatedly circled without lowering himself down to the water. Two further examples:

June 30, 1994. *Angus*, a juvenile male, lowered himself several times from the pier, but without getting his tail wet. Then he slipped slightly and his tail hit the water. Some of this took place while an adult female, who was not his mother, was immersing her tail alongside him.

July 12, 1994. *Grace*, an infant female, lowered herself to the water four times in succession, each time getting her tail wet. She then climbed to the top of the pier but did not drink from her tail, merely looked around as if not knowing what to do next. Several minutes

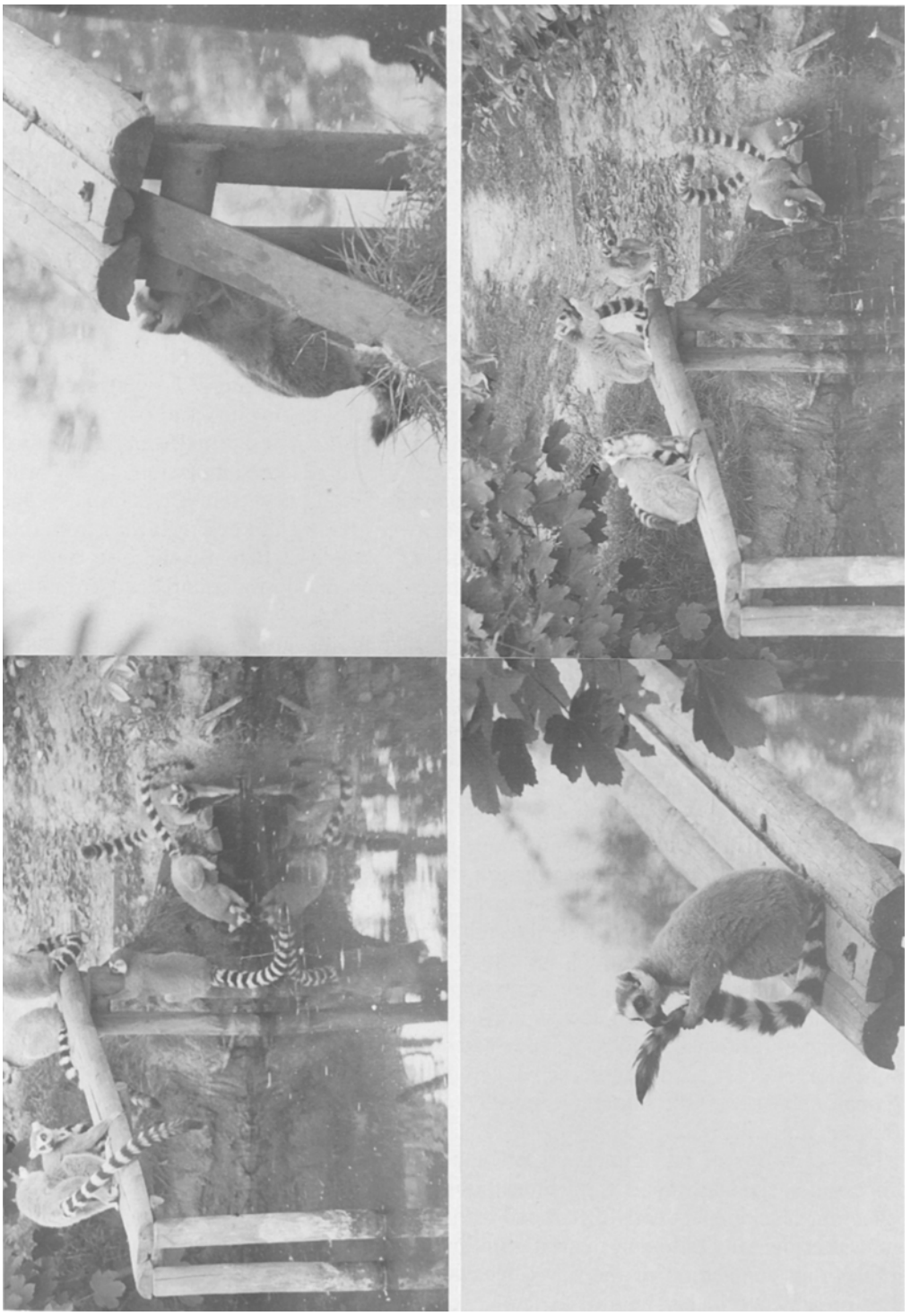

Fig. 1. Sequence showing one of the ring-tailed lemurs descending from the pier, floating its tail on the water, then drinking water from its wet tail.

later her mother (*Claire*) started tail immersing, and allowed *Grace* to share her tail. Interestingly, *Grace* was seen floating and drinking from her own tail in 1996.

Thus, our observations of the lemurs show individual differences in the form and sequence of the elements of the motor pattern of tail immersion, apparent observation of actions by non-performers of the behaviour, incomplete sequences in which the tail fails to be wetted or is not licked, and sharing of wet tails between performers and non-performers of tail immersion.

DISCUSSION

The behaviour of immersing and licking water from the tail, described here, is apparently a novel behaviour which arose spontaneously in this group of lemurs. They also drink by lapping water, both from the moat and from water dishes, licking dew and rain from leaves and several of the lemurs immerse a cupped hand in the moat and drink from the wet hand fur. These behaviours are done as well as, not instead of, tail immersion. In the wild, ring-tailed lemurs drink from rivers, and by licking rain and dew from leaves (JOLLY, 1966; LISA GOULD, pers. comm.). They also reach into tree hollows and lick the drops from their fingers (JOLLY, 1966). However, in many years of research at Berenty, and elsewhere, the ring-tailed lemurs have never been seen to immerse their tails in water and drink from them (ALISON JOLLY, pers. comm.; PAT WRIGHT, pers. comm.).

Because the behaviour was already established in the group when we first started observing them, we have no data on how, or with which individual this behaviour originated, nor the course of its spread through the group. In the potato-washing Japanese macaques, age was apparently an impediment to learning the behaviour, and adult males in particular, did not acquire the habit (KAWAI, 1965). In KAPPELER's experiment, which required lemurs to tip a dish over to obtain a piece of fruit underneath, 8 of a group of 18 animals learned the behaviour within 20 trials, but again, no adult males showed any interest in the task, and consequently none acquired the behaviour (KAPPELER, 1987). In another experiment testing the acquisition of a novel food-related task FORNASIERI et al. (1990) also found that the two adult males in a group of four ring-tailed lemurs rarely attempted the task. However, in the tail immersion behaviour described here, adult males did show the behaviour, including the oldest animal in the group, *Loppy*, a 10-yr old male.

We do not know how this behaviour started. It is possible that the behaviour could have arisen in animals which accidentally fell in, or slipped when miscalculating a jump, immersing part of their bodies. We have several observations of immersions like this. Such immersion has also been seen in the wild. WILSON (1990) observed a female crowned lemur (*Eulemur coronatus*) slip into a river accidentally; the rest of the troop then licked the water from her fur.

The behaviour of tail immersion has almost certainly spread through the group by a process of social learning. It is possible, though unlikely, that each animal which shows the behaviour has independently discovered it for itself, as this would seem to require a lot of lemurs accidentally falling in the water in this, but not in any other group. Social learning implies that acquisition of the novel behaviour is facilitated by social processes, and we have presented evidence here of at least two such social processes, observation and tail-sharing, which could lead to social learning. The most parsimonious explanation is that the mechanism of social learning shown here is stimulus enhancement, where the animal's

attention is drawn to a stimulus, and this makes learning the response more likely. This mechanism has been shown to be capable of explaining phenomena as diverse as the spread of potato-washing in macaques (VISALBERGHI & FRAGASZY, 1990a) and milk bottle opening in bluetits (SHERRY & GALEF, 1984).

In our examples of non-immersing lemurs watching immersing lemurs, the watching is often followed by sharing a wet tail, or licking a wet patch where a lemur has been sitting.

Several features of our observations suggest to us that imitation might also have been involved in the acquisition of tail immersing behaviour in this group, though we accept that the evidence is equivocal. As described above, several of the non-immersers show an incomplete approximation to the full motor pattern of tail immersion. Interestingly, it is the initial, non-stimulus directed elements that they show, notably the turning of the body prior to descending the pier support. Secondly, there are individual idiosyncrasies in the performance of the behaviour, not only in that the tail may be dipped or floated or both, but also in that the elements of the motor pattern may be repeated or omitted by some individuals. This suggests to us the kind of hierarchical organisation of complex tasks referred to by BYRNE (1993, in press; BYRNE & BYRNE, 1993); and we propose that our data could be explained by what BYRNE calls "programme level" imitation. Programme level refers to performing the overall structure of the behaviour, without necessarily duplicating the detailed motor units which make up that structure. Therefore it is as though the lemurs "understand" the overall requirements of the tasks (higher hierarchical level) but perform the lower hierarchical level motor patterns in slightly different idiosyncratic ways.

It is interesting to note that an apparently identical behaviour of tail immersing has been reported by SCHONHOLZER in two hamadryas baboons at Zurich Zoo (cited by VISALBERGHI & FRAGASZY, 1990b). In this case, none of the other 13 baboons in the group who both watched and licked up drops, ever acquired the behaviour of tail immersing. Perhaps it is time to re-assess our views on the evolution of primate intelligence, since a baboon is obviously no match for a cognitive lemur.

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REFERENCES

BYRNE, R. W. 1993. Hierarchical levels of imitation. *Behav. Brain Sci.*, 16: 51.

BYRNE, R. W. in press. Complex skills in wild mountain gorillas: techniques for gathering plant food. In: *Proceedings of the XIV Congress of the International Primate Society.*

BYRNE, R. W.; BYRNE, J. M. E. 1993. Complex leaf-gathering skills of mountain gorillas (*Gorilla g. beringei*): variability and standardization. *Amer. J. Primatol.*, 31: 241–261.

BYRNE, R. W.; WHITEN, A. (eds.). 1988. *Machiavellian Intelligence: Social Expertise and the Evolution of Intellect in Monkeys, Apes and Humans.* Oxford Univ. Press, Oxford.

FORNASIERI, I.; ANDERSON, J. R.; ROEDER, J.-J. 1990. Responses to a novel food acquisition task in three species of lemurs. *Behav. Processes*, 21: 143–156.

GIBSON, K. R.; INGOLD, T. 1993. *Tools, Language and Cognition in Human Evolution.* Cambridge Univ. Press, Cambridge.

HAUSER, M. D. 1988. Invention and social transmission: new data from wild vervet monkeys. In: *Machiavellian Intelligence: Social Expertise and the Evolution of Intellect in Monkeys, Apes and Humans*, BYRNE, R. W.; WHITEN A. (eds.), Oxford Univ. Press, Oxford, pp. 327–343.

HEYES, C. M. 1993. Imitation, culture and cognition. *Anim. Behav.*, 46: 999–1010.
JOLLY, A. 1966. *Lemur Behaviour.* Univ. of Chicago Press, Chicago.
KAPPELER, P. M. 1987. The acquisition process of a novel behaviour pattern in a group of ring-tailed lemurs (*Lemur catta*). *Primates*, 28: 225–228.
KAWAI, M. 1965. Newly acquired pre-cultural behaviour of the natural troop of Japanese monkeys on Koshima Islet. *Primates*, 6: 1–30.
MCGREW, W. C. 1992. *Chimpanzee Material Culture.* Cambridge Univ. Press, Cambridge.
NISHIDA, T. 1987. Local traditions and cultural transmission. In: *Primate Societies*, SMUTS, B. B.; CHENEY, D. L.; SEYFARTH, R. M.; WRANGHAM, R. W.; STRUHSAKER, T. T. (eds.), Univ. of Chicago Press, Chicago, pp. 462–474.
SHERRY, D. F.; GALEF, B. G. 1984. Cultural transmission without imitation: milk bottle opening by birds. *Anim. Behav.*, 32: 937–938.
VISALBERGHI, E.; FRAGASZY, D. M. 1990a. Food-washing behaviour in tufted capuchin monkeys, *Cebus apella*, and crab-eating macaques, *Macaca fascicularis. Anim. Behav.*, 40: 829–836.
VISALBERGHI, E.; FRAGASZY, D. M. 1990b. Do monkeys ape? In: *Language and Intelligence in Monkeys and Apes*, PARKER, S. T.; GIBSON, K. R. (eds.), Cambridge Univ. Press, Cambridge, pp. 247–273.
WHITEN, A.; CUSTANCE, D. M.; GOMEZ, J.-C.; TEIXIDOR, P.; BARD, K. A. 1996. Imitative learning of artificial fruit processing in children (*Homo sapiens*) and chimpanzees (*Pan troglodytes*). *J. Comp. Psychol.*, 110: 3–14.
WILSON, J. 1990. *Lemurs of the Lost World.* Impact Books, London.

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Authors' Names and Address: GEOFFREY R. HOSEY, MARIE JACQUES, and ANGELA PITTS: *Biology and Environmental Studies, Bolton Institute, Deane Road, Bolton, BL3 5AB, England.*