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A STONE IN THEIR HANDS... ARE MONKEYS TOOL USERS?

ABSTRACT: This paper reviews the literature on spontaneous cases of "tool use" in captive, semi-free, and wild New and Old World monkeys. These data are evaluated to determine whether the presently available evidence supports the assumption that monkeys naturally or spontaneously use tools, and understand how the "reported tool" functions in solving a task. Following Panger's (1998, 1999) distinction between tool-using and object-using, we found extremely limited evidence for spontaneous "tool use" in monkeys. The overwhelming number of published reports were associated with species of three primate genera, Cebus, Macaca and Papio. Moreover, the majority of observations described in the literature as "tool use" are examples of object use. Considering the extremely small number of reported "tool-using" events and the fact that typically only 1 or 2 members of a group have been observed to manipulate objects as tools, we conclude, (1) the presently available evidence does not support the contention that monkeys naturally use tools, and (2) in those cases when monkeys are reported to use tools it remains unclear from the animals' behaviour the degree to which they understand how the tool functioned (casual knowledge) in accomplishing the task.

KEY WORDS: Tool use – Object manipulation – Primate cognition – Monkeys – Problem-solving

INTRODUCTION

Since the 15th century, monkeys have been subjects of interest for their manipulative capabilities (Urbani 1998). In particular researchers have theorized about the ability of both human and nonhuman primates to solve ecological problems using tools. There remain several questions, however, concerning whether all primates that are reported to use tools possess similar cognitive capacities. In this regard, tool use can be divided into two distinctive abilities. One, the motor act of manipulating an appliance or object, and two, the cognitive basis for understanding how the appliance functions (association *vs.* insight while solving tool use problems) (see: Visalberghi, Limongelli 1994, 1996, Limongelli *et al*. 1995, Garber, Brown in press). The main objective of this paper is to review the published literature on definitions of tool use in primates and compare it with published reports of spontaneous "tool-using" behaviours by monkeys in wild, semi-free, and captive conditions. These data will be analysed to determine whether non-ape primates that are described as "tool users" actually use tools (see above: Panger 1998, 1999).

Scholars interested in primate cognition have questioned the cognitive basis of tool use in monkeys – and apes – (e.g. from Bierens de Haan 1931, Klüver 1937 to Berthelet, Chavaillon 1993, Garber, Brown in press). Specifically, do non-human primates understand objects as potential tools? In this regard, Beck (1975: 414) provides a definition of "tool use" as "the manipulation of an unattached environmental object, the tool (not part of the user's body), to alter more efficiently the form or position of a separate object, when the user holds or carries the tool *in toto* during or just prior to use and is responsible for the critical connection between tool and incentive." This definition highlights an important set of criteria for distinguishing when an individual is using an appliance as a tool compared

to using an appliance as an object. Thus, Beck (1975) "…excludes as tool use some behaviours that are strikingly similar, in both form and function to those it includes. For example, chimpanzees are not using tools when they open fruits by banging them ON rocks, but they are when they bang fruits WITH rocks (sic)" (Beck 1975: 414). This conception of tool use provides a framework to evaluate and compare tool use in monkeys and apes.

Using a Piagetanian model of ontogenetic development, Parker and Gibson (1977) differentiated between object-substrate manipulation or "*proto tool use*" and tool use. These authors make a distinction between the tool itself and the resource upon which the tool acts, and suggest that the difference "between true tool use and the *proto tool use* seems to lie in the detachment and manipulation of both the object of change and the agent of change (the tool)… the detachment and manipulation of the object of change only is *proto tool use*" (Parker, Gibson 1977: 625).

Panger (1998, 1999) elaborated on this distinction and highlights the difference between tool use and object use. Accordingly, she considers that a primate is using a tool rather than manipulating an object when both agent of change (tool) and the object of change (edible item, solid or liquid) are manipulated in a feeding, drinking or foraging context; e.g. throwing a branch is not tool use, whereas using a branch to obtain a food item is using a tool. However, Panger's definition is primarily associated with differences in motor skills which may not necessary imply cognitive processes involved in the understanding of how the tool functions. Manipulative abilities are a necessary but not sufficient condition for tool use. For example, Torigoe (1985) reviewed evidence of object manipulation in 74 primate species (Torigoe 1985), virtually none of which are reported to use tools in the wild. Rather, it has been argued that true tool use requires evidence of both manipulative abilities and causal knowledge of how the tool functions in accomplishing the task (Visalberghi, Limongelli 1994, 1996, Tomasello, Call 1997, Visalberghi, Tomasello 1998). Causal knowledge or insight can be defined as the ability to mentally represent, associate and control two or more events for obtaining a goal while using an object as a tool, and requires knowing how something works (Visalberghi, Tomasello 1998, Tomasello, Call 1997, Call 2000). A major question in the study of primate tool use therefore, is whether monkeys learn to use tools by insight (how the tool works) or reinforcement (that the tool works) (Visalberghi, Limongelli 1994, 1996, Byrne 1998). In this paper, we address the following questions:

a) Is there evidence that monkeys naturally use tools (Beck 1975, Parker, Gibson 1977, Panger 1998, 1999)?
b) If monkeys use tools, do the data support the contention that monkeys understand how "tools" function?

METHODS

A systematic review was conducted of published reports of "tool use" in monkeys in wild, semi-free and captive conditions. Only spontaneous cases were included. We define spontaneous tool use following Beck's (1975) definition with the provision that the individual manipulating the tool had not been trained previously to use tools as part of some research or experimental protocol. Thus, we have excluded all cases of induced or experimental studies of monkey "tool-using".

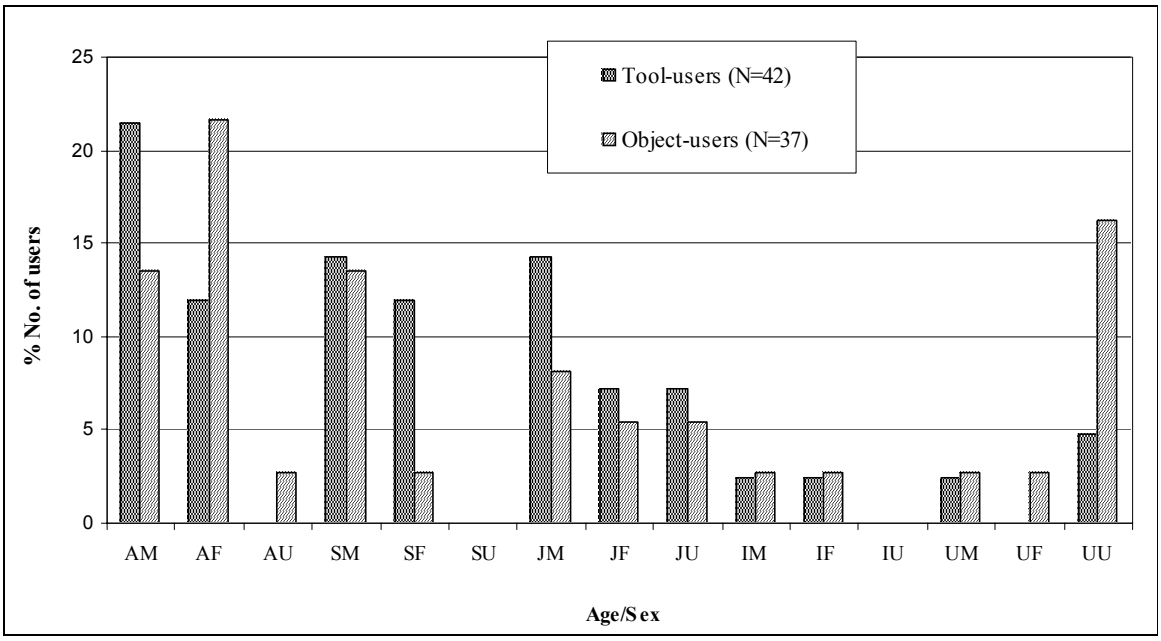

FIGURE 1. Comparison of the sex/age category among tool users and object users (for abbreviations see *Table 1*).

TABLE 1. Reports of "tool use" in monkeys under wild, semi-free and captive conditions (spontaneous cases only). Definitions of tool use and object use as Panger (1998, 1999).

TOOL USE												
Species	**Reported "tool"**	**Object of change**	**"Tool-using" behaviour**	**No. of "using events"**	**No. of monkeys**	**Ratio No. monkeys**	**Observa-tion time**	**Freq. of use**	**Age/sex**	**Event durations**	**Environmenta l context**	**References**
Cebus albifrons	Leaf cup	Water (obtained)	Drinking water	1	1 to >5	0.300	U	–	JU, SF	2 to 5 min	W	Phillips (1998)
Cebus apella	Bait	Fish (obtained and not obtained)	Attracting fishes	11 (obtain fish)	1 of 6	0.167	71.5 min	8.4615	AM	10 to "several" min.	C – island	Mendes *et al.* (2000) [1]
Cebus apella	Branch	Hard fruit (not obtained)	Fruit cracking	1	1 of 20	0.050	22 months	0.0003	JM	10 min.	W	Boinski *et al.* (2001)
Cebus apella	Stone	Palm fruit (obtained)	Fruit cracking	347	14 of 18	0.778	14 months	0.1652	AM, AF, SM, SF, JU, IU	U	SF	Ottoni, Mannu (2001) [2]
Cebus apella	Stone	Nuts with invertebrates (obtained)	Obtaining coleoptera	U	U of 44	–	11 months	–	AM, SM, JM, AF, SF, IF	–	SF	Rocha *et al.* (1996, 1998)
Cebus apella	Stone or wood	Oyster (obtained)	Oyster cracking	U (but ? 2)	1 of 10	0.100	1 day	0.2000	UM	U	W	Fernandes (1991)
Cebus capucinus	Probe	Insect (U)	Probing for insects	1	1 of 21	0.048	300 hr.	0.0033	SM	U	W	Chevalier-Skolnikoff (1990)
Cebus olivaceus	Leave	Water (obtained)	Sponging water	1	1 of 11	0.091	1 day	0.1000	JF	U	C – island	Urbani (1999)
Cebus olivaceus	Orange peel	Water (obtained)	Containing water	1	1 of 11	0.091	1 day	0.1000	JM	U	C – island	Urbani (1999)
Cebus sp.	Twig	Insect (obtained)	probing for insects	U	U	–	U	–	UU	U	W	Thorington (in Jay 1968)
Cebus sp.	Leave	Water (obtained)	Drinking water	U	U of 6	–	U	–	UU	U	C – enclosure	Nolte (1958)
Cercopithecus aethiops sabaneus	Stick	Grass (obtained)	Sweeping and reaching grass	1	U	–	U	–	AF	U	C – island	Pollack (1998)
Erythrocebus patas	Twig	Peanuts (obtained)	Sweeping peanuts	1	1	1.000	1 day	0.1000	AM	U	C – enclosure	Gatinot (1974)
Leontopithecus rosalia	Twig	Insect (U)	Probing holes	20 and "multiple"	8 of U	–	25,000 hr.	0.0008	SM, SF, IF, IM, AM, AF, JM, JF	U	SF	Stoinski, Beck (2001) [3]
Macaca fascicularis	Leaves	Fruits and seed (obtained)	Fruit and seed cleaning	19	U	–	18 months (250 hr.)	0.0760	JU, SF, AM, SM	U	SF	Chiang (1967)
Macaca fascicularis	Stone	Oyster (obtained)	Oyster cracking	1		–	U	–	UM	U	W	Carpenter (1887) [4]
Macaca silenus	Leave	Chrysalis (obtained)	Catching chrysalis	4	U	–	At least 4 months	0.0066	JM, AF, SM	U	W	Hohmann (1990)
Macaca silenus	Leaves	Water (obtained)	Leaves sponging	3	2 of 8	0.250	1 month	0.0200	AM, SM	U	C – island	Fitch-Snyder, Carter (1993)
Papio cynocephalus	Stick	Stone (obtained)	Extracting stone	1	1 of 38	0.026	U	–	AM	"Several min."	W	Oyen (1979)
Subtotal / averages						*0.264*		*0.0702*				*19 entries (18 ref.)*

TABLE 1 (continued). Reports of "tool use" in monkeys under wild, semi-free and captive conditions (spontaneous cases only). Definitions of tool use and object use as Panger (1998, 1999).

OBJECT USE												
Species	**Reported "tool"**	**Object of change**	**"Tool-using" behaviour**	**No. of "using events"**	**No. of monkeys**	**Ratio No. monkeys**	**Observation time**	**Freq. of use**	**Age/sex**	**Event durations**	**Environmental context**	**References**
Alouatta seniculus	Stick	None	Hitting a sloth	1	1 of 3	0.333	1 day	0.1000	UA, UM	U	W	Richard-Hansen *et al.* (1998)
Cebus apella	Stick	None	Hitting other monkey	1	U	–	1 day	0.1000	UU	U	C – enclosure	Cooper, Harlow (1961) [5]
Cebus capucinus	Branch	None	Hitting a snake	1	1 of 3	0.333	1 day	0.1000	AM	U	W	Boinski (1988)
Cebus capucinus	Branch	None	Hitting another	1	1 of 21	0.048	300 hours	0.0033	JM, SM, JU	U	W	Chevalier-Skolnikoff (1990)
Cebus capucinus	Branch	None	Breaking and dropping to another above	21	U of 21	–	300 hours	0.0700	AF	U	W	Chevalier-Skolnikoff (1990)
Cebus capucinus	Snags	None	Pushing and changing direction	2	1 of 21	0.048	300 hours	0.0700	UU	U	W	Chevalier-Skolnikoff (1990)
Cebus capucinus	Stick	None	Throwing	1	1 of 21	0.048	300 hours	0.0033	JU	U	W	Chevalier-Skolnikoff (1990)
Cebus capucinus	Stick	None	Flailing to another	2	1 of 21	0.048	300 hours	0.0067	UU	U	W	Chevalier-Skolnikoff (1990)
Cebus capucinus	Stick	None	Poking to another	1	1 of 21	0.048	300 hours	0.0033	UU	U	W	Chevalier-Skolnikoff (1990)
Cebus olivaceus	Stick	None	Helping to stand up	1	1 of 11	0.091	1 day	0.1000	JM	U	C – island	Urbani (1999)
Cercocebus atys	Stone	None	Grooming her infant	95	1 of 90 to 120	0.014	15 months (300 hr.)	0.0033	AF	3 sec. to 17 min.	C – enclosure	Kyes (1988)
Cercopithecus ascanius	Leaf	None	Cleaning	1	1 of 31 or 23	0.036	10 months	0.0005	UF	50 sec.	W	Worch (2001)
Leontopithecus rosalia	Twig	None	Grooming	20 and "multiple"	8 of U	–	25,000 hr.	0.0008	SM, SF, IF, IM, AM, AF, JM, JF	U	SF	Stoinski, Beck (2001) [3]
Macaca fuscata	Acorn	None	Pacifying by putting it into daughter mouth	1	U	–	14 month (>2500 hr)	0.0004	AF	U	W	Matsubara, Funakoshi (2001)
Macaca fuscata	Chow pieces	None	Grooming	U	1 of 13	0.077	10 months	–	AF	U	C – enclosure	Wienberg, Candland (1981)
Macaca fuscata	Stone	None	Grooming	U	1 of 13	0.077	10 months	–	AF	10 sec. to 15 min.	C – enclosure	Wienberg, Candland (1981)
Macaca fuscata	Twig	None	Grooming	U	1 of 13	0.077	10 months	–	AF	U	C – enclosure	Wienberg, Candland (1981)
Macaca radiata	Stick	None	Genitalia scratching	15	1 of 19 to 22	0.050	21 hr.	0.7143	AF	U	W	Sinha (1997)
Macaca tonkeana	Stick	None	Nose cleaning	3	1 of 8	0.125	1 day	0.3000	AM	5 to 15 min	SF	Bayart (1982)

TABLE 1 (continue). Reports of "tool use" in monkeys under wild, semi-free and captive conditions (spontaneous cases only). Definitions of tool use and object use as Panger (1998, 1999).

OBJECT USE												
Species	**Reported "tool"**	**Object of change**	**"Tool-using" behaviour**	**No. of "using events"**	**No. of monkeys**	**Ratio No. monkeys**	**Observation time**	**Freq. of use**	**Age/sex**	**Event durations**	**Environmental context**	**References**
Papio cynocephalus	Stone	None	Face wiping	1	1 of U	–	1 day	0.1000	JF	U	W	van Lawick-Goodall, Packer (1973)
Papio papio	Stick	None	Scraping the soil	1	1 of 8	0.125	1188 hr.	0.0008	SM	Unclear	C – enclosure	Petit, Thierry (1993)
Papio papio	Stone	None	Breaking cement surface	several	3 of 8	0.375	1188 hr.	0.0025	SM, SM	Unclear	C – enclosure	Petit, Thierry (1993)
Papio sp.	Sand	None	Throwing	1	1 of U	–	U	–	UU	U	C – U	Beck (1975) [6]
Papio sphinx	Stick	None	Digging soil	1	1 of 8	0.125	1 day	0.1000	AM	U	C – enclosure	Vincent (1973)
Subtotal / averages						*0.115*		*0.0895*				*25 entries (16 ref.)*
Total						*0.172*		*0.0796*				*44 entries (34 ref.)*

Abbreviations: W= Wild; SF= Semi-free; C= Captive; U=Unknown; A=Adult; S=Subadult; J=Juvenile; I=Infant; M=Male; F=Female.

Notes: [1] The frequency of tool-using of Mendes *et al.* (2000) is an anomalous value and was not included in the calculation of the subtotal frequency. [2] We consider this entry for the purpose of this table, however it has to be pointed out that Perondi *et al.* (1995) report an experiment of tool use (stick use in boxes) in an island with 60 *Cebus apella* individuals in the Parque Ecológico Tietê, Brazil. In 1997–1998, Ottoni, Mannu (2001) collected data of spontaneous tool use while nut cracking by *Cebus apella* individuals that formed a group after escaping from these park islands, and then also made a similar experimental protocol with this troop, as those from 1995 (Aquino, Ottoni 2001). It was not reported if the individuals that "spontaneously" cracked nuts with stones in the mainland (Ottoni, Mannu 2001) were the same or part of the individuals that were present in the Perondi *et al.* (1995) and/or Aquino, Ottoni (2001) experiments. [3] The cases of use of the radio transmitter antennas fixed in the monkey's necks are not included. [4] The author refers the monkey as "he". [5] The authors name the stick as "instrument". [6] This work is a review of reports; we included one out of two Beck's personal observations and a personal communication to him, because in the other two cases it is not clear if the behaviour was performed spontaneously.

Comments: [a] Data from Chevalier-Skolnikoff (1989) are not added in this table because the author said that "no formal task-reward experiments were set up… [however, she indicated that intentionally] an assortment of novel objects were provided with the food" (Chevalier-Skolnikoff 1989: 562). [b] The data presented by Kortlard, Kooij (1963) is not included, because all entries come from secondary and anecdotal sources, practically most of them anonymous. [c] The use of the monkey's tails as those reported as a tool by Reinhardt (1991) and Behnar, Samuel (1978) were not considered as tools. [d] Langguth, Alonso (1997) report was not incorporated, because even if the authors presented convincing information of tool-using by wild *Cebus apella*, they did not observe the monkeys performing such behaviour. [e] The cases of capuchin stone using reported by Fernandez de Oviedo y Valdes in 1526 (in Urbani, 1998) and Croizat (in Urbani, 2002) are not included. The stones were intentionally provided in order to see how the monkeys select and use them. A similar situation occurs with the nut-cracking behaviour of a captive *Cebus apella* male reported by Nolte (1958), that – in principle – the "tools" were selected for the similar selection purpose described above. The "tools" that Nolte (1958) reported are tennis racquets, wood, "hammer", concrete, plate, screwdriver and shovel; [f] The "tool use" cases reported by Romanes (1977) were not added because it is not clear if they were used spontaneously and the data was secondarily obtained by his sister. Also, Jennison (1927), Eisentraut (1933), Hill (1964), Belt (1985) cases of *Cebus* spp. of nut, oyster and beetle-cracking, and stick use are presented out of context, it is not known if they were spontaneous or induced. [g] The cases of stick and branches use reported by Krieg (1930) for *Cebus apella*, Ueno, Fujita (1997) for *Macaca tonkeana*, and Galat-Luong (1984) for *Papio leucophaeus*, *Cercopithecus campelli lowei* and *Cercopithecus atys* are not included because the monkeys were fastened with a rope. [h] The described cases of spontaneous object and substrate use by *Macaca fascicularis*, *Procolobus badius*, *Cebus capucinus* and *Cebus apella* (Truce, Fuentes 2002, Starin 1990, Panger 1998, Boinski *et al.* 2001, Urbani, Urquiza-Haas 2002, respectively) take in consideration the distinction between object manipulation and substrate use as described by Parker, Gibson (1977) and Panger (1998, 1999).

A bibliographic list was made after searching in Academic Search Elite, Biological Abstracts (BIOSIS), PrimateLit (1940–2002), and Zoological Record reference databases, and citations in Beck (1975), Hill (1964), Tomasello and Call (1997), van Lawick-Goodall (1970) and Visalberghi (1990). The four main primatological journals, *American Journal of Primatology*, *Folia Primatologica*, *International Journal of Primatology* and *Primates* also were systematically reviewed for years 1957–2002. Data were collected from the reports (*Table 1*), as follow:

1) Reported "tool": refers to potential agent of change, and becomes a "tool" when related to a feeding, drinking or foraging context (see above: Panger 1998, 1999).
2) Object of change: refers to the edible item, solid or liquid (see above: Panger 1998, 1999).
3) Reported "tool-using" behaviour: refers to the action required to obtain a goal with the "tool".
4) Number of "using" events: The number of times the "tool-using" behaviour" was observed.
5) Number of monkeys: the number of individual monkeys in the group reported to use tools.
6) Ratio of tool users: the number of tool-using monkeys divided by the number of monkeys in the group.
7) Observation time: corresponds to the total amount of time spent observing the studied animals.
8) Frequency of tool use: Number of ""tool-using" events" per hour. For those cases in which the number of observation hours was not reported, we use hypothetical hours according to the following: 1 day = 10 hours, 1 month = 15 days, 1 year = 12 months. If the observation time was not reported, it was scored as unknown.
9) Age/sex: Age and sex of the tool or object user.
10) Event duration: duration in seconds and/or minutes of the ""tool-using" event".
11) Environmental information: whether the study was conducted in captivity, wild, or semi-free conditions.

RESULTS

Table 1 presents the data obtained from our literature search of several articles on spontaneous "tool-using" in monkeys. The data are divided into cases of tool-using and cases of object-using according to Panger (1998, 1999). Of 44 entries, 19 (43.2%) are reports of "tool-using" during feeding, foraging and drinking contexts (68.4% for food and 31.6% for water). The remaining 25 (56.8%) cases described as tool-using are better represented as object-using cases. From a total of approximately 230 primate species (Cowlishaw, Dunbar 2000) only 11 monkeys species were found to be possible tool users (4.8%), and more than a half (57.9%, N=10/19) of these involved the genus *Cebus*. The other genera in which "tool use" was reported are *Macaca*, *Papio*, *Erythrocebus*, *Cercopithecus* and *Leontopithecus* (*Table 1*). The majority of the reported tools were "sticks" (36.8%, incl. probe, branch, twig, N=7/19), followed by leaves (31.6%), stones (21.1%) and others (10.5%, orange peel and bait), and in practically all events the edible items were obtained (84.2%, N=16/19) (*Table 1*). In the case of object-using, sticks were the predominant manipulated object (i.e. "sticks", 72%, N=18/25).

The number of "tool use" events varied from one case (47.4%, N=9/19) to 20, with the exception of 347 cases reported by Ottoni and Mannu (2001) for confiscated *Cebus apella* living in a semi-free ranging setting. It remains unclear whether some of these capuchins had previously been involved in tool use experiments (Perondi *et al.* 1995, Aquino, Ottoni 2001).

The reported duration of tool use events in these published accounts varied from a "few seconds" to 10 minutes, but in most cases duration was not reported (*Table 1*). For object-using, the number of events ranged from 1 (56%, N=14/25) to 95 (N=1/25), with duration intervals ranging from 3 seconds to 17 minutes. However, as in tool-using, the time engaged in object manipulation frequently was not reported. The proportion of performer group members to non-performer group members in tool-using or object-using events was low (0.264 to 0.115, respectively). The majority of cases were performed by only one individual in the group (47.4%, N=9/19 for "tool-using" events; 80%, N=20/25 for object-using events).

The reported frequencies (by hours) of tool-using and object-using also were extremely low. They ranged from 0.07 cases per hour for tool-using and 0.08/hour for object-using (*Table 1*, also see explanation for calculation in Methods). Among individual species, the frequencies of tool-using and object-using ranged from 0.09/hr to 0.05/hr in *Cebus*, 0.03/hr to 0.33/hr in *Macaca*, and from "unknown" to 0.06/hr in *Papio*. In *Leontopithecus rosalia*, tool-using and object-using were reported at a rate of 0.0008/hr. For *Cercopithecus* and *Erythrocebus*, the frequencies are represented by only one case of tool-using, with no cases of object-using (*Table 1*). We found no cases of tool-using by prosimians, although they have been reported occasionally to manipulate objects in induced captive contexts (Torigoe 1985, Sterling, Povinelli 1999).

When engaged in tool-using behaviour, adult males tended to be the main performers whereas for object-using adult females were the most common performers (*Figure 1*). 42.1% tool-using cases occurred in the wild (N=8/19), 36.8% in captive (N=7/19) and 21.1% in semi-free (N=4/19) conditions. Percentages of object-using varied from 52% wild (N=13/25), 40% captive (N=10/25) and 8% for semi-free (N=10/25) conditions.

DISCUSSION

Based on an extensive review of the published literature, there exist few reported events of tool use in non-ape primates (following the definition of Panger 1998, 1999). In addition, in those instances in which tool use has been

observed, the number of individual tool users and the frequency of tool use events were extremely low. Many reports of "tool-using" presented in the literature are better understood as examples of "object-using" (*Table 1*). Furthermore, most of the "tool use" reports are anecdotal (see implications in Heyes 1993). In the case of monkeys, we have no evidence for even occasional tool use, despite long-term field studies in species such as *Alouatta palliata* (Glander 1992), *Brachyteles arachnoides* (Strier 1992), *Macaca fuscata* (Watanabe 2001), *Cebus capucinus* (Chapman, Fedigan 1990, O'Malley, Fedigan 2002) and *Papio cynocephalus* (Altmann, Altmann 1970).

The data currently available support the idea that monkeys do not use tools under natural conditions. The majority of tool use reports are from capuchin monkeys (*Cebus* spp.) (*Table 1*), a primate genus that is characterized by large brain size and enhanced manual dexterity (for a platyrrhine) (Boinski *et al*. 2001, Visalberghi, McGrew 1997). *Cebus* also has been the focus of numerous captive studies designed to examine tool-using behaviour.

In captive studies examining social transmission of information during problem-solving tasks associated with tools, there is no evidence that capuchins learn by imitation (learning to obtain a goal by understanding the intentions of the model's behaviour – Visalberghi, Fragaszy 2001), by emulation (learning to obtain a goal by watching the behaviour of the model – Tomasello 1996), or social enhancement (learning by trial-and-error after observing the model's behaviour – Visalberghi, Limognelli 1994, Visalberghi, Fragaszy 2001). Similarly in an experimental field study of tool-using in wild white-faced capuchins (*C. capucinus*) (Garber, Brown in press) there was no evidence that any of the 15 group members understood how the tool functioned in solving the foraging problem. This is consistent with the conclusions of many captive studies (Visalberghi, Limongelli 1996, Visalberghi, Tomasello 1998, for an alternative interpretation see: Westergaard, Suomi 1995, 1997). Overall, the current data do not provide consistent evidence that any monkey species has insight or understanding of the properties of a tool and how it functions in accomplishing a task.

In summary, although many species of non-ape primates possess the requisite motor skills to manipulate objects as tools, spontaneous cases of tool use principally have been reported only in three genera, *Cebus*, *Macaca* and *Papio* (*Table 1*). Moreover, even in these genera, observations of tool use are rare, and there is little evidence to support the contention that these monkeys have insight or causal understanding into how external appliances functioned in accomplishing a foraging or social task. Therefore, it can be argued that monkeys are not true tool users.

The review of the present literature highlights important cognitive distinctions between monkeys, and at least some apes and humans (McGrew 1996, Tomasello, Call 1997). The data also suggest that caution must be used in assuming that monkeys represent instructive models in identifying the ecological, social, or cognitive factors that led to the evolution of tool use in early human ancestors. In this regard, future research on cognition in captive and wild prosimians, New World monkeys and Old World monkeys needs to examine more clearly what individuals learn by trial and error, what individuals learn by observing others, and the degree to which problem-solving represents learning by association or learning by insight (Shettleworth 1998).

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