Brief Report

Folia Primatol 1997;68:23–25

Received: September 28, 1995
Accepted after revision: May 29, 1996

Complex Tool Manufacture by a Wild Bonnet Macaque, *Macaca radiata*

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Key Words

Tool manufacture · Tool use · Bonnet macaque · *Macaca radiata* · Field study · India · Cognition · Insight

Tool use has been broadly defined as the external employment of an unattached inanimate object to alter the form, position, or condition of another object, another organism, or the user itself [1]. Tool manufacture has been considered to be a modification of the physical properties of an inanimate object so that it can be used more efficiently as a tool. Tool use has been widely, though sporadically, reported for all the families of nonhuman primates, except the Callitrichidae and the prosimians [1]. Authentic examples of tool manufacture, however, are rare in monkeys (with the notable exception of the New World genus *Cebus,* the capuchins, in captivity) and appear to be restricted principally to the great apes (chimpanzees, orang-utans). Amongst the Old World monkeys, only lion-tailed macaques *(Macaca silenus)* in captive social groups have been observed to manufacture tools by detaching sticks from larger branches to extract food from the narrow openings of enclosed containers [2].

A unique case of tool manufacture and use by a free-living female bonnet macaque *(Macaca radiata)* is reported here. This elderly female, approximately 12–15 years of age, was a member of a large troop of 19–22 adults, inhabiting semi-arid scrublands on the outskirts of the city of Bangalore, southern India. She was often observed to insert a short twig, dry stick, stiff leaf or grass blade, or a leaf-midrib into her vagina and scratch vigorously, possibly in response to some irritation that appeared to bother her persistently, whether or not she was sexually cycling, and even during pregnancy. She was found to scratch her genitalia on 18 occasions between March 1993 and September 1994, during which time she was observed for 21 h. Her dependence on object use is shown by the fact that on 15 of these occasions she used a tool for a total of 34 times, while on 3 occasions she used her forefingers alone.

This paper is dedicated to Right, the subject female, who died in October, 1994.

0015–5713/97/0681–0023$12.00/0

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What was more remarkable, however, was that on 8 out of the 15 occasions on which she used objects, she actively manufactured or modified her tools in the following ways: (1) Dry *Eucalyptus globosus* leaves were stripped of their lamina with the fingers or teeth, the midrib was broken into several pieces, and only a single short piece, 1–2 cm long, was used. (2) Dry *Acacia auriculiformis* leaves were longitudinally slit into halves, and a single half utilised. (3) Short sticks were detached from branched twigs and then used. (4) Dry sticks were broken into several pieces, and only a short piece was used. (5) Twigs or sticks were sometimes rubbed vigorously with the fingers or between the palms prior to use. (It may be added here that bonnet macaques often rub food between their palms prior to ingestion.)

The nature of tool manufacture shown by this macaque is far more complex than the stereotyped behavioural patterns of voluntarily picking up and dropping objects, or of coordinating objects with the substrate, which have been believed to characterise tool use by free-living macaques and baboons [3].

But could the performance of this individual qualify as intelligent object manipulation? There has been a continuing debate over the cognitive skills that possibly underlie the use of tools by nonhuman primates [4]. Inference that the manipulation of an out-of-reach object with a tool implies an understanding of the underlying causality requires that the animal perceives the tool as a detached intermediary, capable of mediating the desired change on another object, and one that can be systematically controlled [5]. The use of different objects by the bonnet macaque to achieve the same end could, in fact, point to such a cognitive ability. However, does her ability also reflect on the insightful use of the tools? For this to be the case, a yet higher order of cognitive processing involving representation would have to be invoked, characterised by the development of a mental model to which the animal could repeatedly refer [6]. This could be demonstrated, for example, if an animal searches for a tool in order to perform a specific task. Could the use of a leaf midrib by the bonnet monkey after the removal of the lamina be a result of such representation? In other words, could she have recognised a tool-like pattern (stick) within an apparently dissimilar object (leaf) through a mental model? If both inferences are indeed true, these cognitive mechanisms would correspond to the two highest levels of development in Piaget's series of (human) sensorimotor intelligence, a model that has often been invoked to define stages of intellectual ability across a variety of situations in nonhuman primates as well [3, 7]. Alternatively, this complexity of tool-making could simply be a result of earlier trial-and-error learning. Unfortunately, the ontogeny of complex behaviours can seldom be studied in the field; rigorous observations in the laboratory are needed.

An unusual feature of this tool use and manufacture is the specificity of the context in which it was performed. Kummer and Goodall [8] have, in fact, questioned the importance of tool use to performers themselves and have speculated on the factors that would constrain the transmission of such use in wild populations. In this troop, observed for over 600 h, no other individual ever demonstrated this particular behaviour although the female frequently used her tools in front of the other troop members. In this case, at least, it could be argued that such object use would not spread simply because of the narrow window of its applicability. This is supported by the observation that other females in this troop were never observed to scratch their genitalia in a manner similar to that of the tool-using female.

From an evolutionary point of view, sophisticated abilities in using tools have been suggested to have evolved independently in *Cebus* monkeys, lion-tailed ma-

caques and the great apes as an adaptation for omnivorous extractive foraging for embedded foods [2, 7]. Bonnet macaques are primarily folivores and frugivores and, accordingly, do not exhibit object manipulative skills to any significant extent in the course of their foraging. However, that they may indeed possess the potential for the elaboration of tools under different, more specific contexts is evident from the performance of this particular individual.

Finally, it is important to emphasise that tool modification by nonhuman primates, of the kind described here, has almost always been associated with foraging activities. Laboratory experiments designed to investigate the tool-making abilities of captive populations have therefore invariably depended on the paradigm of food acquisition. In the light of this unusual case of tool manufacture by an individual that failed to show any other kind of significant object manipulation, the necessity to develop other experimental designs is evident.

Acknowledgment

I thank N.V. Joshi, R.W. Byrne and S. Taylor Parker for their encouragement, and for their critical comments on earlier versions of this paper.

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