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Innovative coconut-opening in a semi free-ranging rhesus monkey (*Macaca mulatta*): A case report on behavioral propensities

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Abstract

The present case report provides a description of the emergence of an innovative, highly beneficial for-aging behavior in a single rhesus monkey (*Macaca mulatta*) on the island of Cayo Santiago, Puerto Rico. Selectively choosing the island's cement dock and nearby surrounding rocky terrain, our focal subject (ID: 84 J) opens coconuts using two types of underhand tosses: (1) a rolling motion to move it, and (2) a throwing motion up in the air to crack the shell. We discuss this innovative behavior in light of species-specific behavioral propensities.

Keywords

Innovation; behavioral repertoire; foraging; Rhesus macaques

Innovations enable individuals to exploit novel social and ecological conditions, and if spread to others, enable group level adaptations. One of the most notable examples of innovation followed by social transmission occurred in 1953, when a female Japanese macaque (*Macaca fuscata*), Imo, was observed washing sweet potatoes (Kawamura 1954) as a potential means of cleaning the food item before consumption (Kawai 1965). Reportedly, after a short period of time, other monkeys from Imo's troop began to perform the same systematic behavior of sweet potato cleaning.

Here, we report observations of a single rhesus monkey on the island of Cayo Santiago, Puerto Rico, who has developed a novel technique for opening coconuts. Of the approximately 1000 individuals presently on the island, our focal subject (84 J, a male born in the 1999 birth season) is the only one that can open coconuts. Specifically, 84 J uses an underhand toss to crack open coconut shells, selectively choosing one of the flattest and hardest surface areas on the island (i.e., a cement dock and nearby surrounding rocky terrain) to do so. Researchers and staff census takers observe the Cayo Santiago population year-round (Rawlins and Kessler 1987). To date, no other subject has ever been noted as having developed the technique used by 84 J. Based on the historical records for this population, which date back to 1938, only two other individuals have ever had any regular success opening coconuts, and did so with far less efficient means (Visalberghi and Frigaszy 1990). Further, the technique developed by these two individuals—basically, a

downward smashing motion—was never transmitted to others, and there has been no documentation of systematic coconut-opening for approximately 40 years.

The rhesus macaques living on Cayo Santiago are provisioned daily with commercial monkey chow. Additionally, this population freely feeds on clay, grass, leaves and flowers on Cayo Santiago. Coconuts, however, which are plentiful on the island, go unexploited given that rhesus monkeys appear unable to penetrate the hard, though brittle, external shell of the food. Subject 84 J lives in social group F with approximately 44 adult males and 87 adult females. Subject 84 J has exhibited his innovative and systematic method of opening coconuts for approximately 2 years (summer of 2008; Cayo census taker G. Cruz, personal communication). On two consecutive days, we presented 84 J with a huskless coconut to provide a more systematic record of his shell-cracking behavior (though 84 J has been witnessed to remove the outer husk of coconuts using his teeth).

The coconut-opening behavior of 84 J has two notable components: a horizontal toss and an underhand vertical throw. The horizontal toss is used to transport the coconut as he moves towards the island's dock (Fig. 1; a video of the behavior can be found at <http://www.box.net/shared/8elrimlzdcc> or <http://www.wjh.harvard.edu/~mnkylab/media/84j.html>). This is a useful technique since it is cumbersome for a largely quadrupedal rhesus to carry a coconut in one or both arms. The second component of the coconut-opening behavior occurs once 84 J has reached the rocky area near the island's dock. Rearing back on his hind legs, he springs upward into a small hop while concurrently propelling his front arms upward in an underhand throw. Towards the peak trajectory of his hop and throw, 84 J releases the coconut from his front hands, projecting the coconut upwards and then allowing it to fall on the nearby cement or rocky terrain. This process is repeated until the shell cracks, allowing him access to the flesh inside. On occasion, 84 J's unique foraging behavior captures the attention of nearby conspecifics, who often steal the fruit if they are dominant. Of the dozens of researchers and personnel who work on Cayo Santiago, none have observed any other monkey using 84 J's technique. Any claim concerning the potential absence of social transmission will, however, require longitudinal and experimental methods to substantiate. Importantly, however, there are certain parallels with observations by J. Berard (Visalberghi and Frigaszy 1990) of two individuals, WK and 436, who were able to crack the shells of coconuts by pounding them against the ground. Despite the fact that others watched WK and 436 open coconuts, including at least one instance with as many as five individuals observing the technique, no individual later employed their method, or succeeded with any other technique. The absence of this technique persists into the present and entreats questions of why this foraging technique has not spread. Though the present report lacks the data to directly address this issue, a recent description of innovation (dental flossing) under natural conditions within a single Japanese macaque in Arashiyama has highlighted certain ecological and biological factors attributing to the emergence of this innovation, as well as the constraints on its transmission (Leca et al. 2010).

As with most innovations, the origins of 84 J's behavior remain unknown. It is not possible to determine how he acquired the skill in question, though trial and error association without reinforcement remains one possible explanation. What is interesting about 84 J's innovation is that it demonstrates the existence of underarm throwing behavior that, until now, was known to exist in Japanese macaques but not in rhesus monkeys (Nahallage and Huffman 2008). In their study on the stone-handling behaviors of Japanese and rhesus macaques, Nahallage and Huffman observed a captive rhesus monkey troop for 368 h and found no instances of throwing, running and throwing, throwing and swaying, and jumping and throwing. 84 J's behavior clearly falls into at least some of these categories, as can be seen in the video.

The present report describes the spontaneous onset of an innovative, foraging behavior in a single individual. Given the functional significance of this foraging behavior, exploration of why this technique has yet to spread and the mechanisms by which it might spread merits further systematic investigation.

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Fig 1.

Image of the dock (a) on Cayo Santiago (courtesy of GoogleMaps). The circles on the map indicate those areas where monkey 84J was presented coconuts (b) and the square shows where he has been documented exploiting the cement structure of the dock and surrounding rocks to crack open the fruit's hard shell (c).