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Report

Primates Take Weather into Account when Searching for Fruits

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Summary

Temperature and solar radiation are known to influence maturation of fruits and insect larvae inside them [1–8]. We investigated whether gray-cheeked mangabeys (*Lophocebus albigena johnstonii*) of Kibale Forest, Uganda, take these weather variables into account when searching for ripe figs or unripe figs containing insect larvae. We predicted that monkeys would be more likely to revisit a tree with fruit after several days of warm and sunny weather compared to a cooler and more cloudy period. We preselected 80 target fig trees and monitored whether they contained ripe, unripe, or no fruit. We followed one habituated monkey group from dawn to dusk for three continuous observation periods totalling 210 days. Whenever the group came within a 100 m circle of a previously visited target tree for a second time, we noted whether or not individuals proceeded to the trunk, i.e., whether they "revisited" or simply "bypassed" the tree. We found that average daily maximum temperature was significantly higher for days preceding revisits than bypasses. The probability of a revisit was additionally influenced by solar radiation experienced on the day of reapproach. These effects were found only for trees that carried fruit at the previous visit but not for trees that had carried none. We concluded that these nonhuman primates were capable of taking into account past weather conditions when searching for food. We discuss the implication of these findings for theories of primate cognitive evolution.

Results and Discussion

Weather variables, such as temperature and solar radiation, are known to influence the ripening rates and growth of fruit [1–6, 8]. Temperature can also affect the development of larvae that are extracted by primates from infested fruit [7, 9]. We investigated whether gray-cheeked mangabeys (*Lophocebus albigena johnstonii*) of Kibale National Park, Uganda, take temperature and solar radiation into account when searching for figs. We predicted that monkeys would be more likely to revisit trees in which they had previously found fruits after a period of sunny and warm days, compared to after a cooler period with overcast skies.

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We studied the ranging pattern of an observer-habituated monkey group in relation to a large number of preselected *Ficus* trees (n = 80) throughout the group's home range. Data collection began as soon as the group entered a critical 100 m radius circle around a target tree and proceeded to the trunk. We then determined whether or not the tree carried fruit. As soon as the group reentered the same circle for a second time, usually a few days later, we noted whether or not individuals proceeded to the trunk, i.e., whether they "revisited" or simply "bypassed" the tree (Figure 1).

The purpose of this study was to investigate whether the likelihood of revisiting or bypassing a target tree was related to the weather conditions experienced during the period since the previous visit. We thus determined the average daily temperature (maximum and minimum) and solar radiation (% high-level radiation) for the time interval between each visit and successive revisit/bypass. We expected averages to be higher during periods prior to revisits than bypasses, but only for trees that carried fruit at the previous visit.

Revisiting Is Influenced by Weather

The average maximum daily temperature was significantly higher when the group revisited than when it bypassed a tree. This was true only for trees that carried fruit during the group's previous visit (with fruit: U = 5476.0, $n_{revisit} = 143$, $n_{bypass} = 91$, p = 0.041; without fruit: U = 2107.5, $n_r = 49$, $n_b = 92$, p = 0.526; Figure 2). Logistic regression analyses showed that the probability of revisiting a tree increased with increasing average maximum temperature for trees that carried fruit (chi-square = 3.938, p = 0.047, df = 1; $\beta = 0.121$, p = 0.050, df = 1; Figure 3). No significant relationships were found between the monkeys' foraging decisions and average daily minimum temperature measured at night (fruit: U = 5951.0, $n_r = 143$, $n_b = 91$, p = 0.271; no fruit: U = 2112.0, $n_r = 49$, $n_b = 92$, p = 0.539).

We also investigated whether the mangabeys returned earlier to a fruit-bearing target tree after warm periods compared to cooler ones. We found a negative relationship between the average maximum temperatures and the number of days between a current and previous visit (n = 74; $r_s = -0.260$, p = 0.025), but only for trees that had particularly high fruit cover of at least 25% during the previous visit. Trees with such large amounts of fruit were unlikely to be depleted at the day of reapproach. If all trees were included, the relationship was no longer significant ($r_s = -0.09$, p = 0.171, n = 231).

For the third data collection period (n = 100 days), we additionally measured solar radiation. This second weather variable also influenced the monkeys' revisiting behavior but effects were weaker. The average daily percentage of high-level radiation tended to be higher for revisits than for bypasses, but only for trees that carried fruit at the previous visit (fruit: U = 1735.5, $n_r = 93$, $n_b = 46$, p = 0.071; no fruit: U = 642.5, $n_r = 23$, $n_b = 57$, p = 0.890; Figure 4). Additional logistic regression analyses

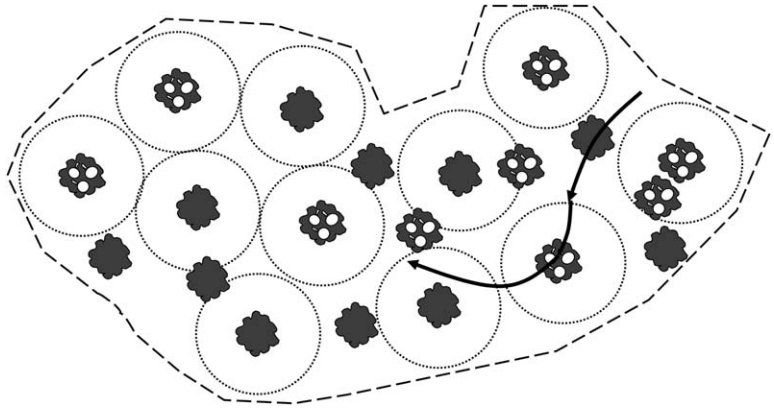

Figure 1. Measuring Revisiting Behavior

The diagram illustrates an example of part of the study group's daily route (arrows) among target trees, each surrounded by an imaginary 100 m radius circle (dotted line). Once the group entered the circle, one observer rushed to the tree to determine the fruiting state and whether the group came into sight and entered the tree. In this example, the group visited one tree with fruit and bypassed one without fruit.

did not reveal a significant relationship (chi-square = 0.28, p = 0.597, df = 1; p = 0.596, df = 1). There was no correlation between the length of the revisit interval and the average percentage of high-level radiation (all fruit-carrying trees: $r_s = -0.09$, p = 0.321, n = 133; trees with >25% fruit cover: $r_s = -0.223$, p = 0.136, n = 46).

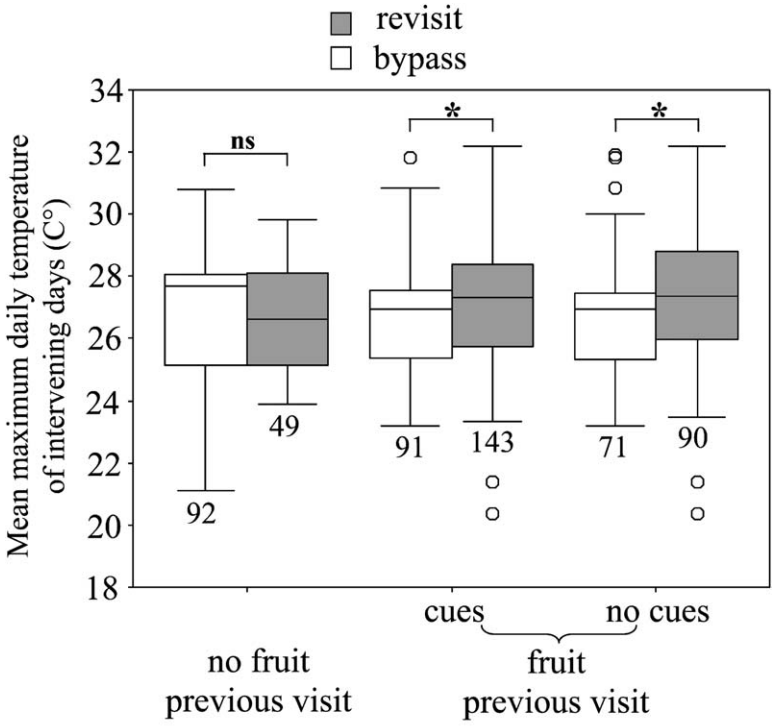

Figure 2. The Influence of Temperature on Revisiting Behavior

Average daily maximum temperature determined for the intervening period between the time the group entered the 100 m radius circle and the time the group last visited the same tree. Shaded boxes represent average temperature values for revisits; white boxes represent bypasses. Different clusters refer to trees that (1) did not carry fruit at the previous visit, (2) carried fruit at the previous visit, and (3) carried fruit at the previous visit but no longer offered any sensory cues. Bars represent the median values of the average temperatures; top and bottom of the boxes represent the 75 and 25 percentiles. Whiskers represent highest and lowest values; circles represent outliers.