Testing Simple Rules for Human Foraging in Patchy Environments

Andreas Wilke (wilke@mpib-berlin.mpg.de)
International Max Planck Research School LIFE, Max Planck Institute for Human Development
Lentzeallee 94, 14195 Berlin, Germany

John M. C. Hutchinson (hutch@mpib-berlin.mpg.de)
Center for Adaptive Behavior and Cognition, Max Planck Institute for Human Development
Lentzeallee 94, 14195 Berlin, Germany

Peter M. Todd (ptodd@mpib-berlin.mpg.de)
Center for Adaptive Behavior and Cognition, Max Planck Institute for Human Development
Lentzeallee 94, 14195 Berlin, Germany

Background

Food in a natural environment is often distributed in patches, spots of higher resource abundance than in the surrounding area. For an animal or human searching on the sea shore, each patch might be a rock pool. Models of animal foraging have considered the situation where such patches vary in their initial quality (return rates), where this may be hard to judge because food items are hidden, and where foraging progressively depletes the resource. As animals learn about and simultaneously deplete a patch they should eventually decide to move because greater success is expected elsewhere.

The optimal strategy in such a situation is given by the *Marginal Value Theorem* (MVT): leave a patch when the instantaneous rate of return falls below the long-term return rate in the whole environment when following the optimal policy (Charnov, 1976). However, the MVT does not offer a mechanistic solution if mean return rate in the environment is not known and if foraging is a succession of discrete events in which items are encountered stochastically (McNamara, 1982). Behavioural ecologists have both derived optimal departure rules in these circumstances and investigated the performance of sub-optimal rules of thumb (such as giving up after a constant time) which may be computationally simpler (Iwasa, Higashi & Yamamura, 1981; Green, 1984; Bell, 1991). Which rules perform well depends on whether patches are evenly dispersed in quality or some are very good and the others very poor. In the former environment finding an item should decrease the tendency to stay, whereas in the latter the opposite is true. This theory indeed explains why related species of insect utilising differently dispersed resources use different rules.

Hypotheses

We propose that humans also should be adapted to decide when to give up on one food patch and move to another, and that they may apply similar simple heuristics as animals have been shown to use. But because humans are intelligent generalists, feeding on some foods which are evenly dispersed across patches and on some which are aggregated in a few better patches, we further predict that humans are sensitive to this aspect of our environment and are able to adapt our heuristics accordingly. Additionally we propose that the patch-leaving heuristics that we use in foraging tasks are also used to decide when to give up on other tasks. We have designed two computerised experiments to test these hypotheses.

Methods

External search: the fishing task

Participants are given a virtual landscape in which they have to monitor ponds (i.e. patches), forage for fish and decide on how long to stay at each pond. All ponds appear equal, but the number of fish in each varies. Each participant experiences either a dispersed, aggregated or Poisson distribution of fishes per patch, and we will also vary the mean travel time between ponds. The probability of finding a fish is proportional to the number left in the pond. Participants see only the number of fish caught at the current pond (and must judge times and rates without reference to a clock). They receive payment at the end depending on the total number of fish caught at all ponds in a fixed time.

Internal search: the word puzzle task

Participants are presented with a modified anagram task in which they search for words from memory. Meaningful words must be generated out of meaningless sequences of letters. Analogously to the first task, participants experience one of three types of patch quality distribution, must decide when to switch to the next sequence, and are paid by their overall success. We attempt to match the environmental parameters in these two tasks as closely as possible.

References

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