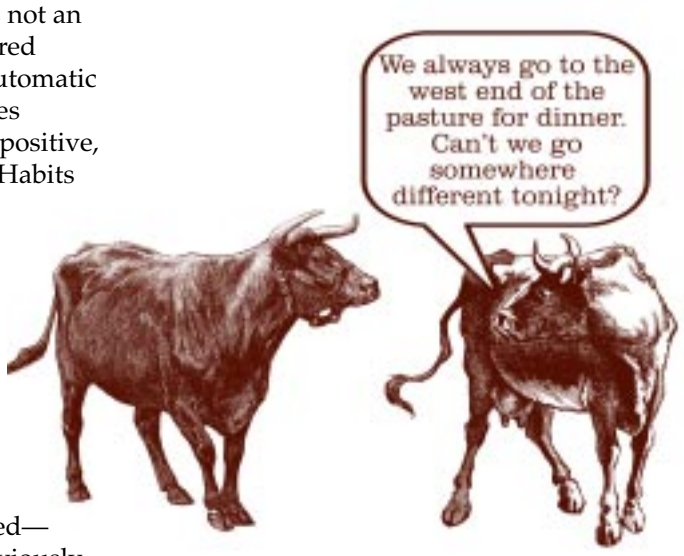
The Dilemma

All animals are creatures of habit. As Aristotle said, "We are what we repeatedly do. Excellence, then is not an act, but a habit." Habits are patterns of acquired behavior that have been repeated so often they are automatic and thus difficult to break. Behaving by consequences ensures habits; if the consequences of a behavior are positive, the likelihood of the behavior reoccurring increases. Habits add an element of predictability to an unpredictable world. They also increase efficiency.



The drawback to habit is that as the world changes, individuals must change or risk becoming obsolete. In the case of foraging behavior, as a result of selecting particular foods and foraging in specific locations, the responses of adults can become rigid to the point that habit is nature. There are two ways to escape this self-balancing feedback loop: changes within the animal that cause the creature to be satiated—get sick and tired—by the behavior, as discussed previously, or changes in social and physical environments that alter set patterns of behavior, as discussed in what follows.

If it ain't broke don't fix it

If variety adds spice to life, then what is the dilemma? The dilemma arises because habit can inhibit exploring new possibilities. Thus, an ongoing tension arises between curiosity about things new and different and a suspicion of them. From the standpoint of foraging, when nutritional and physiological conditions are adequate, familiarity breeds content and novelty breeds contempt.

As Aristotle said, "We are what we repeatedly do. Excellence, then is not an act, but a habit."

Well-fed animals are cautious of new things—that is they are neophobic. Mature animals typically eat small amounts of novel foods. They gradually increase intake of new foods if the foods are nutritious. Young animals also are neophobic, even while learning to forage with mother, but they are less neophobic than older animals. Declines in intake for young and mature animals alike are most dramatic when they are moved to novel environments and are offered novel foods. Sheep in unfamiliar environments prefer familiar to novel foods, even if the familiar foods previously have caused toxicosis. Cautious sampling of novel foods helps herbivores survive in a world where most foods contain toxins.

If animals never experience the effects of toxins, neophobia decreases to a small degree. Lambs are less neophobic when they are repeatedly offered only nutritious novel foods. However, lambs become markedly more neophobic when they experience toxicosis after eating novel foods.

File Photo

Young animals are neophobic (cautious of the unfamiliar), even while learning to forage with mother, but they are less neophobic than older animals. Lambs are less neophobic when they are repeatedly offered only nutritious novel foods. However, they become markedly more neophobic when they experience toxicosis after eating novel foods.

Neophobia also occurs with social interactions and habitat selection. Many herbivores—goats, sheep, cattle, deer, elk, moose, bison—live in subgroups of individuals that show fidelity to one another and to particular home ranges. They prefer to forage with companions on preferred foods in familiar locations. When subgroups of sheep with different food preferences forage in areas where preferred foods are distributed in patches, sheep reared together typically forage in the same locations on different foods, while sheep not reared together forage in different locations on preferred foods.

Necessity is the mother of invention

As discussed previously, animals satiate on familiarity, which is one mechanism that causes them to investigate the unfamiliar. They also are likely to change behaviors under risky survival conditions. The tendency to "explore" options that may or may not pay off is higher in animals that are nutritionally deficient than in those nutritionally satisfied. They eagerly sample new foods and habitats—that is they become neophyllic. As resources become scarce and nutritional conditions inadequate, familiarity breeds contempt and novelty breeds content.

Creatures begin exploring new options when conditions for survival depend on change. For example, lambs fed a basal diet inadequate in energy or protein readily eat novel foods, while lambs fed a basal diet adequate in energy and protein are neophobic. Sheep, goats, cattle, and many wild herbivores range more extensively in the late dry season than in the early and middle wet seasons, when food supplies are abundant and high in nutritional quality. When the going gets tough, survivors seek greener pastures. When forced to search for food, animals eat unfamiliar foods and move to unfamiliar terrain despite the hazards.

Fred Provenza

These elk are part of a small herd that come down from the hills every morning to their preferred breakfast location—the lawns of Mammoth Hot Springs Visitor Center in Yellowstone National Park.

As resources become scarce and nutritional conditions inadequate, familiarity breeds contempt and novelty breeds content.

Bob Nichols, USDA Natural Resource Conservation Service.

NRCS conservationist and farmer discuss pasture managment practices. It is important to take into account nutritional fluctuations in forage throughout the year. When resources get scarce, animals will seek out new, possibly dangerous foods.

Courtesy of Mick Holder

Mick Holder examines elk damage to desert vegetation on his ranch in southern Arizona.

The hazards of exploring new environments

Ignorance of behavior can be devastating. Mick Holder, a rancher in Arizona, writes, "Gila County is mercifully deficient in poisonous plants, but we have lupine and loco in small or moderate stands. In 30 years of ranching, I never had a problem with either. I leased rangeland in Apache County and moved a portion of my cattle to that location during a drought period and suffered severe losses to poisonous plants, while the sister cattle left here in Gila County on equally poor rangeland did not have one case of loco or lupine poisoning. Did they not recognize the plants because they had been relocated 100 miles east?"

It may seem strange, but animals prefer familiar to unfamiliar foods, even if the familiar foods are toxic, and this response is especially pronounced in unfamiliar environments. Cattle in Gila County preferred familiar, toxic foods to unfamiliar foods. Providing animals with familiar, nutritious foods while they are adapting to unfamiliar environments can mean the difference between life and death. Holder concluded that "The only plausible explanation I would make after reading your paper is that moving cattle to Apache County suspended their aversions to familiar plants—loco and lupine—due to the unfamiliar settings or the lack of diversity of browse found in the Pinyon-Juniper habitat . . . . [a] painful lesson for us both."

Fred Provenza

There also is evidence that the same dose of a toxin has a much greater effect in an unfamiliar environment compared to a familiar one. The added stress heightens the toxin's action on the animal, likely by diminishing the effectiveness of detoxification processes, much as stress suppresses immune responses. Thus, cattle may have ingested amounts of toxic plants that were sublethal in the familiar environment but lethal in the unfamiliar environment.

Correcting nutritional deficits

There has been a longstanding debate over the ability of animals to balance their diets nutritionally. Some contend herbivores are unable to prevent nutrient imbalances; others claim they innately recognize nutrients in foods. There is little evidence to support either position. However, there is ample evidence that animals forage to correct nutritional imbalances and deficiencies.

Animals acquire aversions to nutrient-deficient diets. The reduced preference for the familiar diet depends on the severity of the deficiency. Aversions cause animals to sample other familiar foods or to sample novel foods. If the consequences of eating the novel foods are positive—they help to rectify the deficit—animals acquire a preference for the new foods and forage in the new locations. This "aversion-sample-preference" sequence helps animals to maintain nutrient balance, and it is a manifestation of the satiety hypothesis.

File Photo

There is evidence that animals forage to correct deficiencies.

A decrease in preference for familiar over novel foods is the primary behavioral manifestation of a nutritional deficiency. For example, cattle, sheep, and goats deficient in phosphorus decrease intake of the familiar diet and increase their intake of novel alternatives including soil, bones, and rabbits. Lambs deficient in essential amino acids acquire strong aversions to the food(s) they were eating during the deficiency and acquire preferences for foods that rectify the deficits.

This combination of behaviors—aversion-sample-preference—may emerge in strange ways when animals are foraging on rangelands. The shrub blackbrush, for example, is deficient in macronutrients. Several years ago during a winter-grazing study, we confined Angora goats in groups of 11 goats to 6 adjacent blackbrush pastures. As the study progressed, goats became increasingly averse to blackbrush. In one pasture they began to eat woodrat houses. Goats acquired a preference for woodrat houses because chambers inside the dwellings contained a "cake" of urine-soaked (nitrogen-rich) vegetation that helped them to rectify their macronutrient deficit. By the end of the study, goats that ate woodrat houses had lost an average of 12% of body weight. Groups that had not discovered woodrat houses as a source of macronutrients had lost 20% of body weight.

Fred Provenza

All it took was one goat to discover that this woodrat house (above) provides a good source of nitrogen and other goats followed, which helped to rectify their macronutrient deficiency. Below, Angora goats graze amidst blackbrush.

Fred Provenza

The carnivorous herbivore

Animals sometimes engage in strange behaviors. In the case of foraging, cattle eat the flesh and bones of rabbits, deer eat antlers, goats eat woodrat houses, and bighorn sheep eat rodent middens. Various wild (caribou, red deer, white-tailed deer, bighorn sheep) and domestic (cattle, sheep, goats) herbivores eat other mammals (lemmings), birds (arctic terns, ptarmigan eggs), and fish. Livestock lick urine patches of rabbits and humans, chew wood, consume soil, and eat fecal pellets of rabbits. Why do herbivores eat these strange foods?

M. F. Wallis de Vries

A few cards short of a full deck or just short on nutrients? A nutrient deficiency caused this cow to exhibit the strange behavior of consuming rabbits.

Conventional wisdom says they're bored, but that doesn't fit with the finding that well-fed animals equally bored avoid eating strange foods. Herbivores deficient in nutrients acquire aversions to familiar foods. In essence, the deficiency "makes them

continued on next page. . .

The carnivorous herbivore continued. . .


File Photo

sick" and they associate the illness with the familiar diet. In turn, they readily sample novel foods.

We once reared a group of lambs deficient in minerals. Their intake of the familiar diet began to decline, so we offered them another diet. Their intake of the new diet was high at first, but then declined. This pattern was repeated until we realized that they were deficient in minerals. Once we corrected the deficiency, intake of the basal diet and performance returned to formerly high levels. Cyclic patterns of intake are typical when animals are deficient in nutrients. They acquire an aversion to the familiar food and readily sample novel foods. When animals eat strange foods or when they spend inordinate time foraging, it indicates unmet nutritional needs.


File Photo

The question often arises as to the value of cafeteria-style mineral feeders. Strong scientific evidence shows that ruminants respond to excesses and deficits of energy, protein, sodium, phosphorus, and sulfur, and it is possible that they respond similarly to a broader array of minerals. Low concentrations of minerals limit intake, intermediate concentrations increase intake, and excessive amounts decrease intake. There are many anecdotal reports of animals in confinement, on pasture, and on rangelands selecting different minerals depending on their individual nutritional state and the chemical characteristics of the forage. Producers also report that ruminants decrease intake of specific minerals in free-choice feeders when those minerals are fed in confinement. For now, however, there is little scientific evidence to support or refute the contention. Carefully controlled studies that consider interactions between mineral nutrition and behavior are urgently needed.

Cycles of behavior

Behavior, then, can be viewed as an ongoing dynamic that involves interactions between the familiar and the unfamiliar in two interacting feedback loops. (1) Satiety-Variety-Familiarity Loop: Experiences early in life cause preferences for foods and habitats; they are the origin of habits and the reason animals are reluctant to explore unfamiliar foods and habitats. Satiating on the same foods encourages animals to eat a variety of different familiar foods and to forage in various familiar locations.
(2) Aversion-Sample-Unfamiliarity Loop: If familiar foods and haunts become inadequate, animals investigate new options; old habits die and new habits are born. If they encounter suitable foods and habitats, they acquire preferences anew and move back into the satiety-variety-familiarity loop but with a broader repertoire of experiences.