Foraging as a Behavior Modification Tool

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Feather destructive behaviors (FDB), also known as psychogenic feather picking, and stereotypic behaviours are commonly encountered in pet psittacine birds. Recently, the use of foraging has been suggested as a means to manage FDB and stereotypies in psittacine species. This discussion looks at the application of foraging in a practical setting. The pros and cons of a proposed foraging model are evaluated by both the author and bird-owning clients. Tool use in birds is also explored. While the focus of this presentation is on foraging, the author wishes to reinforce that FDB are complex and are rarely 'cured' with one modality of treatment.

Foraging as a Natural Behaviour

Self-destructive and stereotypical behaviour problems are prevalent in captive bred birds, especially psittacine species. Some of the most troublesome of these aberrant behaviours are feather picking/destruction and self-mutilation. It has been suggested that 1 in 10 captive parrot species develop psychogenic feather picking behaviour.[1] Similar behaviours termed 'self-injurious behaviour' (SIB) have been recognised and studied in primates and have been compared to those noted in birds (feather damaging behaviour or FDB).[2, 3] The author strongly encourages the reader to review those comparisons made by Drs. Orosz and Delaney between SIB in primates and FDB in birds.[2] Stereotypies are abnormal repetitive behaviours that most commonly develop in animals kept in enrichment deficient environments and are also described in pet birds.[4]

Foraging likely represents a natural behaviour of wild birds and other animals. Foraging is simply the act of searching for and finding food. Based on field studies, it appears that many avian species spend the majority (> 50%) of their daily activity foraging and feeding.[5] As a generalization, parrots actively feed in the morning and the evening.[5] Because foraging occupies a significant portion of a bird's daily activity, it likely has social and behavioural importance. Meehan et al has stated that 'foraging is one of the most severely constrained classes of behaviour in captive parrots', which leads one to consider the potential implications of this common behavioural deficit on bird welfare.[1]

Interestingly, captive orange-winged Amazon parrots (*Amazona amazonica*) monitored remotely using video camera were noted to demonstrate behaviours associated with grooming (such as 'preen self') primarily in the morning and evening. These birds had 'a complete diet at arm's length' and were noted to ingest food about 3 to 6 minutes per hour throughout the day (for a total of 30-72 minutes per day). The observers noted that for a 'huge amount of time', the birds were 'inactive'.[6] This is in contrast to wild parrots that are reported to actively forage for significantly longer times such the Puerto Rican Amazon parrot (*Amazona vittata*) that spends an average of 4 to 6 hours a day foraging for food.[1]

Numerous studies have been conducted on the behavioural aspects of foraging in wild birds. Foraging behaviour in wild birds represents a trade-off between the risk of predation (while busy searching for food) and the benefit of energy gain.[7] This statement suggests that birds must forage optimally in effort to reduce their risks. However this does not suggest a bird will simply eat rapidly, deplete a food source and leave.

For example, studied wild type fowl demonstrated a more costly foraging strategy by moving more between patches of food without ingesting more feed than domestic fowl. Also the birds would leave a patch of food before it became depleted to seek out another patch. This was interpreted as a survival strategy by the wild type birds (keeping longer distances between food patches, not depleting food so that the bird could find another food source and return if needed and possibly keeping more alert by staying more vigilant and spending less time eating at any one location).[7] Mallard ducks (*Anas platyrhynchos*) will deplete food patches in shallow water (even if less food is available) before foraging in deep water.[8] Deep water foragers have their eyes underwater and are presumably at greater risk of predation than those in shallow water that can better observe their above water environment.[8] Studied wild-caught captive chaffinches (*Fringilla coelebs*) with higher peck rates were considered better foragers and also better detectors of predators simply because the birds had more 'head up' time and were more vigilant.[9] Lesser spotted woodpeckers (*Dendrocopos minor*) were noted to feed more in the afternoon than morning and spend less time feeding with greater food availability.[7] This study implied that when enough food was present, the woodpeckers resorted to other non-feeding activities (such as nest excavation or sitting idle to reduce their predation risk and energy loss).[7]

Still other avian species use completely different foraging methods that help them adapt to their environment or physical limitations. Many Paridae species (tits and chickadees) gather seeds then hide them in many locations to be later retrieved in lean times. This storing of excess food in the environment rather than as fat is found in multiple animal species.[10] Black-capped chickadees (*Parus atricapillus*) and scrub jays (*Aphelocoma coerulescens*) have been shown to remember both where and what food they store with impressive accuracy. Many food storing avian species have a large hippocampal volume with size that increases the longer and more food a bird is capable of storing. These food storing capabilities have been equated with episodic memory, a cognitive feature previously thought to be exclusive to humans.[10] In preparation for migration, hummingbirds prefer to hold territories and limit their foraging bouts to less than a minute in effort to save and store fat while using fast burning carbohydrates.[11] This is very important for a species with metabolism so high that if it only used liver and muscle glycogen during flight, the bird would literally deplete its energy stores within several minutes.[11]

Many Antarctic procellariiforms (petrels, albatrosses and shearwaters) have large olfactory bulbs and are known to forage over thousands of kilometers finding patchily distributed food using sense of smell, visual cues and probably more complex social structures such as group feeding and sex differences.[12, 13] Other seabirds, such as the northern gannet (*Morus bassanus*) demonstrate sex-based differences in foraging such that the females are more selective in foraged sites, make longer and deeper dives and spend more time on the sea surface than males.[14]

Birds may forage differently in the presence of other avian species. Studied starlings foraged more slowly when in social, compared to solitary, food patches.[15] The starlings were more drawn to food patches with social groups and would hurry their foraging when away from the flock and slow down when close to it.[15] The specialist frugivorous tanager (*Spindalis portoricensis*) tracks fruit abundance by relying on the loud calls of the gregarious and omnivorous tanager (*Nesospingus speculiferus*) to locate new foraging areas. While the omnivorous tanager eats equal parts plant and animal, the specialist eats almost entirely plant material. When in the mixed flock, the frugivorous bird (*S. portoricensis*) will mimic the foraging behaviour of the ominivorous tanager to the point of 'testing' food items not normally in the specialist's diet. This appears to be a commensal relationship between the species.[15]

Foraging in wild birds may even play a role in competitive exclusion of some species. When compared to wild lands, urban habitat generally have less species diversity.[16] One study tested the hypothesis that some introduced species (such as the European starling [*Sturnus vulgaris*] and house sparrow [*Passer domesticus*] are more efficient foragers and are able to outcompete less efficient foragers (often native species) in urban versus wild areas. The study (conducted in an urban and wild desert location) pointed out that predation risks were higher in the wild environments. The subsequent reduced predation risk and higher resource abundance drove the increased density of birds in the urban environment but the more efficient urban foragers excluded the native species leading to decreased avian diversity. The end result is more birds but fewer species in the urban environment. This was attributed to the ability of the invasive urban specialists' ability to more effectively consume the available resources and force the less efficient wild land species out of the urban environment.[16]

A Brief Comment on Treating Fdb

While FDB are common, their causes are often complex as are their treatments. The author wishes to make it clear that many approaches to managing and/or treating FDB have been proposed and published elsewhere. Socialization, diet, underlying disease, environmental stressors and other causes may contribute to FDB and should be addressed when managing these abnormal behaviours. As noted below, strong correlations between foraging (or lack of foraging) and the development of FDB and other abnormal behaviours in birds. Foraging is presented as a tool to help manage selected abnormal behaviours in birds.

How Lack of Foraging May Affect Behaviour

The question then becomes 'if you remove the ability to perform a natural behaviour, how does that affect other behaviours?'. In very simple terms, the behaviours of birds can be divided into 3-4 categories. These include: foraging, socializing with other birds, grooming/self-preening and sleeping/resting. Although 'sleep/rest' may not be categorized as a 'behaviour' it likely represents an important aspect of a bird's health and may have behavioural implications. In a captive situation, several behaviours are likely disrupted, one of which being foraging. If for example, the ability to forage is removed that leaves 2 to 3 other behaviours: socializing with other birds, grooming/self-preening +/- sleep/rest. Looking even further at birds that are isolated and have limited contact with even humans (caged bird), this may leave grooming/self-preening and sleep/rest as the only 'natural behaviours' a bird can conduct.

The author is proposing the idea of behaviour displacement. When one behaviour is altered or abolished other behaviours become more emphasized. With this theory in mind, if a bird is denied one or more behaviours (ie: foraging, socialization) then the remaining behaviours (grooming/self-preening and sleeping/resting) and/or abnormal behaviours are emphasized. This is not to say that lack of foraging will lead to overzealous feather grooming, FDB or inactivity, but it may be a risk factor and component. Although many species differences exist and direct conclusions may not be made, feather picking is actually considered a 'redirected foraging behaviour' in chicks (*Gallus gallus domesticus*).[17]

At this time, the only identified non-medical risk factors associated with 'feather picking' in populations of psittacine birds have been limited to a.) being an African grey parrot (*Psittacus *erithacus*), b.) being female and c.) not displaying curiosity via play behaviours.[18] However, in domestic chicks (*Gallus gallus domesticus*) foraging activity has been inversely correlated with the rate of feather picking.[17, 19] Recently, Meehan et al demonstrated that by enriching the environment with appropriate foraging substrates and increasing physical complexity, psychogenic feather picking in young orange-winged Amazon parrots (*Amazona amazonica*) was both prevented and reduced.[1]

In Meehan et al's study with orange-winged Amazon parrots, both physical and foraging enrichments were used on test subjects.[1] The physical enrichments included alternate perching sites and moveable, climbing and swinging objects that were intended to increase the physical complexity of the cage. Foraging enrichments required the parrots to chew and sort through, manipulate and/or open objects to get to food and were intended to provide the parrots with an opportunity to perform some amount of work to retrieve the food. A control group received no enrichments. After 3 16-week periods, the control group began receiving enrichments and parrots from the enriched group were removed from the study. All birds were parent raised to weaning (18 weeks) and then moved to individual cages. Visual barriers were designed such that birds could only see the parrot in the adjacent cage but vocal contact was possible throughout a common room. A feather scoring system was developed to evaluate feather self-damage. The end results after the 48-week test were that the birds used foraging over physical enrichments and that feather scores significantly improved as a result of enrichment. The authors concluded that they 'strongly recommend that all populations of captive parrots be provided with a varied enrichment protocol designed to elicit foraging behaviours and enrichment interaction'.[1]

Psittacine species are not the only birds reported with feather destructive behaviours. In chickens, the inability to access substrates appropriate for dust bathing or foraging is highly correlated with feather picking in laying hens.[20] Furthermore, dust bathing in chickens is 'affected profoundly by both substrate type and the birds' previous exposure experience'. Chicks rarely dust bathe with straw but do so readily with shavings litter. If chicks are exposed to shavings for even 10 days at an early age they are significantly less likely to feather peck when housed on wire at a later age compared to chicks never exposed to shavings. However regardless of previous exposure, adult chickens housed on shavings showed more ground pecking and less feather pecking than did birds kept on wire. High stocking densities and compacted litter are significant risk factors for feather pecking in growing chickens and further supports the hypothesis that birds redirect pecking behaviour towards feathers in the absence or inaccessibility of appropriate substrate. Chickens may also increase feather pecking at 'point of lay'. Also, changing substrate after a bird has developed a preference for a particular substrate during the rearing phase can precipitate feather pecking.[20] In chickens, genetic predisposition has been shown to influence foraging behaviour and the development of feather picking. [21] Genetic predisposition for feather destructive behaviours brings up an even greater concern in the psittacine population as 'feather pluckers' deemed unsuitable for pet homes may be instead placed in breeding situations.

Foraging studies in other avian species have shown additional support for foraging. While it may be assumed that a foraging bird would attempt to obtain food as efficiently as possible (in effort to reduce the risk of predation and maximize energy stores), both pigeons (*Columba livia*) and domestic fowl prefer to peck at a key to find grain rather than eat the same freely available food.[22, 23] Neuringer concluded that pigeons would prefer to peck at a disk many times to earn a food reward than simply eat freely available food.[24] Neuringer also stated 'responding for food, like playing and exploring, appears to be a natural part of the behaviour of animals and does not necessarily depend upon any prior motivating operations'.[23] In studied starlings, the birds chose to obtain a high percentage of mealworms by searching through covered holes rather than freely from a dish.[22] While the starlings would increasingly eat mealworms from the open dish, the birds obtained almost a quarter of their food from the covered holes even after 8 hours of starvation. As starvation progressed, the birds ate less hidden mealworms but it was clear that the starlings preferred to search the experimental holes.[22]

Stereotypic Behaviour

Meehan *et al.* published another paper describing the effects of environmental enrichment on cage stereotypy in orange-winged Amazon parrots.[4] Stereotypic behaviour is described as 'abnormal repetitive, unvarying, and functionless behaviours that are often performed by captive and domesticated animals housed in barren environments'. These behaviours resemble those noted in mentally handicapped, unmedicated chronic schizophrenic and autistic patients along with stereotypies induced by some neurologic lesions and amphetamines. While the cause is not completely understood, explanations of stereotypies have included 'captive environments where highly motivated behaviours are frustrated, functional goals are not attainable or behavioural competition is low'.[4]

The authors describe four distinct phases of behavioural change that characterize the development of stereotypic behaviours.[4] The first change is that the behaviours become more stereotypy-like and less variable over time and has been termed 'ritualization'. In the second phase, the stereotypic behaviours are elicited by a greater diversity of environmental stimuli and are termed 'emancipation'. Next, the stereotypies become 'established' and are fixed in the routine actions of the animal and remain unchanged even when the environment is modified. In the last phase called 'escalation', the stereotypies become more frequent and occupy a greater proportion of the bird's time.[4]

Meehan et al described two main forms of stereotypies in birds as oral and locomotor.[4] The authors further note that in the parrot colony source used in their study (described below), 96% of the birds perform locomotor and/or oral stereotypies and different individuals spend up to 85% of their active time performing these abnormal behaviours.

Locomotor stereotypies were described (direct quotes) as involving "the repetition of an identical pattern of movement. The pattern of foot and body movements is identical on each repetition of behaviour. This pattern had to be repeated two or more times for the bout of behaviour to be classified as a stereotypy".

"**Pacing**: The parrot walked back and forth across the perch, turning around upon reaching either end of the perch. Alternatively, the parrot faced the front of the cage and side stepped from one end of the perch to the other. Pacing can be performed along the entire length of the perch or just a few steps.

Perch Circles: The parrot walked the length of the perch, climbed up the sidewall of the cage, climbed across the top of the cage, down the opposite sidewall to the perch, completing a vertical circle across the top of cage and down sidewall.

Corner Flips: The parrot turned in small circles in a top corner of the cage.

Route Trace: The parrot walked and/or climbed a repeated identical route around the cage."

Oral stereotypies were described (direct quotes) as involving "the repetition of an identical pattern of oral movements. Oral stereotypies also may be performed in an identical location in the cage.

This pattern had to be repeated two or more times for the bout of behaviour to be classified as a stereotypy."

"**Wire Chewing**: The parrot gnawed repeatedly on the wire bars of the cage. While gnawing, individual parrots may pull violently on the wire, making a snapping sound. These movements involve identical body postures or identical locations within the cage.

Sham Chewing: The parrot made chewing movements with nothing in its mouth.

Food Manipulation: The parrot picked up a food item (usually a pellet) in the mouth. The food item is not chewed, but is instead turned around in the mouth repetitively.

Dribbling: The parrot dropped and picked up an object repeatedly- usually with the beak while on perch."

Additionally, avian studies suggest that oral stereotypies are related to limited foraging opportunities while locomotor stereotypies result from lack of space and physical complexity.[4]

The 64 week stereotypy study involved 16 orange-winged Amazon parrots, parent raised to 18 weeks old and then moved to individual cages allowing limited visual and full vocal contact between birds.[4] During the course of the study, a total of 12 foraging (items that required the birds to manipulate objects through holes, chew through barriers, open containers and sort through inedible material) and 12 physical (items that add physical complexity to the cage such as alternate perching sites, moveable objects and climbing/swinging opportunities) enrichments were used. However, only 4 foraging and 4 physical enrichments where used during each of the 3 16 week periods. Control (no enrichment) and test groups (enrichments) were set up. The control group birds were given a 16 week period of enrichments after the 3 16 week periods had ended. All parrots were observed remotely using a videotape.[4]

Meehan et al's findings were as follows.[4] In all tests, the foraging enrichments were used more frequently than the physical enrichments. In fact, the physical enrichments were often used to gain access to the foraging enrichments. The control birds developed significantly more stereotypies than the enriched birds during the 48 weeks. In fact, 8 of 8 control birds exhibited stereotypies by the 48th week accounting for 6-25% of their active time (67% was locomotor stereotypy and 33% oral stereotypy). In contrast, 4 of the 8 enriched birds demonstrated some stereotypy by the 48th week accounting for 4-10% of their active time (92% was locomotor stereotypy and 8% was oral stereotypy). When the control birds were introduced to enrichments for 16 weeks (after completing 48 weeks of no enrichments), the parrots performed significantly less stereotypy (especially towards the end of the study) and changed the types of stereotypies performed (90% locomotor stereotypies and 10% oral stereotypies).[4]

These and other findings (see Meehan et al's paper) make some important points. First, the degree of environmental enrichment used in this study did not eliminate the stereotypies but did significantly reduce the incidence of these abnormal behaviours in the enriched birds when compared to controls. Second, the stereotypies were primarily limited to locomotor stereotypies in the enriched birds suggesting that foraging enrichments provided may have significantly reduced the incidence of oral stereotypies. This also suggests that limited space, lack of flight, lack of social contact and other factors may have contributed to locomotor stereotypies. It has been shown in other avian species that lack of foraging opportunities is related to the development of oral stereotypies and locomotor stereotypies may result from lack of space and physical complexity. Third, this study shows that in these young parrots the stereotypies observed 'can be nearly completely prevented' by using an enrichment protocol that incorporates foraging and locomotor strategies. Last, the authors note that these were young bird that had not reached sexual maturity- which may have changed the outcome reported.[4]

More in-depth findings of the study (found in the paper) suggest that these abnormal behaviours follow 4 distinct stages.[4] First, an inception phase followed by an escalation phase occurs for stereotypy development. During resolution of the stereotypy, a reversal phase is followed by attenuation. The inception and reversal phases are silent while the escalation and attenuation phases are defined by significant behaviour changes. Meehan et al's study showed that the behaviour change during escalation took some time to develop (inception) and that once the stereotypies began to decline (once enrichment was provided to the control group), they did so at a rate similar to the rate of escalation (during the early phase of the control group). This suggests that declines in stereotypies are gradual with the introduction of enrichments. The 'reversal' phase is silent and precedes the significant decline in stereotypies (aka attenuation).[4]

Tool Use in Birds

While tool use has been reported in many animals, this advanced behaviour has been generally limited to primates, elephants and New Caledonian crows (*Corvus moneduloides*).[25] Tool use can be described as 'the external employment of an environmental object to alter more efficiently the form, position or condition of another object, another organism, or the user itself when it holds or carries the tool during or just prior to use and is responsible for the proper and effective orientation of the tool.' There are few reports of spontaneous tool use in parrots. A black palm cockatoo (*Probosciger aterrimus*) in New Guinea was noted using a piece of leaf as a wedge while feeding from kanary nuts (*Canarium commune*). Wild hyacinth macaws (*Anodorhynchus hyacinthinus*) were observed in the Pantanal using a piece of leaf wrapped around acuri fruit (*Schleea phalerata*) to allow the bird to strip the mesocarp off and prevent the nut from slipping.[25]

In a study using 4 juvenile domestic raised (separated from parents at hatch) and 2 wild caught adult hyacinth macaws, birds were given access to a variety of tools (pieces of wood, leaf, nutshells, fruit, vegetables, pellets, leg band, sand, feces, plastic, fabric and metal) and handed an indaia nut (*Attalea dubia*).[25] All birds used tools during nut manipulation. While tool use at some point resulted in successfully opening the nut in all cases, the birds could (12 out of 27 episodes) or not be using a tool when the actual opening occurred. Interestingly, the adults used only pieces of wood and leaves to manipulate the intact nuts. The juveniles used a large variety of tools to manipulate both encapsulated and non-encapsulated nuts. The high variability in tool choice used by juveniles may indicate play/exploratory behaviour and trial and error learning.[25]

While it can be argued that the adult hyacinth macaws learned this behaviour in the wild, the juveniles did not have the opportunity to watch and learn from the more experienced adults.[25] However, the younger juveniles may have socially learned from the older juveniles (not the parents). Woodpecker finches (*Cactospiza pallida*) have been shown to use tools but only if the tools and food are presented at a crucial learning period in their development. Exclusively by trial and error, the finches hone their tool use skills.[25]

Practical Applications of Foraging

The prelude above gives insight as to the value of foraging, but applying it to an individual bird situation can be challenging. The most obvious question is how to apply these principles in a practical private practice, zoo, rescue, or other setting.

The author has been working with owners of pet psittacine birds diagnosed with psychogenic feather picking. Psychogenic feather picking was diagnosed based on historical and physical examination findings and normal screening labwork (complete blood count, biochemistry panel, choana and cloacal aerobic cultures and fecal float, direct and gram stain; old world psittacine species were screened for psittacine beak and feather disease virus [PBFD] unless the bird originated from a PBFD screen negative closed aviary). Owners and their families, when appropriate, were advised of simple management steps in an attempt to reduce feather picking. These steps typically included, but were not limited to: socializing the bird to 'bird confident' people, increasing availability of toys, encouraging (providing positive feedback) play activity, keeping the bird below shoulder level, improving diet as needed and making a conscious effort to not encourage feather picking.

In addition to basic management changes, all owners were asked to incorporate foraging strategies into the bird's daily activities. When away from home, the owners were instructed to provide a small amount, if any, food in the bird's cage. When home the owners were instructed to place the bird on a separate 'foraging tree' away from the cage. Due to work schedules, some owners kept their birds in the cage throughout the day and were instructed to have all food hidden in foraging toys within the cage. Because some birds were not initially accepting of the idea, owners were asked to gradually introduce foraging until used as the main food source by the bird.

The 'foraging tree' was offered as an open design. Unless the bird was restricted to the cage, owners were instructed to provide foraging opportunities on a separate structure (the 'foraging tree') outside of the cage. Ideally the 'foraging tree' would provide multiple areas to climb and suspend toys and foraging devices. The tallest sections (or branch) were to be shorter in height than the owner's shoulder level. Some people modified existing stands, perches or cage materials, while others purchased commercially available bird tree stands and a few people made their own 'foraging tree'.

Owners were instructed to use foraging toys used on the 'foraging tree' and/or within the cage. The foraging toys required that the bird do some action in effort to retrieve food. Multiple different levels of difficulty could be found in the individual foraging toys. Some simple foraging toys were: crumpled paper with food inside, paper covering a food bowl, holes drilled through wood with food inserted and others. Intermediate level toys included: a piece of food tied to a rope and hung from a branch, food hidden in opaque containers with a simple cover, food hidden in see-through containers with a simple opening mechanism, and more. Advanced foraging toys included: puzzle toys filled with food, toys requiring the birds to untie knots and open latches to get to food, toys that were somewhat durable (such as untreated wood) that must be chewed apart to get to the food, and more.

Owners were individually questioned about the effectiveness of the foraging strategy. When possible, the author routinely performed recheck examination and queried the owners regarding positive and negative aspects of foraging. All owners were asked to complete a detailed questionnaire regarding multiple aspects of foraging and the effects on their own bird. The results of survey and outcome of the studied birds will be presented at the conference meeting.

Conclusion

Feather destructive behaviours and stereotypies are commonly seen in pet psittacine birds. Until recently with the help of environmental enrichment (specifically foraging), no management techniques have been proven beneficial when treating FDB's and stereotypies. Environmental enrichment for laboratory nonhuman primates is mandated by federal law as the value of enrichment (including foraging) has been clearly shown for this group of animals.[26] However, no such guidelines exist for pet birds and yet it has been suggested that 1 in 10 captive parrot species develop psychogenic feather picking behaviour.[1] Foraging represents a natural behaviour that may significantly improve the mental well-being of captive avian species.

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