CAPTIVE BIRD WELFARE AND ENRICHMENT (PARTS 3 AND 4)

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ABNORMAL REPETITIVE BEHAVIOURS (ARB'S)

Abnormal repetitive behaviours (ARB's) are simply defined as inappropriate, repetitive and unvarying behaviours in either motor pattern or goal (Garner, 2005). ARB's are further categorized into stereotypies and implusive/compulsive behaviours. **Stereotypies** are 'unvarying inappropriate repetition of a particular set of movements and/or body postures that lack any goal or function' (Garner, 2005). Classic stereotypies in birds include sham chewing and route traces in a cage.

Impulsive/compulsive behaviours are 'repetition of an inappropriate goal with variable flexible goal-directed behaviour' (Garner, 2005). Classic impulsive/compulsive behaviours in birds include feather damaging. The big difference is that each episode of feather damaging is goal directed and flexible. There is no goal or function with a route trace (stereotypy).

By taking what we know about human brain function, we may be able to apply this information to ARB's in birds. Human brain behaviour is divided between 2 systems. The first (**response selection system**) selects and sequences individual responses to immediately present internal (blood sugar) and external (visual) stimuli. The second **(goal selection system**) systems selects and sequences goals, attention to salient environmental features and plans based on internal abstract information and not set stimuli. This second set is termed 'cognitive-attentional set' (Garner, 2005).

The goal selection system primes and edits selections made by the response selection system. Further, the goal selection system makes more abstract decision while the response selection system initiates the actual movements. Response selection system is also responsible for subtle unconscious movements that are part of silent communication such as a smile when a person is happy or eye twitch when nervous.

The brain needs to function as a whole in effort for both systems to work properly. The response selection system is distributed across the basal ganglia motor system. Damage or dysfunction in these regions produce 'recurrent perseveration' abnormalities which equates to inappropriate repetition of responses. A human with damage in this system might be able to respond to a question appropriately but then repeats the answer when asked a similar but different question.

The goal selection system is distributed across the prefrontal corticostriatal loop. Damage here produces 'stuck-in-set-perseveration' abnormalities which results in inappropriately repeated cognitive-attentional sets (goals, plans, rules, etc) but the patient has normal flexible goal-directed responses. A human with injury to the goal selection system could likely correctly name the suit of different playing cards as they are turned over but would keep naming the suit when asked for card value. A patient with response selection deficits would likely repeat the name of the suit with each card on the first part of the test.

In humans, obsessive compulsive disorders and stereotypies are mutually exclusive behaviours and require different treatments. This is important simply because, in humans, management of obsessive compulsive disorders is different than that of stereotypies (Garner et al., 2003). This issue will be further addressed later.

Stereotypies are considered to result from recurrent perseveration (response selection system dysfunction) and impulsive/compulsive ARB's correlate with stuck-in-set perseveration. Animals also follow this type of brain-ARB classification.

In fact, stereotypies have been directly correlated with recurrent perseveration in studied blue tits (*Parus caeruleus*), marsh tits (*P palustris*) and parrots. Conversely, studied animal barbers (mostly mice) perform poorly on tasks compared with controls and severity of barbering correlates with stuck-in-set perseveration (Garner, 2005).

Evidence supports that ARB's in birds may have a similar, or even same, basis as that noted in humans and other animals- most notably brain dysfunction. By first recognizing stereotypical and/or impulsive/compulsive behaviours, we can work towards means to address the problem. Some birds may respond favorably to environmental changes alone, but the owners really need to be aware of the potential severity of these clinical signs.

STEREOTYPIC BEHAVIOUR

Stereotypic behaviour is described as 'abnormal repetitive, unvarying, and functionless behaviours that are often performed by captive and domesticated animals housed in barren environments'. For the most part, stereotypies are absent in the wild (Garner et al., 2003). 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 behavioral competition is low' (Meehan et al., 2004). It should be noted that not all stereotypies indicate abnormal brain function as environment alone has been shown to strongly correlate with stereotypical behaviour in many animals including birds (Garner, 2005).

There are scattered studies evaluating the effects of caged environments and stereotypies in birds. As is true with deprivation reared rats and primates, blue tits (*Parus caeruleus*) and marsh tits (*P palustris*) showing stereotypies perform poorly in tasks involving extinction learning (Garner et al., 2003). In Garner et al.'s study, wild caught blue tits housed for 3 years developed stereotypical route traces (ranging from 7-90% of active time between individuals). Extinction learning tests the animal's ability to stop a learned behaviour (such as pecking at a cue to get a food treat and then stopping when food treats are no longer delivered). In the experiment, a food reward was removed from a cue. The birds displaying high levels of stereotypy continued to peck at the cue (lack of extinction) while those showing little or no stereotypy stopped the behaviour. This supports that under these conditions, stereotypy was linked to perseveration as measured by a lack of extinction learning (Garner et al., 2003).

An additional experiment showed that marsh tits with stereotypies persisted with food caching with daily pilfering. Low-stereotypy birds reduced or stopped the amount of caching (normal response). This again supports the correlation between stereotypies and recurrent perseveration (the tendency towards inappropriate repetition of previous responses). The design of the trails also strongly supported the environmental (caging) as the main cause (Garner et al., 2003).

Few other studies describe stereotypies in birds, all seemingly related to captive conditions. Route-tracing has been noted in physical space restricted canaries (Garner et al., 2003). There are numerous reports of various stereotypies in the poultry literature. Hand-reared Hawaiian crows (*Corvus hawaiiensis*) raised in isolation show more stereotypies than birds raised with siblings (Garner et al., 2003). There are widespread reports of stereotypies in several zoo species, caged starlings and parid species kept in behavioral research (Garner et al., 2003).

Meehan et al described the effects of environmental enrichment on cage stereotypy in orange-winged Amazon parrots (Meehan et al., 2004). The authors describe four distinct phases of behavioral change that characterize the development of stereotypic behaviours (Meehan et al., 2004). 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 (Meehan et al., 2004).

Meehan et al. described two main forms of stereotypies in birds as oral and locomotor (Meehan et al., 2004). The authors further note that in the parrot colony source used in their study (described below), 96% of the birds performed 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:

'Locomotor stereotypies involve the repetition of and 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 the 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.'

The **oral stereotypies** were described (direct quotes) as:

'Oral stereotypies involve 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 (Meehan et al., 2004).

A 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 (Meehan et al., 2004). 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 enrichments (items that add physical complexity to the cage such as alternate perching sites, moveable objects and climbing/swinging opportunities) 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 (Meehan et al., 2004).

Meehan et al's findings were as follows (Meehan et al., 2004). In all tests, the foraging enrichments were used more frequently than the physical enrichments. 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. Eight 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) (Meehan et al., 2004).

These and other findings make 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. Garner points out that even when using environmental enrichments, stereotypies are noted to be difficult to cure with longer periods in captivity in some studied animals (Garner et al., 2003). 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 opportunity 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 birds that had not reached sexual maturity- which may have changed the outcome reported (Meehan et al., 2004).

More in-depth findings of the Meehan's study suggest that these abnormal behaviours follow 4 distinct stages (Meehan et al., 2004). 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) (Meehan et al., 2004).

Garner et al critically evaluated stereotypies in orange-winged Amazon parrots and compared results with those in studies humans with stereotypic behaviour (Garner et al., 2003). The study design was such that a psychiatric task was given to the parrots in a similar fashion as is used to diagnose stereotypy in autistic and schizophrenic patients. In essence, the task measured recurrent perseveration or the tendency to inappropriately repeat responses. The study results showed that stereotypy in caged parrots reflects a general disinhibition of the behavioral control mechanisms of the dorsal basal ganglia, just as with affected humans (Garner et al., 2003).

Several conclusions were drawn as a result of Garner et al's work (Garner et al., 2003). Animals that display stereotypies are of questionable use in neuroscience, behaviour and neuropharmacologic studies. By studying abnormal animals, including birds, we cannot necessarily assume the results pertain to a 'normal' population. Further, by raising animals in a barren environment to create 'standardization', researchers may be 'responsible for introducing unwanted variability and reducing external validity'.

The work supports that pharmacologic treatment (such as selective serotonin re-uptake inhibitors or SSRI's) of stereotypies in veterinary medicine may be inappropriate as these drugs are best aimed at managing obsessive-compulsive disorders. The use of such drugs may non-selectively suppress all behaviour by suppressing dopamine release, which is better known as 'Parkinsonism'. The end result is inactivity, not necessarily treatment of stereotypies. Treatment should be aimed at early intervention and providing appropriate environmental modification.

By understanding the animal's ethology, we can better identify environmental triggers and create rich and varied social and physical enrichment protocols to prevent or manage stereotypies. This creates opportunities to consider the natural behaviour of affected birds in developing preventative and treatment strategies.

Last, stereotypies may indicate frustration and poor psychological welfare in captive animals. By recognizing and addressing stereotypies, we have an opportunity to improve animal welfare (Garner et al., 2003).

Meehan's publications support that locomotor stereotypies (route trace) are related to a lack of physical space while oral stereotypies (sham chewing) relate to lack of foraging. By classifying the stereotypy, we can better target therapy to (hopefully) reduce the abnormal clinical signs. Length of time in captivity can be correlated with the degree of stereotypy. Depending on the degree, some animals may never completely eliminate the abnormal behaviour even with proper environmental enrichment. Also, the rate of development of the abnormal behaviour may parallel the rate of 'cure' assuming correct measures are in place to help the bird. Owners that understand these points may better tolerate a longer period of therapy and more readily follow your advice.

Garner's work also brings up the issue of how birds learn new (or don't learn, in the case of those with stereotypies) tasks. Birds with stereotypies may have difficulty learning new tasks even if the reward for completing an old task is eliminated (lack of proper extinction behaviour). Clinically, this may offer an explanation why some birds given a new task and reward (for example teaching a bird to forage) may have difficulty getting started. The bird may simply be in a loop it cannot easily get out of (and may be frustrated) as is described in humans with stereotypies. In other words, affected birds may know the correct choice, but continue to take the wrong action. This can be frustrating for owners as they want immediate results. Clinicians should work to help owners understand that birds with stereotypies may have difficulty learning a new task and to be patient.

Stereotypical behaviour is also a concern when assessing animal welfare. The presence of stereotypies is a symptom of behavioral dysfunction (implying compromise of normal function). The associated maladaptive behaviour (ie: inappropriate food caching when stores are frequently pilfered) and tendency to repeat previous unrewarding responses may lead to a novel form of frustration and may induce physical suffering and frustration of goal-directed behaviour. Stereotypies are 'often considered to indicate poor welfare' (Garner et al., 2003).

THE EFFECT OF ENVIRONMENT AND BEHAVIOUR ON STUDIES

Normal behaviour allows the animal to maintain homeostasis. When birds are placed in captive environments, homeostasis may be lost and abnormal behaviours may begin. Once uncharacteristic behaviours begin, the bird may express abnormal physiology.

As Garner has proposed, captive environments can affect experimental trials in the following ways: validity (using abnormal animals); reliability (changing interindividual variation by introducing abnormal animals); and replicability (altered type and number of individuals between labs) (Garner, 2005). Additionally, of those animals that perform abnormal behaviours, there can be significant variation in severity.

At least in chickens the environment can have a significant effect on behaviour and other health. Crowding prevents normal social behaviours and often results in feather picking, cannibalism, jostling and impaired gait in chickens (Overall and Dyer, 2005). In one study, temperature, season, humidity and ventilation accounted for an 84% variation in fecal cortisol in housed, commercial production chickens (Overall and Dyer, 2005). Chicks raised on plastic slotted floors from hatch had higher plasma corticosterone concentrations at 10 weeks of age compared to those raised on wood shavings litter.

The impact of animal well-being on research results has been fairly well studied in a variety of mammals. For example, the natural killer cell activity has been shown to be higher in the spleens of environmentally enriched mice compared to those coming from mice housed under standard (minimally enriched) conditions (Weed and Raber, 2005). Environmental enrichment functionally changed the outcome of the experiments in rats with focally induced brain ischaemia (Weed and Raber, 2005).

Abnormal repetitive behaviours in birds have been shown to involve the same neuropsychological mechanisms as ARB's in humans (Garner, 2005). Studied birds with stereotypies have been shown to have abnormal perseveration responses.

Again, perseveration involves a failure of behavioral control. Assuming other brain functions are normal, patients with perseveration can have normal cognition, will and knowledge. Humans with stereotypies and perseveration abnormalities, often select incorrect perseverative responses despite knowing the correct response (often leading to frustration) (Garner, 2005).

So, whether or not a stereotypy is related to physiologic differences that may affect other experiments, stereotypies will likely be a confounding factor in behavioral experiments. For example, marsh tits with high levels of stereotypy persisted with food storing when their sites were pilfered (normal response is to give up) while those with low levels of stereotypy did give up cashing (Garner, 2005).

The following behavioral tasks have been shown to be affected and correlated with stereotypies in parids and parrots: operant tasks, contrafreeloading and food store pilfering (Garner, 2005).

Wild caught garden warblers (*Sylvia borin*) have been shown to have higher food choice plasticity leading to higher nutrient intake compared to those captive reared (Schaefer et al., 2008). The study reported that 'hand-raised animals are often poor surrogates for testing the foraging behaviour of wild animals'. The authors based their conclusion on the theory that wild birds have much broader previous feeding experiences that made them quicker to adjust food choice to varying sugar intakes. Further, the wild or hand-raised status of the bird must be considered when interpreting results of a foraging study (Schaefer et al., 2008).

Weed and Raber state 'With regard to experimental repeatability, studies have demonstrated that using the same strain and species as in a previous experiment is not enough to guarantee that the animals currently used are the same physiologically and behaviorally as those utilized in the past. Therefore, the careful documentation and communication of both the inanimate and social environmental parameters under which an animal has been maintained are critical for the future repeatability of the experiment' (Weed and Raber, 2005).

Established, consistent and well documented enrichment protocols have the potential to reduce inter-individual and inter-laboratory variability by removing (or at least reducing) the range of variation introduced by abnormal physiology. This in turn can enhance experimental reliability and replicability (Garner, 2005).

As we carefully review and compare similar studies, it would be prudent to consider the environment and behaviour of the bird. Abnormal behaviours may alter results and many in ways we do not yet fully understand. This would require that researchers publishing studies accurately describe the environmental and behavioral circumstance of the birds used in the studies. The materials and methods description needs to go beyond stating the size the cage, day/light cycle and *ad libitum* food and water feeding.

Case studies will be presented during the lecture to help identify abnormal behaviours and devise foraging plans for captive birds.

CAPTIVE BIRD WELFARE AND ENRICHMENT (PART 4)

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IT'S ALL FUN AND GAMES UNTIL SOMEONE GETS HURT

Environmental enrichment can create dangers that should be considered. A simple example would be a bird that gets entangled in a toy. A rebound effect has been reported in primates where removal of the enrichment resulted in a return to baseline behavioral pathology (Weed and Raber, 2005). Also enrichment may serve to increase aggression among cage inhabitants possibly as the result of competition for a specific item.

There are numerous reports of adverse effects of enrichment in primates. Mild trauma, fractures and even death have been noted in rhesus monkey colonies after social enrichment efforts were instituted (Bayne, 2005). Intestinal foreign bodies (composed of enrichment items), elevated zinc levels (from chewing on galvanized cage wire), elevated cortisol levels (after exposure to new social stimuli) and reduced survivability to Simian Immunodeficiency virus (related to social disruptions) are also reported in primates (Bayne, 2005).

Reports of complications of enrichment have also been noted in other animal species. Conjunctival irritation from nesting material in nude mice and an oral (whiffle ball) foreign body becoming entrapped in a rabbits incisors have been noted (Bayne, 2005).

On the flipside, there are numerous reports that quantitatively evaluate the positive benefits of enrichments. These include (Bayne, 2005):

- increases in dendritic branching and spines, synaptic connections and size of neural cells in enriched rodents;
- reduced protein deficits in the brain of enriched mice;
- faster learning rates in enriched rats; aand
- greater cerebral weight, length and cortical depth in enriched rodents.

No quantitative negative effects of enrichment have been reported in birds, other than with aggression in poultry. However, there are many anecdotal accounts from pet bird owners attempting to increase enrichment opportunities that resulted in fractures, entanglements (especially with rope type toys), cagemate aggression and gastrointestinal foreign bodies.

When designing an enrichment protocol for an animal, consider the potential negative implications. For example, can this bird become injured by a particular toy? A common concern with parrots is whether or not they can break the enrichment item and ingest its parts.

The following are general guidelines when considering safe enrichment items for birds:

- If the item is constructed of synthetic components, use sturdy and large enough materials to prevent ingestion.

- For multiple birds in a cage, provide multiple enrichment devices to reduce item guarding and aggression.
- For birds fearful of new items, slowly introduce the enrichment to the bird's cage or the bird to the enrichment area as needed.
- Social enrichment may need to be carefully chaperoned until it is clear the birds can safely intermingle and there is an escape mechanism in case aggression occurs.

Devising an Enrichment Plan

Once the problem(s) has (have) been identified and the individual species biology is understood, you can develop a plan for enriching the bird's life. In terms of published primate enrichment protocols, programs vary but share two ideals. One is that programs are best designed and maintained when species-specific expertise is used. The other is that the people involved with setting the protocol include the principle investigator, animal care and use committee members, the veterinarian and animal care staff (Nelson and Mandrell, 2005).

While these ideals are established for research projects involving primates, the principles are sound and can be applied to many other situations. The first point about having species-specific expertise is vitally important with birds. Designing an enrichment protocol that is incompatible with the animals' behaviour, physical attributes or its existing environment may not only be fruitless but may also cause frustration and potential harm. Second, multiple people are involved with developing the protocol when considering a pet bird, aviary, zoo, wildlife park, etc just as is true with a primate study colony. The veterinarian must work within the means of the client and develop a follow-up protocol using support staff to ensure the enrichment program's success.

Another potential concern of lack of proper environmental enrichment is that the genetic structure of populations of animals exposed to these abnormal (captive) environments may shift favor to a more sedentary behaviour and reduced wariness as the population adapts (Newberry, 1995). This becomes a concern for animals in genetic conservation programs. Future reproductive success and overall survival should be enhanced by the proper availability of foraging and predator evasion at appropriate stages of development (Newberry, 1995).

The goals of the enrichment program are to be outlined so that all involved know what to do and expect. Common goals may include: 1.) increase behavioral diversity, 2) increase the number or range of normal behavioral patterns, 3.) reduce frequency of abnormal behaviours 4.) increase the animal's ability to cope with challenges in a more 'normal way', 5.) increase positive utilization of the environment (Nelson and Mandrell, 2005).

Further, several premises can be said about what enrichment should or should not do (Newberry, 1995; Nelson and Mandrell, 2005):

- Do no harm;
- Reduce distress in a measurable way;
- In terms of a study, it should enrich both the animal and the experiment;
- Should satisfy current guidelines (such as those laid out by IACUC);
- Should safeguard the animal's health and welfare; AND
- Should not burden the animal's caretakers, enrichment methods should be practical.

As reported by Newberry, a 'common shortcoming of attempts at environmental enrichment is the provision of toys, music or other stimuli having little functional relevance to the animals' (Newberry, 1995). 'Enrichment will fail if the environmental modifications have little functional significance to the animals, are not sufficiently focused to meet a specific goal, or are based on an incorrect hypothesis regarding the causation and mechanisms underlying a problem.' Newberry also notes if animals are unable to control their exposure to social and physical stimuli, the efforts will also be hindered. At least in research, the problems listed occur most often when enrichment is in the form of toys or music (Newberry, 1995).

Last, it is important to document strategies that work and build upon those successes. Behaviour is not static and as a result, enrichment programs tend to be in a constant state of evolution.

Foraging Enrichment

Contrary to other forms of enrichment, foraging enrichment may 'substantially promote species-typical behaviour and improve the well-being of captive primates' (Lutz and Novak, 2005). This appears to be true in birds as well. Although far more studies are needed to solidify this statement in birds.

Probably the main reason foraging promotes 'species-typical' behaviours is that birds and most other animals spend so much of their time in the wild searching for food. It is only 'natural' for birds to want to exploit their foraging tendencies even in captivity.

Foraging enrichment simply includes any means of food dispersion (either scattered through an environment or hidden in an object). Foraging devices can be highly variable but should depend in part on an enriched animal's skill level.

The addition of foraging devices and its effect on various laboratory animals, with the exception of birds, has been widely studied. Published benefits of foraging (of which there are many variables present) include increased locomotion, decreased inactivity, decreased interspecies aggression and decreased stereotypies (Lutz and Novak, 2005). Foraging has also been shown to decrease incompatible behaviours. For example pacing and back flipping decrease with foraging primates (Lutz and Novak, 2005). An animal cannot pace and flip and forage at the same time.

In addition to the studies with foraging enrichment and stereotypies in Amazon parrots, the effects of foraging on African grey parrots (*Psittacus erithacus*) with pterotillomania have been reported (Lumeij and Hommers, 2008). In the study, 18 pterotillomanic African grey parrots were divided into control and piper feeder foraging groups for 4 week crossover trials. The group with the pipe feeder significantly increased foraging time and feather score. The authors noted that 'each minute spent on foraging increases the odds of improvement of feather score with 1.8%'. The authors also concluded that feather picking and foraging were inversely related, pipe feeders are effective treatment strategies in clinical cases and that 'redirected foraging hypothesis might be an explanation for feather picking in parrots' (Lumeij and Hommers, 2008).

Physical Enrichment

Physical enrichment includes everything in the environment (toys, swings, ladders, mirrors, etc) to the environment as a whole (for example a large flying room). While lack of physical enrichments have been shown by Meehan to be related to locomotor stereotypies, there are relatively few studies investigating this form of enrichment in birds.

While we cannot directly correlate behaviour study results from other animals, we can at least learn about trends and apply that information to birds. In chimpanzees, novel and destructible objects are used more frequently than indestructible items (Bloomsmith and Else, 2005; Lutz and Novak, 2005). Pigs prefer enrichment devices that are chewable and deformable and the manipulatability, destructibility and chewability help sustain animal-material interaction (Kim et al., 2009). There are many other factors that play into toy usage including species of the animal, toy novelty, number of toys present, frequency of toy rotation, and single versus social housing (Lutz and Novak, 2005).

Anecdotally, this appears to be true in many captive bird species. The author has also noted that birds of many species experienced with toys become easily bored and require more frequent rotation to keep interested compared to those living in a relatively barren environment. For those birds with only one or two toys, the bird may be reluctant to play with a new item initially. However, these birds that learn to accept new items over a period of time may also become easily bored with toys.

Kim, et al devised a study that considered size, color and hardness of environmental enrichment cubes in orange-winged Amazon parrots (Kim et al., 2009). The basic design was such that 10 adult (4 to 5 years old) mixed sex (6 male and 4 female) and mixed raised (2 males and females were parent raised and the remainder were hand-raised) orange-winged Amazon parrots were housed in individual cages all kept in one room. Variably sized, colored and dense wood blocks and rawhide rectangles were suspended in the cages via a stainless tube and recording device that measured movement. As the bird interacted with the enrichment device, movement was recorded as a means to determine time the birds spent interacting with the studied object. The interactions were almost entirely associated with grasping/biting/manipulating the object using the bird's beak (Kim et al., 2009).

Kim's findings were as follows: Yellow cubes elicited greater use than natural, violet, red, blue, green or red ones and orange cubes were preferential to green and blue cubes. There was no effect on the colors used in a comparable trial with the rawhide rectangles. The smallest blocks (2.5 cm^3) were preferred over the larger blocks (3.8 and 5.1 cm^3). Finally, the birds preferred the softer (Douglas fir) blocks to the harder (birch/maple) versions of the same color. Kim's findings support that color, hardness, size and material are important factors when considering enrichment devices for orange-winged Amazon parrots (Kim et al., 2009). As a note of interest, Pepperberg reported that her famed African grey parrot, Alex, had difficulty distinguishing orange from red or yellow (Pepperberg, 2006). This observation only serves to note that color preferences and even vision may be different between parrot species.

Kim's study supports that long wavelength colors (yellow and orange) are preferred over others as these 'long wavelength colors' dominate in avian signaling. Red is also a long wavelength color but was not preferred over yellow in these OWA parrots. One possibility may be that OWA parrots are more naturally attracted to yellow colors as ripe yellow fruits are more common in the parrots' natural habitat. Also, seed predators, such as parrots, are known to visit orange and yellow fruit morphs more frequently than red versions (Kim et al., 2009). Color of enrichment devices should at least be considered when designing enrichment protocols.

The size of the cubes and attractiveness to the birds may be linked with how well the bird could manipulate and destroy the object. In Kim's study, the 2.5 cm^3 cubes fit in the parrots' beak making for easy manipulation (Kim et al., 2009). It is then possible that an object can be too large or too small for ideal manipulations and should be considered when designing toys for birds. Ideally, the toy should be able to be either held or ideally, fit in a bird's beak to allow for maximum and sustained bird-object interaction.

The presence of vertical panels has been shown to alter behaviour in broiler chickens (Cornetto and Estevez, 2001). In general, resting time increases and foraging time decreases in chickens kept in pens with panels. The authors theorized that the visual barriers (panels) decreased interactions with conspecifics or other disturbances allowing the birds to rest more. It was concluded that the provision of cover can have a positive impact on well-being, behaviour and possibly bird performance (Cornetto and Estevez, 2001).

Studies on toy use in laboratory primates give conflicting results as to whether abnormal behaviour is reduced (Lutz and Novak, 2005). No relationship has been found between toy use and decreased stereotypic behaviour in primates. One benefit reported is that toys may be incorporated into biting rituals redirecting the injury to the toy and not the primate (Lutz and Novak, 2005).

Clinical experience working with behaviorally abnormal birds also parallels reported findings in primates. However, this should not preclude the use of toys with birds. Rather, this may help us realize that other enrichment devices are likely more effective at 'treating' some abnormal behaviours in birds.

Sensory Enrichment

Sensory enrichment includes visual, auditory, olfactory or tactile enrichment. There are a variety of videos, music CD's and others items readily available to the bird owning public that may serve as sensory enrichment. Most of these items are intended to help teach birds to sing or say certain phrases. Anecdotal reports support that birds do respond (both positive and negative) to various sensory enrichment. The internet and YouTube have provided numerous videos showing birds dancing to various songs as an example.

Visual enrichment has been studied in primates and supports that primates do indeed prefer to watch slide and video shows (Lutz and Novak, 2005). Singly housed primates view more videotapes than those socially housed. Some primates have even shown preferences for specific types of videos and appear to discern social relationships when viewing video of matched species (Lutz and Novak, 2005).

Most studies show that when given the choice, captive primates will depress a lever for musical sounds (Lutz and Novak, 2005). The type of music or sound also plays a role on their selection, at least in primates (Lutz and Novak, 2005). Again, numerous anecdotal reports support that different birds have background sound preferences.

Classical music has been reported to reduce fearfulness (measured by increased feeding time and tonic immobility) in meat chickens (Cornetto and Estevez, 2001). Also improved body weight and feed conversion was obtained by the combination of an enrichment object and music (Gvaryahu et al., 1989; Cornetto and Estevez, 2001).

One word of caution is that habituation appears to be a drawback of some sensory enrichment (like mirrors and television) as is reported in chimpanzees (Bloomsmith and Else, 2005). Additionally, some birds may become visibly stressed with loud sounds, certain images, etc.

Occupational Enrichment

Occupational enrichment includes items that elicit activities including problem solving, learning, and choosing and controlling some feature in the bird's environment (Bloomsmith and Else, 2005). This is different from the use of puzzle foraging toys that do require problem solving. Rather these may include items that give birds choices about how they spend their time. Although it comes with certain risks, free flight in the house can fall into occupational enrichment. More specifically, providing switches that turn on and off electronics, moveable mirrors that allow a bird to see a different area or performing tricks for physical stimulation rewards can serve as occupational enrichment. Levels can be designed for birds, as is described in the primate literature that allow the bird to select a visual stimulus at will.

Social Enrichment

The most dynamic form of enrichment is social. Social enrichment is considered the 'most effective form of enrichment for primates' (Lutz and Novak, 2005). This could probably be said of most, if not all, captive social species.

Social enrichment includes direct and indirect social interactions between animals. Indirect includes seeing or hearing other animals. Direct includes cage mate pairing, social rooms with numerous animals and allowing contact through bars between cages.

Social compatibility is one of the biggest factors determining the success of this form of enrichment. Some animals just don't get along! Also, social compatibility is not static and changes over time. This is certainly true with pet birds too.

Studied socially housed primates show fewer stereotypic and other abnormal behaviours than those individually housed (Lutz and Novak, 2005). Extensive research on isolation rearing in primates has shown 'devastating effects on behaviour' (Lutz and Novak, 2005). Perhaps social enrichment is most important to young developing animals, including birds.

The cost:benefit of social enrichment should be considered in terms of the ability of the animal to perform 'species-specific' behaviours (which is likely high when compatible birds are housed together) versus the potential drawback (cagemate aggression). Anecdotal observations supports that social enriched birds tend to be more behaviorally sound. However, injuries resulting from social bird housing are fairly common. Injuries may be considered somewhat normal 'species-specific' behaviours.

CONCLUSION

Feather destructive behaviours and stereotypies are commonly seen in pet psittacines. Until recently with the help of environmental enrichment (especially foraging), no management techniques have been proven beneficial when treating FDB's and stereotypies. Environmental enrichment for laboratory nonhuman primates is mandated by US federal law as the value of enrichment (including foraging) has been clearly shown for this group of animals (Byron and Bodri, 2001). 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 (Meehan, et al., 2003).

Foraging enrichment represents a natural behaviour that may significantly improve the mental well-being of captive avian species. Social, environmental and other forms of enrichment may also be used to improve the lives of captive birds. Multi-modal enrichment protocols should be considered for all captive bird species.

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