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Assessment and Treatment of Feather Plucking in Sulphur-Crested Cockatoos *Cacatua galerita*

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Abstract: The objectives of this project were to reduce feather-plucking behaviour in a pair of sulphur-crested cockatoos (*Cacatua galerita*) and to find the underlying cause of the behaviour. The study was carried out via the application of a number of treatments which were chosen due to past research. These researches determined that the possible causes of feather-plucking are stress, boredom and lack of adequate socialisation. The treatments researchers used were medicine (Haloperidol), socialisation, training and feeding enrichment. The success of the treatments was verified by behavioural observations, feather-condition score and by corticosterone level testing of the parrots. Overall, the project was a success with the reducing of abnormal behaviours, improving of feather condition score and decreasing of corticosterone levels during the treatment period. The most successful treatment was the training sessions as they provided the parrot with much needed social attention as well as the mental stimulation that a clever animal such as a cockatoo requires. These results are significant as it helps to shed some light on the underlying causes of feather-plucking and how to reduce the behaviour. Parrot training is easily applicable to all captive parrots whether they are held in a zoo environment or kept in a household.

Key words: Cockatoos, socialisation, training, feeding, social attention

INTRODUCTION

Self-inflicting behaviour (also known as self-injurious behaviour and self-mutilation) is described as the deliberate harm of body tissue without intent of suicide (Favazza, 1998; Laye-Gindhu and Schonert-Reichl, 2005). It has been observed in many species of animals including mammals and birds. There are many different types of self-mutilating behaviours observed in animals. The most common examples are feather plucking, skin plucking, self-biting, head banging and wound scratching (Schaefer, 1970; Goldstein, 1989; Schroeder *et al*., 2001). Self-inflicting behaviours have been commonly observed in captivity, often alongside a range of other abnormalities including screaming, aggression and excessive fearfulness (Meehan and Mench, 2002).

In birds, self-inflicting behaviours manifests itself in the form of feather plucking which is a behavioural disorder that often occurs in captive parrots like *Psittacus erithacus* as well as in other birds (Van Zeeland *et al*., 2009). It has been estimated that this behaviour occurs in 10% of captive parrots (Grindlinger, 1991) and tends to occur in the wing skin fold, inner thighs and the breast (Harrison, 1986; Rosenthal, 1993). Feather picking, plucking and chewing are all regarded as abnormal behaviours (King, 1993).

There are many theories on the causative effects of feather-plucking. Schmid *et al*. (2005) suggested that past trauma could be the main cause of stress they also stated that the trauma endured by African grey parrots captured in the wild must be considerable. They mentioned that this trauma of capture has long-lasting effects and consequences on the behaviour of the parrots that leads to the development of phobic behaviour such as self-mutilation.

Lack of enrichment or environmental stimulation is also suggested to be a cause for feather-plucking (Mertens, 1997). This was supported by a study performed by Van Hoek and King (1997) on the Crimson-Bellied Conure (*Pyrrhura perlata perlata*). They explained that preening is a normal behaviour exhibited by birds however, over-preening and excessive self-grooming is a displacement activity leading to feather plucking. They concluded that the introduction of environmental enrichments led to a decrease in over-preening and feather-plucking behaviours.

Van Hoek and King (1997)'s research is supported by Lumeij and Hommers (2008). They studied the effects of

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feeding enrichment and feather-plucking in parrots. Their results revealed that the use of feeding enrichment increased feather condition score in the subject birds. They stated that the influence of foraging time on feather condition score was significant and explained that each hour spent on foraging multiplies the improvement of feather condition score with a factor 2.9. They concluded that redirected foraging hypothesis might be an explanation for feather-plucking in parrots and that an increase in foraging time may provide an effective treatment strategy for this behaviour disorder.

An alternate theory put forward to explain feather-plucking is the effect of breeding method on the abnormal behaviour. Kaleta (2003) carried out research which claims that stereotypical behaviour in caged parrots is often induced by hand-rearing and so is difficult to reduce. This differs from parent-reared birds that (Schmid *et al*., 2005) claimed are usually well-balanced birds which have learnt all of the specific behaviour patterns of the species.

This statement is supported by Schmid *et al.* (2005). They carried out a study to investigate how hand-reared, parent-reared and wild-caught African grey parrots (*Psittacus erithacus*) differed in their behaviour. Schmid *et al.* (2005) explained that hand-reared parrots chose a specific human being as a partner. This triggers frustration in the birds as human bonds cannot fully satisfy their social requirements. Because of this, hand-reared grey parrots are more prone to developing attention seeking behaviours such as feather plucking and other abnormal behaviours.

The research and studies carried out into the effects of rearing methods on feather-plucking were developed by Meehan *et al.* (2003) who stated that isolation from con-specifics may contribute to the development of abnormal behaviours such as feather-plucking. Psittacine birds are social animals that live in large numbers and those that are isolated tend to be under-stimulated (Levine, 1987). Meehan *et al.* (2003) also explained that this is because parrots in zoos are often housed singly in cages that eliminate or constrain social behaviour. This idea ties in with Schmid *et al.* (2005) which suggested that hand-rearing does not meet the social needs of the parrot thus leading to feather-plucking behaviour. Although, Meehan *et al.* (2003) who study showed that although no birds demonstrated feather-plucking, the birds housed singly did demonstrate over-preening behaviour which is associated with feather-plucking (Van Hoek and King, 1997). This suggests that birds housed individually rather than in groups have the potential of developing feather-plucking behaviour as they age.

Schmid *et al.* (2005) also stated that in wild-caught birds, the difficulties of adjusting to a new environment, forced bonds with humans, handling and housing are probably the cause of feather plucking. However, in other studies done by the researchers they concluded that housing, occupation, social interactions and health of the birds did not have an influence on feather plucking behaviours. It is therefore suggested that removal from the nest early leads to stereotypical behaviours such as feather-plucking due to maternal deprivation. The latter, suggests that intrinsic factors such as rearing history, breed, genotype and individual disposition may also determine whether or not an animal develops stereotypical and self-mutilating behaviours.

Though, the mechanisms remain unclear, another hypothesis that has been suggested is neurotransmitter deficiencies (Johnson, 1987). Positive results have been seen in 10 psittacine subjects through a clomipramine treatment as well as another trial where Doxepin was given to fewer subjects (Grindlinger, 1991; Johnson, 1987). However, the plucking resumed as soon as drug treatment was discontinued (Iglauer and Rasim, 1993) suggesting the use of pharmacological treatment seems to improve feather plucking only for a limited period of time. Side effects included sneezing, ataxia, lethargy and decrease in learning ability were observed during the treatment period (Mertens, 1997).

The purpose of this project was to reduce or completely eradicate the behaviour of feather-plucking in these parrots through the use of various treatments. These treatments were socialisation, training, oral medicine and feeding enrichments. The oral medication used was haloperidol which was discovered in 1958. This drug has been used to treat symptoms associated with schizophrenia, delirium and acute psychotic symptoms (Iglauer and Rasim, 1993). As a psychoactive drug this dopamine antagonist has been shown to modify behaviour and moods associated with birds in captive environments (Davis, 1991). Training was selected as a treatment method due to its success in reducing abnormal behaviours in other species. Martinez (2006) was successful in reducing abnormal behaviours in black bears via training. As far as researchers know, it is the first time animal training has been used as treatment on feather plucking parrots. Since, parrots in captivity are usually given readily available food that is consumed rapidly whereas in the wild they would have to spend up to 6 h per day foraging for it (Snyder *et al*., 1987). Foraging may be a behavioural need that can be provided through feeding enrichment. There is already some evidence for contra-freeloading in captive parrots

indicating that they prefer to perform some amount of research for food even when food is readily available for consumption (Coulton *et al*., 1997).

Since, there is no single indicator used to determine the welfare of an animal, many studies have found that a combination of measures can be used as a tool to assessto improvecaptive animals' welfare (Shepherdson *et al*., 2004; Hill and Broom, 2009). Hence, the key significance that this research has compared to past treatments for feather-plucking is that it involves the use of different treatments simultaneously as opposed to only using a few separately. This treatment is a combination of physical (socialisation, feeding enrichment and medication) and mental (training programme) treatment methods. By utilizing behaviours assessment, feather condition score (Meehan's Feather-Scoring System) and corticosterone levels differences, a noticeable improvement in the feather condition is expected.

This study has significance as feather-plucking occurs in all captive environments including zoos, pet shops and homes (Engebretson, 2006; Hoppes and Gray, 2010). Aside from medication which might need to be prescribed by a veterinarian, the results especially training of this study can easily be applied to all establishments in order to reduce feather-plucking in birds.

MATERIALS AND METHODS

Subjects: Two sulphur-crested cockatoos from two different areas in the Taipei Zoo were the research target individuals. Both parrots are rescue parrots from householdsand both have past injuries that prevent them from flying. The first is a 30 years old female with severe plumage problems who is housed alone. However, her owner had never seen her plucking her feathers in the past and proposes that it is more of a genetic problem than a behavioural problem. This parrot is relaxed, friendly and quick to take to strangers.

The second is a male with moderate plumage problems. He was previously housed with two other birds of other species and showed signs of stress and discomfort to new objects and people. He craves attention, showing behaviours consisting of screeching, head-bobbing and claw biting if the other parrot is receiving attention. Since, this experiment was taken as treatments to the parrots with behaviour disorder problem there was no need to apply for permission from zoo ethical committee.

Enclosures and feeding: The parrots were housed individually in cages (l×w×h = 250×100×195 cm). Each cage contained two hard wooden perches, a water-bowl and two pipe feeders. One cage was placed between two experimental cages. Vocal and visual contact was possible between two parrots in the room. Birds were exposed to natural daylight through a 180×80 cm side window at the room. Parrots' diet contains 45% commercial pelleted foods and 25% fresh vegetables and fruits, 10% of seeds and 5% of nuts and table scraps.

Procedures

Enclosure setting: Two separate enclosures (with one empty enclosure in between) were first prepared with various types of environmental enrichment to make a suitable habitat for the birds to live in for the duration of the study. The main enrichmentsused were logs, ropes and metal platforms for the birds to stand on. Other objects placed inside included branches with leaves, mirrors and chains. Before transporting the birds from their original cages to the new experimental enclosures, a day was spent observing the behaviour of parrot No. 1 (2 h in the morning, 2 h in the afternoon) to evaluate the feasibility of the experiment design. The second bird was not observed since the area where he was kept was in a breeding area, human presence may disrupt the breeding programs of other birds.

Treatments

Socialization: Socialization was decided as a treatment method based by Meehans and Mench (2002) study. The study revealed that when tested with parrots there is an underlying motivation to interact with human handlers that can be modified by exposure to inanimate environmental enrichment. Socializing with the birds was done twice a day for 20 min each by two trainers (researchers) in rotation. This consisted of petting them and talking to them as well as hand-feeding sunflower seeds inside the enclosure. Parrot 1 was taken outside for walks as it was unable to fly. Parrot 2 did not go outside. Each period of socialization was followed by 40 min of observation.

Animal training: Because the cognitive ability and intelligence of parrots is high (Pepperberg, 1999, 2004), social needs and psychological needs have been likened to that of human toddlers and primates (Birchall, 1990; Davis, 1998). It was decided that a training program would provide the cognitive requirements for the parrot whilst also providing some social needs.

The method used for training the animals was target training where the birds needed to touch a stick before receiving food. The bridge was a clicker and the reward

was a seed. The birds were trained for 20 min during the afternoon followed by a 40 min of observation period inside the enclosure each day by two trainers (researchers) who rotated each day.

Medicine: The medication was selected as a method of treatment used by Iglauer and Rasim (1993) for reducing feather-plucking behaviour in grey parrots (*Psittacus erythacus*). Haloperidol has been used by many avian veterinarians for a number of years in select cases of behaviour disorders in birds. In this study, the medication was given orally each morning to only parrot 2 followed by an hour observation by the same trainer, since parrot 1 refuse to feed. The dose of Haloperidol for each parrot is 2.5 drops per kg throughout this study. However, this medicine was given infrequently due to the parrot's unwillingness to take it.

Feeding enrichments: The treatment was based on a study carried out by Van Hoek and King (1997), Mertens (1997) and Lumeij and Hommers (2008). Various types of feeding enrichments were added separately twice a day to the enclosure to prolong feeding time in an attempt to reduce feather-plucking behaviour. The enrichments added were:

- A rodent ball with larger holes soldered into it and filled with seed. This enrichment was intended to stimulate the parrot by getting the bird to roll the ball around causing the seeds to drop out. The rodent ball was the standard ball used as a toy for rodents. The dimensions were 7×7×7 inches. Holes were soldered at the top and bottom and were approximately 2 mm in diameter
- A feed tray with brushes attached to it. Seeds were put in between the fibres of the brush encouraging the parrots to feel for and manipulate the seeds out of the brushes in order to feed
- A plastic hanging feeder with holes in the side. This enrichment was designed for the parrots to manipulate the feeder around with its beak to reach the holes in order to extract food
- A bunch of Mulberry leaf and bamboo was introduced to the parrots in the morning to encourage parrots to pluck and chew leaves instead of chewing their own feathers. The reason researchers choose these plants was because other species at the zoo also consume them and these are not toxic to parrots

Time table: The observation period was performed 10/7/2012 to 24/7/2012 before treatment and 26/7/2012 to 6/9/ 2012 after treatments.

Base line period: The 2 h observation each morning and afternoon between 10/7/2012 and 24/7/2012 was made.

Treatment period (26/7/2012 to 6/9/2012):

- Morning hour; feed medicine and behavioural observation for an hour
- Morning 20/40; socialization for 20 min followed by 40 min of observation
- Afternoon 20/40; training for 20 min followed by 40 min of observation
- Afternoon hour; no treatment and an hour observation
- Afternoon 2nd 20/40; socialization for 20 min followed by 40 min of observation

Data collection: Scanning sampling method was followed to record the observations. Every 30 sec, the observer would record the behaviour that the bird was performing at that time.

Definitions of behaviour: Parrots behaviour was observed, defined and classified in order to find out their activity budget (Table 1).

Method of collecting data: In order to determine whether the plumage condition had improved on the bird, the 10 point feather scoring system by Meehan *et al*. (2003) was used. The use of this system involved taking the feather condition score from the chest, legs, back, tail and wings of the bird (Table 2). The score given to each of these led to an overall score. Due to the subjectivity of the system, the average of three people was taken in the analysis. Since, it is quite difficult to count the feathers on the birds, photographs were taken.

Another method of determining the success of the research was the collection of faeces from the birds which were then tested for the level of corticosterone. Since, blood drawing from birds would cause extra stress and affect the result, researchers used non-invasive method to exam the corticosterone level from birds' faeces in this study which also lead to better welfare concern of the study objects. Samples of the parrot's faeces were collected once every 2 days from the beginning of the study, extracted by methanol and analysed with Enzyme-Linked Immunosorbent Assay (ELISA) at the Taipei Zoo physiology lab. Corticosterone testing was used because corticosterone is an indicator of a stress response. When a stimulus is perceived as being threatening to the parrot, stress-responses are initiated resulting in the release of corticosterone steroid from the adrenal gland (Cockrem, 2007).

Table 1: Definition of behaviours

Behaviour types	Description
Resting	When the parrot was either still or asleep, the latter was identified by the bill being tucked behind the scapulars and the eyes closed (Southern, 1974; Luescher, 2006)
Preening	Grooming its feathers. It is a natural behaviour and in the wild, parrots spend a lot of time preening (Murphy *et al*., 2011; Lanning and Shiflett, 1983) however, over-preening has been said to lead to feather plucking behaviour (Van Hoek and King, 1997; Kennedy and Draper, 1991)
Feather-plucking	Also called pterotillomania, defined as the act of a bird plucking his own feathers (Van Zeeland *et al*., 2009)
Feather-chewing	The observed act of chewing the plucked feather
Playing with feeding enrichment	Defined when the parrot was observed using the feeding enrichment
Aggression	Signs of aggression either towards other parrot, the observer or events outside the enclosure (i.e., construction research or animals in adjacent field). Aggressive signs displayed by the subject birds were limited to aggressive displays and vocalisations rather than lunging and attempts to attack
Display	Parrot displays observed included head-bobbing which is described as being a form of greeting towards trusted individuals
Scratching	Two types of head-scratching were observed. A quick, basic scratch that is a response to irritation and a prolonged period of scratching which is a vital part of plumage maintenance for cleaning and oiling the feathers (Simmons, 1961; Burtt and Hailman, 1978)
Claw-biting	The parrot was observed chewing its own claws. It never removed parts off them, just chewed on them
Branch-biting	Later on in the project, branches were inserted into the enclosures for the parrots to chew on and strip leaves off as a form of enrichment
Other	Other behaviours observed include feeding (without the use of enrichment), drinking and cage climbing. Another key behaviour that was observed was screaming which is a natural behaviour with many reasons for it such as play behaviour, defining territory and communication (Martin, 2011)

Table 2: The scale of Meehan *et al*. (2003) feather condition score

Feather condition score	Description
Scoring system used for the chest, flank, back and legs	
0	All or most feathers removed, down removed and skin exposed, evidence of skin or tissues injury
0.25	All or most feathers removed, down removed and skin exposed. No evidence of tissues injury
0.5	All or most feathers removed, some down removed and patches of skin exposed
0.75	All or most feathers removed, down exposed and intact or feathers removed from more than half of the area. Some down removed and patches of skin exposed
1	Feathers removed from less than half of the area, some down removed and skin exposed
1.25	Feathers removed from more than half of the area. Down exposed and intact
1.5	Feathers removed from less than half of the area. Down exposed and intact
1.75	Feathers intact with fraying or breakage
2	Feathers intact with little or no fraying or breakage
Scoring system used for the wings	
0	All or most primaries, secondaries and coverts removed. Down removed, skin exposed and evidence of skin or tissue injury
0.5	All or most primaries, secondaries and coverts removed, down removed, skin exposed and no evidence of injury
1	More than half of coverts removed, down exposed and intact or more than half or primaries and secondaries removed. Down exposed and intact
1.5	Fewer than half of coverts removed, down exposed and intact or more than half of primaries and secondaries removed. Down exposed and intact
2	Feathers intact with little or no fraying or breakage
Scoring system used for tail	
0	All or most tail feathers removed or broken
1	Some tail feathers removed or broken or significant fraying of tail feathers
2	Feathers intact with little or no fraying or breakage

Statistical analysis: Pearson's correlation was used on the feather score vs. the corticosterone levels of the parrots. Pearson's correlation is a measure of the linear correlation between two variables (X and Y). It gives a value between +1 and -1 as an inconclusive result.

RESULTS

Feather condition: The feather condition score of both subject birds was taken at the start of the study on July 12th, 2012, August 10th, 2012 and at the end of the study on September 28th, 2012. During this period re-feathering occurred from back followed by chest/flank and neck indicating that feather plucking behaviour had decreased.

The feather condition of both birds improved over the course of the treatment period. For parrot one, the feather condition increased to a total of 5.25 by the end of the study (Table 3) and for parrot 2 the feather condition increased to a total of 6.75 by the end of the study (Table 4). This indicates that the combination of treatments was a success in reducing feather plucking in the birds.

Corticosterone levels: The corticosterone test reveals a sharp, initial decrease for parrot 1 from an initial level of 181.08 ng g^{-1} at the start of the project to a final level of 114.53 ng g^{-1} at the end with periods of fluctuations from high corticosterone levels to low corticosterone levels (Fig. 1). The mean corticosterone level of parrot one

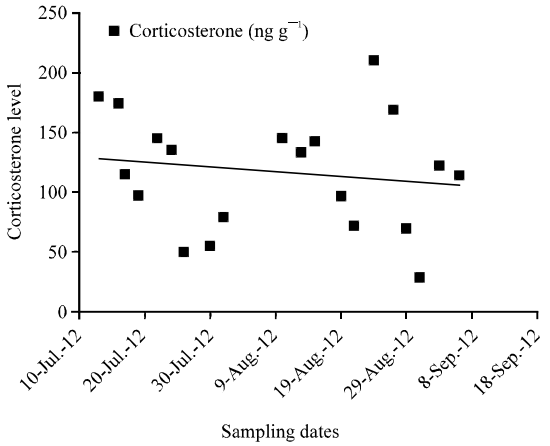

Fig. 1: The corticosterone levels during the course of the project for parrot 1

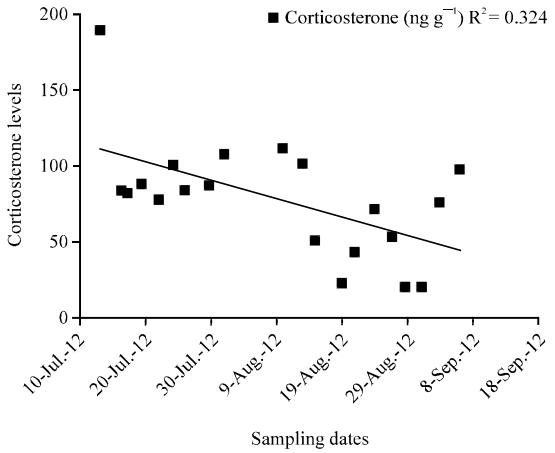

Fig. 2: The corticosterone level throughout the course of the project for parrot 2

Table 3: The feather condition score for parrot 1

Date/Body area	Chest/Flank	Back	Legs	Wings	Tail	Total
12/07/12	0.25	0.75	0.25	0.5	1	2.75
10/08/12	0.75	1.00	0.50	1.0	1	4.25
28/09/12	1.25	1.00	0.50	1.5	1	5.25

Table 4: The feather condition score for parrot 2

Date/Body area	Chest/Flank	Back	Legs	Wings	Tail	Total
12/07/12	0.75	0.75	1.5	0.5	1	4.50
10/08/12	1.00	1.25	1.5	1.0	1	5.75
28/09/12	1.25	1.50	1.5	1.5	1	6.75

before treatment (10/7/2012 to 24/7/2012) was 142.08 and 107.29 ng g^{-1} after treatments (26/7/2012 to 6/9/2012). Some of these fluctuations coincide with periods of high activity around the parrot enclosure, such as work being carried out in the adjacent paddock. On stress free periods however, the results reveal that overall, the treatment programme has reduced the corticosterone levels of the parrot.

For parrot 2, the results of the faeces analysis revealed a very sharp, initial decrease from 190.37-83.91 ng g^{-1}. From there the levels remain relatively constant for a period of time before a sudden drop to 51.59 ng g^{-1} (Fig. 2). The mean corticosterone level of parrot two before treatment (10/7/2012 to 24/7/2012) was 104.04 and 68.59 ng g^{-1} after treatments (26/7/2012 to 6/9/2012). Again, after the drop, the corticosterone level remained constant revealing that the treatment program used was successful in reducing the corticosterone levels of the parrot. Both of these results show that the subject birds had reduced stress levels during the treatment.

Feeding enrichment: Of the number of toys/puzzles/activities that either researchers created on the own or purchased from bird shop, most were selected as everyday items that are easy to manage by zoo keeper or household situation. Although, parrot 1 initially used rodent ball and plastic hanging feeder, she quickly grew bored of it and the enrichment was ignored. Although, feed trays with brushes were used regularly by parrot 2, mulberry and bamboo leaves were chewed partially by both parrots each day, none of any feeding devices attracted parrots' attention >5 min, hence feeding enrichment itself was not considered as an independent successful treatment to reduce subjects' plucking behaviour.

Training: The training sessions led to a reduction in feather-plucking behaviour of both parrots. As shown in Fig. 3 for parrot 1 there was a change from an average of 2% of time spent feather plucking before treatment to 0% after each training session. Other abnormal behaviours such as prolonged claw biting also decreased from 9-4%.

For parrot 2, the results also showed a decrease from 2% of feather plucking behaviour observed before the treatment period to 1% after the training session. It should be noted however that parrot 2 did not take the training sessions as well as parrot 1, often showing signs that it did not wish to be trained such as lack of persistence during target training during the training session and often ignoring the instructions of the trainer and only grasping basic target training during the treatment period. Both parrots showed a large decrease of feather chewing behaviour after training treatments (parrot 1 from 24-0%; parrot 2 from 6-2%).

Medicine: The medication led to a small decrease in feather plucking and chewing. During the preliminary study, the parrot was observed to be feather plucking an

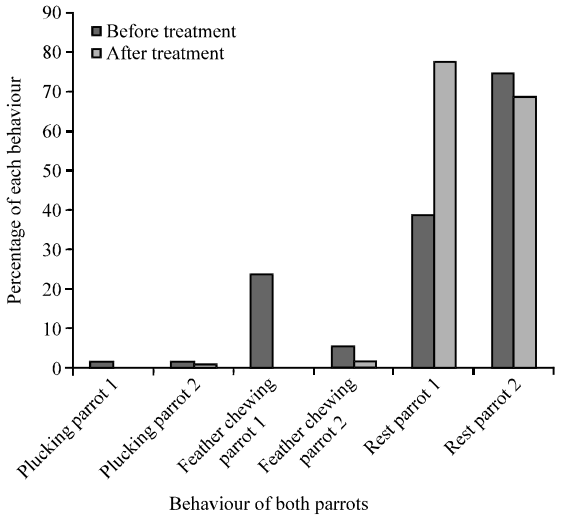

Fig. 3: The results of the training sessions for both parrot 1 and 2

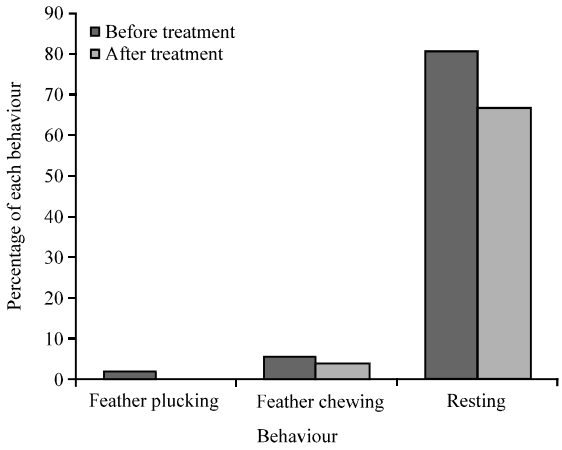

Fig. 4: The result of the use of medicine on parrot 2

average of 2% of the observation and was observed chewing on feathers (but not observed actually plucking the feather) for 6% of the observation. This decreased to an average of 0% (although feather plucking was still observed but only rarely) and chewing feathers decreased to 4% (Fig. 4). Even though the results are not drastic, the use of medicine did lead to a decrease in feather-plucking and chewing behaviour.

Socialisation: Socialisation was used as a method of reducing feather-plucking, the results and effectiveness of this are detailed in Fig. 5. For parrot 1, the results show that socialisation led to a decrease in feather-plucking (from 3-1%) and feather-chewing behaviour (from 3-1%) however when compared to the other treatments used the parrot does exhibited more feather-plucking behaviour.

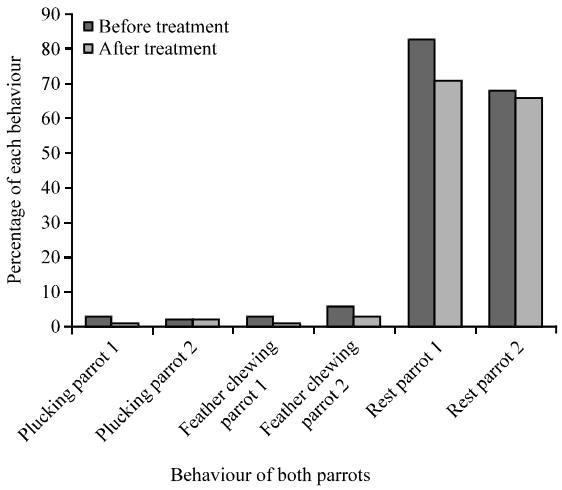

Fig. 5: The results of socialisation on both parrots

For parrot 2, although there was no observed change in the average percentage of observation spent feather-plucking (2%), the behaviour of chewing feathers (sometimes with no observed feather-plucking at the time of observation) did decrease from 6-3% which indicates that increased socialisation does lead to a minor improvement in eliminating abnormal behaviours such as feather-plucking and feather-chewing.

Statistical analysis: The use of Pearson's correlation shows negative correlation between corticosterone level and feather condition score for both parrot 1 and 2. The correlation for parrot 1 was -0.995699365 and -0.959681203 for parrot 2. This means that the improvement of the feather condition score for both parrots correlates with the decrease of the corticosterone level during the treatment period. The R^2-value of feather score vs. the corticosterone levels for parrot 1 is 0.0234 and 0.3242 for parrot 2.

DISCUSSION

Medicine: The study reveals that overall the use of medicine leads to the decrease in feather-plucking behaviour of parrot 2. However, a relatively high percentage of feather-chewing behaviour was still observed but the act of feather-plucking was not observed. In the past, medicine was considered as successful as one of the option to reduce feather-plucking but is a viable solution only in zoo environments due to the cost and difficulty of obtaining the medicine and the skills required for administrating it to the parrots. Today itmay or may not be an ideal practice treatment for home or pet shop owners depending on how easily the

haloperidol can be obtained by the owner. A new finding in this study in contrast to Mertens (1997)'s study, there were no effects on resting or aggression behaviours.

Socialisation: Minor changes were observed after the socialisation treatments with the degree of feather plucking and feather-chewing behaviour decreasing. This suggests that even though inadequate socialisation may be a factor of feather-plucking in some birds, it is not the primary factor as increased socialisation on its own did not have an effect onreduction of feather-plucking. Researchers used con-specific rather than human exposure to see if association (visual and vocal) between the two subjects would decrease feather plucking. Parrot 2 displayed aggressive behaviour toward parrot 1 and there was no improvement in feather plucking. It is proposed that a further study to introduce other birds to find out effects of introduced animals.

Feeding enrichment: Feeding enrichment was used with both parrots but it was difficult to check its effectiveness in reducing feather plucking behaviour due to the fact that feeding enrichment was in the cage at the same period as other treatments such as the use of medicine. Despite using the rodent ball feeder initially, parrot 1 quickly grew habituated to it and eventually ignored the feeder altogether. Overall, the use of feeding enrichment cannot be considered successful for parrot 1. The enrichment used by parrot 2 was the brush feeder. Other enrichments such as the rodent ball and a hanging nut feeder were attempted but due to the parrot's timid nature he refused to approach them and so the other enrichments were removed.

It is possible that the design of the feeder and ease of use led to the parrot's habituation to the enrichment. As a result, further studies need to be carried out using different, more complex forms of enrichment with alterations made to the enrichment in the enclosure after a period of time. However, the observation did reveal that parrots spent a larger percentage of the time chewing fresh mulberry/bamboo leaves and stems. This is very similar to providing feather-plucking parrots mop heads to encourage parrots to chew which is considered as an alternative object which parrots pay attention to instead of their own feathers. The fresh branches and leaves can be easily obtained in the zoo, home or pet shops and contain more fibres and minor elements that captive parrots may need compared with artificial chewing objects.

Training: As for the understanding, feather chewing can lead to over preening and plucking problems and should be considered as feather associated abnormal behaviour. The training sessions showed positive results for both birds showing a decrease in the percentage of observation spent feather plucking and feather chewing. Also after a 20 min session of training the parrot is much more relaxed and less stressed. However, increased socialisation with the birds without the use of training did not make any difference to the percentage of feather plucking behaviour. It is to be suggested then that the cause of feather-plucking lies not fully with inadequate social needs being met (although this may be a factor) but largely due to an inability to display and stimulate cognitive behaviour. As a result, a training session where the parrot had to think, move, work and touch to gain feed items whilst also socialising with the trainer was much more successful in reducing feather-plucking behaviour than just socialisation on its own which does not provide any cognitive and mental stimulation. Even though training is not a natural behaviour for parrots, it allows the parrots to gain the same mental stimulation that they achieve during the wild whilst foraging for food. This was the case by Learys's study where training was successful in reducing abnormal behaviour in bears and in a study by Coleman and Maier (2010) where positive reinforcement training was used to reduce abnormal behaviours in rhesus macaques (*Macaca mullata*).

Because of this, it can be predicted that as the training sessions grow more complex and thus stimulating more cognitive behaviour in the parrot will lead to an even further decrease in abnormal behaviours as the parrots mental needs are better met.

Corticosterone: A high level of corticosterone in the faeces is an indicator of stress in the animal which may be a cause of feather-plucking behaviour. This is supported by Owen and Lane (2006) who determined that feather-plucking parrots have higher base-line corticosterone levels and higher chronic stress levels than non-pluckers. Due to this research, it was determined that corticosterone level testing would be a useful tool to use in determining the success of this treatment and will further support the results of the behavioural observation and will correlate with feather condition scoring.

For both parrots, the corticosterone levels in the faeces decreased during the treatment period. This decrease in stress levels coincides with the reduced feather-plucking behaviours recorded in the behavioural observations. This indicates that high-stress level in parrots is a key factor in the development of feather-plucking behaviour. This could tie in with the success of training programmes as lack of mental stimulation could easily cause stress in birds and thus

result in the high levels of corticosterone. Wells *et al.* (2003) explained that stressful situations increase corticosterone levels and Owen and Lane (2006) verified this by concluding that feather-plucking parrots have higher corticosterone levels than non-feather-plucking parrots. The period of pre-treatmentto test for corticosterone determination was brief which weakens the conclusions.

CONCLUSION

Owning to the restrict regulation of the zoo management policy and there were only two parrots exhibit feather plucking behaviour, the project did not apply to a larger number of birds and cover a longer time period, the treatments also overlap within each other, such as medical and training sections to make it difficult to distinguish the success of specific treatment, however, researchers attempt to approach the issue that many captive parrots do associate with this behaviour problems in a limited resource and timeline. It is hoped this pilot study would encourage more attention to the issue and further studies of this topic may be considered in the future to promote better well-being of captive parrots.

Over the course of the project, feather-plucking and corticosterone levels decreased over the treatment period whilst the feather-condition score of both parrots increased. This led to the project being considered a success. The most successful treatment for feather-plucking was the training programme. It is hypothesised that this treatment was the most successful because the use of training not only provided the parrots with the social interactions and attention that they crave but also provided them with much needed mental stimulation by getting them to research and think in order to earn food which was used as the stimulus.

The parrot training programme and added environmental enrichment of fresh branches and leaves is easily applicable not only for parrots in zoos but also parrots housed in pet stores, bird parks and in the home. The use of medicine was also successful in reducing feather-plucking behaviour. However, the treatment is limited due to cost and difficulty in obtaining the medicine required and the expert care needed to safely and correctly administer the medicine to the parrot which may not be possible for some home owners.

From the results of the behavioural observations and the success of the combination of treatments, the major cause of feather plucking in parrots is considered to be a lack of mental stimulation. Stress is a by-product of the lack of social interactions and lack of mental stimulation and the results of the corticosterone test provided support for this argument. As a result of stress, feather-plucking behaviours develop. In order to combat this, it is suggested that parrots in captivity should be provided with a training programme ona regular bases to provide this much needed mental stimulation and to reduce the likelihood of abnormal behaviours such as father-plucking from developing. Once the abnormal behaviours associate with feather-plucking occurs, it is crucial to determine whether owner should introduce one or multiple treatment methods to approach the problem depending on each individual subject's temperament and how animals react to the treatment. In conclusion, the combination of training, environmental enrichment and haloperidol decreased feather plucking for parrots in this study.

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