

Annotated Bibliography

My themes for organization are based on the methods of study the articles used. They are either comparing metabolites and FDB expression, comparing FDB expression between distinct species, determining methods for reducing FDB expression and new methods for studying FDB presence.

Comparing stress hormones/ internal metabolites and FDB presence:

1. Costa, P., Macchi, E., Valle, E., Marco, M. D., Nucera, D. M., Gasco, L., & Schiavone, A. (2016). An association between feather damaging behavior and corticosterone metabolite excretion in captive African grey parrots (*Psittacus erithacus*). *PeerJ*, 4, e2462. <https://doi.org/10.7717/peerj.2462>

Summary: This article investigated the level of stress hormones present in several different groupings of African Grey parrots (*Psittacus Erithacus*). Prior to this study, it was known that chronic stress was involved in feather damaging behaviour or FDB. However, the impact that hand raising/rearing parrots had on their stress levels were unknown and not quantified. The goal of the study was to compare the stress levels between three groups as well as looking at the differences across different seasons, ages and sex. Costa et al (2016) did this by looking at the stress hormone corticosterone metabolites (CM) present in the droppings of parrots that were parent-reared (PR) versus hand-reared (HR). The HR parrots were broken down into another category based on whether they displayed FDB (FDB-HR) or were healthy (H-HR). 82 parrots had their droppings collected during the fall and spring seasons. The results of the study found that FDB-HR birds had 3 times the amounts of CM compared to both the H-HR and PR birds. When comparing the CM presence in PR and H-HR parrots, there was not any significant difference. This is similar with the impact of the season, as it had no significant impact on the CM found. The only group that showed any difference in CM due to age was the H-HR and when looking at the role of sex in the production of CM in the HR birds, males produced more CM than females. The ultimate take-away from this study is that parrots displaying FDB produce a much larger amount of stress related hormones, indicating that the reason for the FDB is related to stress. Suggested further research includes looking into the impact of social preference for humans by the birds as well as looking at the stress-related risk factors involved with FDB.

Contribution: The reason this article is important is because it shows a physical connection between stress and FDB. By comparing the difference methods of raising parrots as well as the impact of sex, age and season, evidence is given for determining what factors could influence the FDB/stress. The study also provided the CM values, which showed that birds with FDB

showed significantly more stress hormones than those that are healthy. The results of the study provide follow-up questions as to what causes the stress in the HR birds and why it is higher than birds that are PR.

2. Owen, D. J., & Lane, J. M. (2006). High levels of corticosterone in feather-plucking parrots (*Psittacus erithacus*). *The Veterinary Record*, 158(23), 804–805.

<https://doi.org/10.1136/vr.158.23.804>

Summary: The aim of this study was to support the idea of using corticosterone, a stress hormone, as a reasonably good indicator of detecting and measuring stress and feather damaging behaviour (FDB) in African Grey parrots (*Psittacus erithacus*). Several articles that have been looked at use these steroid hormones as ways to quantify the stress levels in birds displaying FDB. Comparing two groups of birds, one containing seven FDB displaying birds and the other having 10 healthy, fecal samples were taken and had the corticosterone, stress hormone, levels compared. The results showed the group displaying FDB had a significantly higher amount of corticosterone present in their feces than the group without FDB, with the FDB group being four times higher than the controls. What these results support is the idea that birds displaying FDB have more chronic stress levels than the healthy birds. What this study does not provide evidence for is what type of stress factor is causing the increase in corticosterone, which could be the topic of further research or comparing the results with other studies looking into these factors. Ultimately, this article demonstrates and supports the use of corticosterone as a method to quantify stress levels in birds displaying FDB and how this method is easy preformed and is non-invasive.

Contribution: This study is important as it supports and provides evidence to other studies already investigated that used corticosterone or its metabolites as a reasonable method to measure stress levels. By using this hormone, a more accurate and reliable measurement can be provided for the present stress levels in birds displaying FDB rather than methods that use visuals such as scoring feather damage or rating the damage by looking at the area of impact. This study could also provide evidence for other species as most organisms should have a stress hormone that can be used to quantify the stress impact.

3. Clubb, S. L., Cray, C., Arheart, K. L., & Goodman, M. (2007). Comparison of selected diagnostic parameters in African grey parrots (*Psittacus erithacus*) with normal plumage and those exhibiting feather damaging behavior. *Journal of Avian Medicine and Surgery*, 21(4), 259–264. <https://doi.org/10.1647/2006-039R.1>

Summary: The aim of this article was to determine, through clinical studies, if feather damaging behaviour (FDB) could be detected in African Grey parrots (*Psittacus erithacus*). FDB is well known in this species and known causes of include behaviour, parasitism, bacteria or fungal infections, allergies or other medical conditions. 51 parrots negatively testing for circovirus I, a

known cause of feather disease, had blood samples taken before and six hours after an injection of Thyroid-stimulating hormone (TSH). 24 of the birds displayed FDB prior to the study. These samples were submitted for complete blood count, plasma protein electrophoresis, and stress related hormone testing. The results showed an overall 2-fold increase in white blood cell (WBC) count after the TSH injection as well as a decrease in lymphocyte count. The WBC count was not significantly different between the healthy and FDB birds, but the lymphocyte count was significantly lower in the FDB. No significant difference was found in the stress related hormones after the TSH injection. The FDB birds did show a significantly higher number of alpha-1 and 2 globulins as well as lower levels of gamma globulins. What these results support is a relationship between FDB, thyroid function and stress-related responses. Further points of research include assessment of neurotransmitters and stress indicators, whether plasma proteins are results of FDB or causes, if long-term FDB impacts response to TSH, or how histamine levels compare between chronic and acute FDB.

Contribution: This study is incredibly important because it demonstrate that FDB is not just a visible response to stress, but also a highly impactful behaviour internally as well. The question that arises from this study is whether the FDB came first or if the internal changes cause the FDB. Another highly supportive element that comes from this article is the idea that the behaviour can be quantified. FDB is usually a highly visible condition that can be watched but having the ability to quantify it provides the ability to determine stress levels in parrots even when it is not highly visible.

4. de Almeida, A. C., Palme, R., & Moreira, N. (2018). How environmental enrichment affects behavioral and glucocorticoid responses in captive blue-and-yellow macaws (*Ara ararauna*). *Applied Animal Behaviour Science*, 201, 125–135.
<https://doi.org/10.1016/j.applanim.2017.12.019>

Summary: The authors of this article looked at the impact of providing and removing environmental enrichment for a group of captive Blue-and-yellow Macaws (*Ara ararauna*). It is well known that the environment that the parrots live in contribute to odd behaviours and stress responses, such as feather damaging behaviour (FDB). What is not known is the positive or negative impact the enrichment has and how can this be quantified. The objective of this study was to observe changes in behaviour, as well as in stress hormones or corticosterone metabolite (CM) levels, by using three stages of enrichment exposure: pre-enrichment with no objects present in the cage, enrichment with foods and physical/occupational items being added, and post-enrichment with the objects removed. 22 parrots took part in the study and the researchers observed their physical behaviours and took fecal samples to determine the impacts of the changing enrichment availability. The results showed that there was an increase in locomotion and movement between the pre-enrichment and enrichment phase but only locomotion decreased in post-enrichment. There was a significant decrease in vocalization,

preening and object interaction between pre-enrichment and enrichment however preening increased significantly in the post-enrichment stage. Biting itself was another behaviour that decreased from pre-enrichment to enrichment. When looking into the results of the CM changes, there was no significant difference found between all three phases however, there was relationship found in the resting parrots in the post-enrichment stage with them having higher CM levels. Overall, the impact of environmental enrichment was positive for reducing some behaviours however, there was no significant reduction in CM levels or abnormal behaviours. Suggested future research includes studying if the negative response for preening was due to something like boredom or if it was a frustration response.

Contribution: This study is important as it further relates the stress response to different CM levels in parrots. The impact of the CM in this study was not significant but it does reinforce the idea that CM is reliable for determining stress in parrots. The other key point that this study provided was the negative relationship between preening and the changing of enrichment availability. It was not provided whether the preening was FDB or not but the increase in time spent after the decrease suggests a relationship between enrichment and stress.

Studies determining methods to reduce FDB:

5. Dislich, M., Neumann, U., & Crosta, L. (2017). Successful reduction of feather-damaging behavior by social restructuring in a group of golden conures (*Guaruba guarouba*). *Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians*, 48(3), 859–867. <https://doi.org/10.1638/2015-0279.1>

Summary: This study investigated the fluctuation of feather damaging behaviour (FDB) in a group of Golden Conures (*Guaruba guarouba*) over a period of 10 years. Previous research showed that birds displaying FDB can be affected by many diverse sources of stress such as disease, rearing, genetics, neurobiology or the socio-environmental conditions. The factor brought into focus in this article deals with the socio-environment and the impact of male: female ratios in a group of parrots. Using a group of 20 birds, and differing male to female ratios over a span of 10 years, FDB had high expression at the start and end of that period. After ruling out disease as the cause of FDB, a high male: female ratio was present during both times. To confirm the main cause of FDB being stress, the ratio of heterophil: lymphocytes (H: L) was determined for the group. Using exclusion methods and creating groups with different ratios, it was found that groups with a more even number of males to females recovered their damaged feathers at a better rate than the groups with higher ratios. It was also found that the FDB was not dependent on the age, gender or origin of the birds. When looking at the H: L, birds before restructuring had a significantly larger ratio compared to after. Generally, a more even ratio decreases the amount of stress in a group of conures, which is supported by the decrease in H: L levels in the group before and after restructuring the group. Future studies could investigate

the impact of these ratios in other species of parrots that have different social structures or to use corticosterone as another method to support the results of this study.

Contribution: This research is significant as it provides another source of stress for parrots that is not just environmental based. The impact of gender ratios seems to cause enough stress to a whole group, rather than one individual, to express the FDB. Further questions come up including the ideas of whether personalities would impact the expression, does species matter and how would sample size impact the expression.

Comparative studies of FDB between species:

6. van Zeeland, Y. R. A., Spruit, B. M., Rodenburg, T. B., Riedstra, B., van Hierden, Y. M., Buitenhuis, B., Korte, S. M., & Lumeij, J. T. (2009). Feather damaging behaviour in parrots: A review with consideration of comparative aspects. *Applied Animal Behaviour Science*, 121(2), 75–95. <https://doi.org/10.1016/j.applanim.2009.09.006>

Summary: This review article compared three types of harmful behaviours in parrots, humans and laying hens. At the time of the study, most background information was based on expert opinions instead of experimentation. This is not the case now as many studies, including the primary article above, have found ways to not only study it, but quantify and determine what factors induce feather damaging behaviour or FDB other than environmental factors. The objective of the study was to compare FDB, Trichotillomania (hair pulling) and feather pecking in hens as they all share similar causes, with one of which being stress. Looking mainly at the section of FDB, descriptions are given as to what FDB looks like and the areas of the body that are mainly affected (neck, chest, or the inner thigh). FDB also targets feathers that are already damaged. The main species described is in African Grey's or *Psittacus Erithacus* as they are the most owned parrot. The most common sources of stress came from a lack of foraging activities, social isolation, rearing, improper cage size, or environmental conditions. The review also looked at several other potential reasons for the behaviour such as disease, genetics or neurological factors, which had minimal impact. The article also suggested that the FDB came from a state of over-grooming as it acts as a source for stress or anxiety relief. Several strategies are given for preventing potential stressors such as expanding cage size, increased foraging activities, providing social opportunities or toys to prevent boredom. Future research is highly suggested to be done as FDB is a challenging behaviour as it is difficult to distinguish from basic grooming. One question that seemed apparent throughout the article was if changing the enrichment or conditions while the birds are young will impact the appearance of FDB later.

Contribution: This article is important to as it provides several other articles that closely relate to the research topic. It also discusses several ideas of potential stressors for the parrots as well as possible strategies to reduce the behaviour. The author does an excellent job of summarizing

a lot of information in the field as it breaks down and discusses several diverse sources for the FDB and mostly determines that it is environmental factors that cause the behaviour. Lots of future research is suggested with most looking at reducing the stress factors.

7. Ebisawa, K., Nakayama, S., Pai, C., Kinoshita, R., & Koie, H. (2021). Prevalence and risk factors for feather-damaging behavior in psittacine birds: Analysis of a Japanese nationwide survey. *PLOS ONE*, 16(7), e0254610. <https://doi.org/10.1371/journal.pone.0254610>

Summary: The purpose of the current study was to identify the prevalence of feather damaging behaviour (FDB) and attempt to correlate risk factors with the expression of FDB, with a focus on human, conspecific, or other animal presence, bird species, age, sleeping habits and separation anxiety. FDB is a well-known problem among pet parrots, but it has many different risk factors associated with it. The research team performed an online survey in Japan, with no specific species being required to participate, and asked participants to provide information about bathing, feeding, types of food, reproductive behaviour, stereotypic behaviours, and whether there were signs of separation anxiety. The main types of parrots identified in the survey included Lovebirds, Conures, Budgerigars, Cockatoos and Cockatiels and the total number of responses was 2,331. The results showed that 11.7% of responses indicated FDB. For each group, Cockatoos showed the most FDB with 30.6% of these responses displaying FDB, followed by African Grey's at 24.5%. Lovebirds had a prevalence of 23.7%, Budgerigars with 4.9% (this group had the most responses), and Cockatiels had 7.6%. The survey also found that Conures were 2.5x more likely to display FDB than Budgerigars, African Grey and Lovebirds were almost 7x more likely and Cockatoos had 9.5x higher odds of displaying FDB. Age played a role in FDB prevalence as well as young adults showed FDB 2x more than juveniles and adults were 3x more likely to display it. Separation anxiety was also significantly correlated to the expression of FDB. Overall, the most significant risk factor for FDB appears to be the type of species of bird, with age and separation anxiety also providing significantly more risk for the expression of FDB. Future studies suggested looking into the impact personalities of the owners and the type of human-bird interactions have on behaviour.

Contribution: This study serves as a crucial look at the impact of species on FDB expression. Most studies look at the impact FDB has in one species, African Grey's, but with the information from this study, it appears that looking at FDB in Cockatoos could provide more information. This study was also one of the few that looked at the impact of separation anxiety and FDB as most studying of the behaviour is done visibly and watching it happen. This is important as there could be distinct types of FDB, when in view of humans and when they are gone.

Relatively new methods for determining FDB risk factors:

8. Cussen, V. A., & Mench, J. A. (2015). The relationship between personality dimensions and resiliency to environmental stress in orange-winged amazon parrots (*Amazona amazonica*), as indicated by the development of abnormal behaviors. *PLOS ONE*, *10*(6), e0126170. <https://doi.org/10.1371/journal.pone.0126170>

Summary: The purpose of this article was to determine if there was any relationship between the personalities of Orange-Winged Amazon parrots (*Amazona amazonica*) and the ability to resist stress factors. Previous knowledge in this field consists mostly of ideas and comparisons to humans and how our personalities impact the methods for dealing with stress. It is stated that this study is the first to evaluate the relationships between personality, environment and abnormal behaviours, such as feather damaging behaviour (FDB). The 13 parrots used were hatched, parent reared with human interaction and then housed individually before having a baseline behaviour chart made. The main method of study was to observe the behaviours of the birds with enrichment, without, and then with again. Each stage was 20 weeks in length and while having normal feeding and watering, no extra interaction was provided to the birds. FDB was observed and measured indirectly by measuring feather condition. The methods used for personality scoring were done while the birds were juveniles, and they were rated as extraverted or neurotic. The results of the study showed a positive relationship between personality and behaviour expression as birds that were more neurotic had significantly poorer feather conditions during the enrichment deprivation. This relates to the significant increase in time spent preening during deprivation. However, there was a result that showed the feather damage remained high after a return to baseline time spent preening, suggesting the quality of preening changed after the deprivation period. Overall, the study found that birds that were more neurotic were more likely to increase the amount of damage done to their feathers compared to the Extraverted birds. More research should be done to look more into the change of preening quality, as well as general look at personality impact on behaviour expression.

Contribution: The reason this article is important is because it provides another possibility for how stress can lead to FDB. With birds having different personalities, this means that the effects of stress will cause different reactions and behaviours. As seen, birds that are more neurotic suffered from the stress more than the extraverted ones. This area of literature is limited so several questions are left as it could also relate to internal differences between the parrots such as levels of corticosterone or other stress hormones.

9. van Zeeland, Y. R. A., van der Aa, M. M. J. A., Vinke, C. M., Lumeij, J. T., & Schoemaker, N. J. (2013). Behavioural testing to determine differences between coping styles in Grey parrots (*Psittacus erithacus*) with and without feather damaging behaviour. *Applied*

Animal Behaviour Science, 148(3), 218–231.

<https://doi.org/10.1016/j.applanim.2013.08.004>

Summary: The intention of this research was to investigate African Grey's (*Psittacus erithacus*) responses based on whether feather damaging behaviour (FDB) was expressed or not. The impact of coping strategies was also a main interest. FDB is considered a coping strategy when they are dealing with stress. To test the correlation, three behavioural tests were performed on 22 birds, with 11 of them displaying FDB. The first test, the Manual Restraint Test (MRT), took the birds and manually restrained them for 5 minutes. A blood sample was also taken and used to identify any changes in corticosterone and norepinephrine concentrations. The second test, Novel Object Test (NOT), presented each bird with a foraging toy for 2 minutes. The third test, Open Field Test (OFT), took the birds into an open field and allowed flying time. Each bird was graded for a coping skill based on their responses to these tests and were classified as proactive or reactive. The results of MRT showed that birds without FDB vocalized significantly more than birds with FDB. The results of the blood sampling found the FDB birds had a lower corticosterone response than the non-FDB, with no significant differences in norepinephrine found. During NOT, seven of the non-FDB birds froze and never approached the object while the majority of the FDB either actively avoided it or explored it. In OFT, FDB birds were faster to explore the area and stay in the air for longer than those without FDB. When looking at coping strategies, a correlation can be made as the non-FDB birds were more likely to display a reactivity while the FDB displayed more proactivity. Further research is suggested to investigate whether this difference of coping is due to fear, confusion, or due to the difference in corticosterone levels that FDB were displaying previously.

Contribution: This was an important study to include as it looked directly at comparing how FDB impacts the lives of parrots. Generally, FDB causes the birds to be less “worried” about major changes compared to the non-FDB. What questions arise from these results is why do the FDB birds react in such a significantly unusual way compared to the FDB? Is it mainly due to experience, the different stress hormones present or how FDB was used a coping mechanism?