

Accepted Manuscript

The Grey Matter: Prevention and reduction of abnormal behavior in companion grey parrots (*Psittacus erithacus*)

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PII: S1558-7878(16)30232-5

DOI: [10.1016/j.jveb.2016.12.003](https://doi.org/10.1016/j.jveb.2016.12.003)

Reference: JVEB 1022

To appear in: *Journal of Veterinary Behavior*

Received Date: 2 June 2016

Revised Date: 8 December 2016

Accepted Date: 13 December 2016

Please cite this article as: Greenwell, P.J., Montrose, V.T., The Grey Matter: Prevention and reduction of abnormal behavior in companion grey parrots (*Psittacus erithacus*), *Journal of Veterinary Behavior* (2017), doi: 10.1016/j.jveb.2016.12.003.

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1 **Title:** The Grey Matter: Prevention and reduction of abnormal behavior in companion grey
2 parrots (*Psittacus erithacus*)

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16

17 **Abstract**

18 Grey parrots (*Psittacus erithacus*) are popular companion birds, particularly noted for their
19 ability to mimic human speech, their intelligence and longevity. They are also prone to
20 developing abnormal behaviors such as feather damaging behavior (FDB). This review
21 explores the current available knowledge on grey parrots kept as companion birds with
22 respect to behavioral problems and their management. The potential causes for the
23 development of abnormal behaviors in this species are explored. Recommendations are
24 made for future research and advice is provided on the synthesis and application of available

25 research to owners, breeders and clinicians of grey parrots so that their well-being is
26 maximized in captivity.

27

28 **Keywords:** Grey Parrot, Abnormal Behavior, Feather Damaging Behavior, Environmental
29 enrichment.

30

31 **Introduction**

32 Captivity may deny parrots the opportunity to fully engage in behaviors observed in the wild.
33 This is particularly the case for individuals kept as companion animals in households where
34 constraints are placed on social interaction, flight, foraging and maintenance behaviors such
35 as bathing and preening (Kennedy and Draper, 1990, van Hoek and Ten Cate, 1998,
36 Engebretson, 2006; Gaskins and Hungerford, 2014). The impinging of normal behavior
37 patterns may lead to the development of abnormal behaviors. Abnormal behaviors are
38 believed to be common in psittacines, although estimates of their prevalence vary, with 10%
39 (Grindlinger, 1991), 15.8% (McDonald Kinkaid et al., 2013) and 17.5% (Costa et al., 2016) of
40 parrots being stated as presenting with feather-damaging behaviors (FDB). The presentation
41 of FDB varies though by species and genus.

42 Abnormal behaviors that may be observed in grey parrots include feather damaging
43 behaviors, reproductive behaviors directed towards owners (regurgitation/ mating attempts),
44 aggression, and excessive vocalizations (Schmid, 2004). Stereotypic behavior may also be
45 observed. Stereotypies are defined as unvarying, repetitive, and functionless behaviors
46 (Garner et al., 2003) and are commonly noted in captive animals. Stereotypies such as
47 abnormal repetitive behavior (ARB) (e.g. weaving, pacing) are observed in other parrot
48 species (Meehan and Mench, 2006) but rarely documented in grey parrots.

49 The grey parrot has been selected for review due to its popularity as a companion bird in
50 Europe, the United States and the Middle-East (Birdlife International, 2016) and because it is
51 frequently presented at veterinary clinics due to being prone to developing abnormal
52 behaviors (Seibert, 2006).

53 Collating and assessing available species-specific research may aid in developing a
54 proactive response to preventing abnormal behavior in grey parrots kept as companion
55 birds. During this review we will introduce the abnormal behaviors seen in grey parrots and
56 then consider the wild ecology of grey parrots. Understanding the ecology of a species gives
57 clinicians and caretakers the insight to provide optimal care (within the constraints of
58 captivity) for their charges (Kirkwood and Hubrecht, 2001), and helps us understand why
59 parrots may be particularly susceptible to developing abnormal behaviors in captivity. We will
60 then review other factors that impact upon susceptibility to abnormal behaviors in grey
61 parrots and consider aspects of husbandry and management may affect the development
62 and maintenance of abnormal behaviors in grey parrots. We highlight how this research can
63 be applied by clinicians, breeders and owners and other caregivers to reduce or prevent
64 abnormal behaviors in companion grey parrots.

65

66 **Abnormal behaviors seen in grey parrots**

67 A range of behaviors may be observed in captive grey parrots that can be classified as being
68 abnormal or viewed as behavioral problems. In this context we define abnormal behaviors as
69 behaviors which differ in frequency and form from those observed in wild populations
70 (Wiepkema, 1985). Causation may vary between and within abnormal behaviors, however
71 Yenkosky et al. (2010) argue that parrots presented with behavioral 'problems' are showing
72 the manifestations of post-traumatic stress disorder (PTSD) . The diagnostic criteria for
73 PTSD in humans includes the exposure to actual or threatened death or serious injury, either
74 by directly experiencing or witnessing the traumatic event (American Psychiatric Association,

75 2013). Yenkosky et al. (2010) maintain that removal for hand-rearing, extraction from the
76 wild or living in a socially-and emotionally- deprived environment are all traumatic
77 experiences for parrots to contend with. *'From the perspective of traumatology, there are no*
78 *avian "behavior problems," only birds suffering psychological distress that lack adequate*
79 *developmental and/or environmental resources to self-heal and/or coping skills that would*
80 *permit at least some degree of adjustment to the alien, abnormal, dysfunctional environment'*
81 (Yenkovsky et al., 2010, p. 17 – 27). Environmental conditions and the provision of
82 enrichment devices may be key contributors in improving behavioural health or reducing
83 abnormal behaviours in parrots kept as companion birds and treatment therapies can be
84 considered in four sequential steps: establishing a secure environment; enabling greater
85 control and empowerment of the individual; enabling control of social relationships and
86 desensitization therapy assistance (Yenosky et al., 2010).

87 Feather damaging behavior (FDB) in grey parrots

88 Feather damaging behavior in psittacines is frequently described as an abnormal repetitive
89 behavior/abnormal behavior (van Zeeland et al., 2009; Jayson et al., 2014; Cussen and
90 Mench, 2015) instead of a stereotypic behavior because repeated fixed-action motor
91 patterns are absent. Some authors, however, classify FDB as stereotypic (Owen and Lane,
92 2006), and some definitions of stereotypic behavior support the use of this term (Mason,
93 2006).

94 Gaskins and Hungerford (2014) note that grey parrots are likely to engage in FDB, with grey
95 parrots being eight times more likely to show FDB than other parrot species (except
96 cockatoos, which were thirteen times more likely to evidence FDB). Of 42 birds showing
97 FDB in this study, nearly a quarter of birds were grey parrots, the highest percentage of
98 single-species in the study. Though age of onset of FDB ranges across species, Gaskins
99 and Hungerford (2014) found that grey parrots may initiate FDB when still under 1 year old,
100 with 7/8 birds in their study initiating the problem at this age. This result prompted the

101 authors to recommend exploration of early behavioral history, and its relevance for
102 behavioral therapy.

103 Jayson et al. (2014) explored the predisposing factors of FDB in grey parrots kept in the
104 United Kingdom. In a single bird per questionnaire study, 39.4% (N=137) of questionnaires
105 identified individual birds demonstrating FDB. In this study the significant predictive factors
106 for FDB in grey parrots were length of ownership and sleep lasting greater than 12 hours
107 each day. Age was not associated with the likelihood of FDB, but the authors hypothesize
108 that birds maintained in a static environment may adapt poorly if changes subsequently
109 occur. If the environment is sub-optimal, prolonged exposure may lead to the development
110 of FDB. Seibert (2006) states that optimal environments permit birds to engage in species-
111 specific behaviors while Cussen and Mench (2015) use this term to indicate an enriched
112 environment. Lack of sleep has been proposed as a factor in FDB onset (Kennedy and
113 Draper, 1990), but Jayson et al. (2014) found that sleep for greater than 12 hours each day
114 increased the likelihood of FDB developing by seven times.

115 The isolation of being in a darkened environment for an extended period may lead to
116 boredom, where an animal adapts to its environment in an abnormal way indicative of
117 understimulation, so that the animal may maintain a sense of selfhood (Wemelsfelder,
118 1984). Covering the cage with a sheet, or placing the bird in a darkened room, removes
119 visual, and possibly, vocal contact with the owner or other birds, which may result in a sense
120 of loneliness. FDB may start as a way to cope with these negative affective states
121 associated with isolation (van Zeeland et al, 2009b).

122 Rosenthal et al. (2004) removed feathers from parrots (including grey parrots) showing FDB
123 and from control birds with no FDB to determine the extent to which inflammatory changes
124 were present in the skin, feather follicles or pulp of FDB birds. Only one FDB bird showed
125 inflammatory skin cells. One feather pulp sample from a FDB bird grew bacteria, as did one
126 feather pulp sample from a control bird. These results lead to the conclusion that that

127 dermatitis and folliculitis are unlikely primary causes for FDB, and should not be assumed
128 unless confirmed through further diagnostic techniques (Rosenthal et al., 2004).

129 Garner et al. (2008) found that biopsies from grey parrots frequently showed traumatic skin
130 lesions, possibly as a result of FDB. Samples taken from grey parrots showing skin or
131 feather disorders indicated that of 77 skin biopsies, 74% were labeled as traumatic skin
132 disease. In this same study 26% (N=77) of grey parrots showed inflammatory skin disease.
133 These results suggest that biopsies are necessary to identify lesions that may be associated
134 with feather picking in grey parrots (Garner et al., 2008).

135 FDB is considered a multifactorial disorder, and that any underlying inflammation, pruritus,
136 irritation, discomfort or pain may be an inciting factor in the development of FDB (van
137 Zeeland and Schoemaker, 2014a). Comprehensive reviews on FDB in parrots that include
138 medical causes of FDB and diagnostic techniques, can be found in van Zeeland and
139 Schoemaker (2014a, 2014b).

140

141 Aggression

142 Welle and Luescher (2006) define aggression as the biting or lunging at another parrot or
143 human. It is important to note that under this definition aggressive interactions have an
144 element of biting, but not all biting has an element of aggression. Kennedy and Draper
145 (1990) state that parrots have three distinct periods of development (juvenile, adolescence
146 and adult) and biting may occur in any of them, aggression may also be presented in
147 adolescence and adulthood. Juvenile parrots exhibit a 'teething' stage and may have little
148 control over bite pressure. As young parrots reach adolescence some authors believe that
149 they may try to assert their "dominance" over human owners through aggressive reactions or
150 threats or that they try to establish territory around their cage (Welle and Luescher, 2006).
151 However Friedman et al. (2006) warn against using "dominance" terminology due to its
152 ambiguity in psittacine studies, as there is limited research on social hierarchies in parrots

153 and state that “*This lack of scientific consensus of what dominance is should call into*
154 *question its usefulness for understanding and managing companion parrot behavior...*”
155 (Friedman et al., 2006). Biting may also occur once adulthood, and therefore sexual
156 maturity, is attained as aggression may be directed at perceived competitors (Kennedy and
157 Draper, 1990).

158 Schmid (2004) noted that aggression was observed in grey parrots which had formed a bond
159 with a human and, conversely, that parrots which had no bonded partner were also
160 particularly aggressive to people. Aggression was also particularly noted in birds between 4-
161 7 years old. Grey parrots may also develop a fear of people, regardless of previous
162 familiarity. Welle and Luescher (2006) suggested that poor socialization when young,
163 inappropriate wing clipping resulting in injury and pain, or emotional instability due to hand-
164 rearing all potentially influence the onset of fear biting. Grey parrots may also show territorial
165 aggression (Gaskins and Bergman, 2010), where their cage or favored area is defended
166 (Welle and Luescher, 2006).

167

168 **Wild ecology of grey parrots**

169 Despite its popularity as a companion animal, information on the ecology of wild grey parrots
170 is lacking in comparison to other parrot species. Researchers of this species advocate
171 further studies on its ecology, behavior and conservation (Amuno et al., 2007; Tamungang et
172 al., 2013; Tamungang et al., 2016).

173 The available literature on the wild ecology of grey parrots suggests that providing
174 appropriate care in captivity will be challenging. Wild grey parrots exhibit a high degree of
175 sociability, with roosting sites including up to 10,000 individuals (Juniper and Parr, 1998).
176 Strong monogamous pair bonds are reported (de Grahl, 1987; Aydinonat et al., 2014) and
177 individuals display contact-calling between trees when foraging (Chapman et al., 1993).
178 Sustained flight is required to travel between seasonal feeding and roosting locations.

179 Tamungang et al. (2016) observe that populations fluctuate depending on season and
180 habitat; grey parrots will move away from drier range areas during the dry season (Birdlife,
181 2016). Nesting sites are located in tree cavities (Juste, 1996) which affects light and humidity
182 for eggs and nestlings. These environmental factors may be potentially important
183 considerations in the artificial rearing of young birds (Wilson and Luescher, 2006). Rainfall
184 and ambient humidity varies seasonally through the species range (Tamungang et al.,
185 2016). Kennedy and Draper (1990) and Schmid (2004) suggest that humidity and bathing
186 may be a predisposing factor in FDB in captive birds if bathing opportunities are not provided
187 or are infrequent. Peron et al. (2011) state that the maintenance of stable monogamous
188 pairs over multiple breeding seasons, biparental care, affiliative behaviors and mobbing of
189 potential predators all support that this species has the cognitive abilities to function in
190 complex social situations and to demonstrate cooperative behaviors.

191

192 **Susceptibility to abnormal behaviors: species traits, cognition, and personality**

193 Comparative studies on general characteristics between species within the order
194 psittaciformes are limited, however the literature suggests that there are trends in personality
195 seen amongst genera. Members of *Amazona* are considered “extrovert” and voluble (Silva,
196 1991) with males becoming aggressive during breeding times (van Sant, 2006). Though the
197 general personality traits of grey parrots have not been confirmed through empirical
198 research, Roskopf and Woerpel (1991) suggest that grey parrots are susceptible to FDB
199 due to their ‘high strung’ and intelligent nature, and Wilson (2000) describes them as a
200 “highly sensitive species”. Silva (1991) advises that this species is shy and therefore best
201 avoided by aggressive individuals or those with large families, while Wilson & Luescher
202 (2006) suggest that grey parrots are more likely to present phobic behaviours than many
203 other species.

204 Variation in personality not only occurs between parrot species and may also be important in
205 the occurrence of FDB within individual grey parrots. van Zeeland et al. (2013a) explored the
206 effect of coping styles on the presence (n=11) or absence (n=11) of FDB in grey parrots. In
207 general, coping styles may be categorized into 'proactive'/'bold' or 'reactive'/'shy' styles, in
208 which bold individuals exhibit higher levels of aggression, superficial but fast exploration of
209 the environment and tend to have fixed behaviors which are rarely swayed by external
210 stimuli (Koolhaas et al., 1999; Korte et al., 2005). Shy individuals tend to 'freeze', are less
211 aggressive, demonstrate more thorough but cautious exploratory behavior and adapt more
212 readily to external stimuli or the situation in which it is presented (Koolhaas et al., 1999;
213 Korte et al., 2005). In humans and other species, individuals displaying bold coping
214 mechanisms have an increased propensity for stress-related behavioral or health issues
215 (Korte et al., 2005). van Zeeland et al. (2013a) exposed grey parrots to a range of tests to
216 measure coping styles; birds with FDB demonstrated behaviors characterized to a bold
217 coping style. Significant differences were observed between birds with and without FDB in a
218 novel object test. Parrots with FDB had an active response in either approaching or avoiding
219 the object, whereas birds without FDB either froze or had a passive response to the object.
220 In an Open Field Test there were also significant differences in response. Birds with FDB
221 were more active and had shorter latency times prior to exploration, with greater area
222 covered and longer time spent in exploration, compared to birds without FDB. Knowledge of
223 personality characteristics such as 'boldness' could be used as a tool in management of
224 abnormal behaviors by identifying which individuals are more at risk of developing FDB, and
225 identifying the role of personality traits in the etiology of FDBs in grey parrots.

226 There has been a wealth of research into the cognitive abilities of grey parrots. Grey parrots
227 not only demonstrate some ability to comprehend human-given cues such as gaze direction
228 and pointing (Giret et al., 2009) but also possess the ability to learn to use English speech in
229 a meaningful way for interspecies communication (e.g. Pepperberg, 2002a, 2002b).

230 Grey parrots can demonstrate both cooperative (Péron, et al., 2011) and insightful problem
231 solving (Pepperberg, 2004). This species has also been demonstrated to display inferential
232 reasoning (Mikolasch et al., 2011; Schloegl et al., 2012; Pepperberg, 2013), advanced
233 numerical competence (Pepperberg, 1994; Pepperberg and Gordon, 2005; Pepperberg,
234 2006a, 2006b; Al Aïn et al., 2009; Pepperberg 2012) and comprehension of object
235 permanence (Pepperberg and Kozak, 1986; Pepperberg et al., 1997).

236 While the cognitive abilities of grey parrots differs between individuals (e.g., Mikolasch,
237 2011; Pepperberg, 2004; Pepperberg, 2007), the high-end cognition demonstrated by grey
238 parrots should be considered in the husbandry of this species and as a potential contributing
239 factor for behavioral concerns.

240

241 **Husbandry and management: effects on abnormal behaviors**

242 Influence of rearing-method

243 It is important to note that the majority of parrot species can still be classed as “non-
244 domesticated”, having similar thresholds and behaviors to wild counterparts (Kalmar et al.,
245 2007). Due to the lifespan of some parrots, veterinary clinicians may still be treating wild-
246 caught birds (the USA banned the import of CITES listed wild birds in 1992, the UK in 2007)
247 or birds that are only one or two generations removed from their wild counterparts. Such
248 birds will display wild-type behaviors since no selection has been applied or had time to act
249 to change behavior. Parrots are bred and hand-reared in large quantities each year to satisfy
250 the demand for pet birds (Schmid, 2004; Schmid et al., 2005; Fox, 2006). It is considered
251 that hand-raised grey parrots make for better companion birds (Rosskopf and Woerpel,
252 1991), being tamer, more confident and easier to handle. More recent research suggests
253 that parent-reared young are less likely to develop behavioral problems (Schmid, 2004).
254 Studies on orange-winged amazon parrots (*Amazonica amazonica*) show that if young are
255 handled in the natal nest as they develop, they can show comparable levels of tameness to

256 hand-reared individuals (Aengus and Millam, 1999). Slight variation was seen in tameness
257 dependent on the age that handling started, suggesting that there may be a sensitive period,
258 where handling of chicks has a greater effect on future behavior. Wild caught birds are
259 unlikely to seek human attention and nervousness persists in captivity (Silva, 1991).

260 Schmid et al. (2006) investigated effects of rearing methods on later behavior in grey
261 parrots, studying wild-caught, parent-raised and hand-reared birds. Aggression and person-
262 preference were highest for hand-reared birds while wild-caught individuals developed more
263 phobic behaviors as pets, demonstrated greater feather-plucking and had poorer overall
264 health. It also appears that greater time spent in the natal nest with the parents benefits the
265 chicks as these birds are less likely to develop stereotypies than chicks which are removed
266 at <5 weeks. Feeding chicks with tubes instead of spoons or syringes also resulted in
267 increased aggression and overall poorer health as adults. Schmid et al. (2006) summarize
268 that once adulthood is reached hand-reared grey parrots demonstrate more problem
269 behaviors than those naturally reared.

270 Aydinonat et al. (2014) suggest that though parent-reared birds are less likely to mal-imprint
271 on humans, they are equally affected by the effects of solitary housing. Social development
272 continues once chicks fledge the nest and interact with other birds and isolation from
273 conspecifics is likely to result in negative changes to behavior and physiology. Regardless of
274 rearing method the importance of appropriate imprinting and early social interactions of grey
275 parrots must not be underestimated (Schmid, 2004).

276 Wilson and Luescher (2006) highlight the importance of light levels for neonatal parrots. Wild
277 grey parrots nest in tree cavities (de Grahl, 1987) and nesting cavities of parrots are
278 generally small and deep (Silva, 1991) so limited light enters the nesting cavity. Breeders of
279 grey parrots state that nest boxes are most accepted if placed in darkened sections of the
280 cage/aviary (Silva, 1991; Jordan and Pattison, 1999). If reared under high levels of light,
281 phobias are more likely to develop, particularly for species which are considered highly
282 strung, such as grey parrots (Wilson and Luescher, 2006). Phobias may be presented as

283 hyper-reactivity to sounds, to direct eye contact or to human proximity within the parrot's
284 comfort-zone around the cage, eliciting a strong escape flight response from the perceived
285 threat (Wilson and Luescher, 2006).

286

287 Housing and Environment

288 Brinker and Friedman (1999) recommend that cage placement for grey parrots should be
289 dependent on the personality of the individual. Cages should be placed against a wall to
290 ensure that the bird is able to see people approaching the cage, and ideally there should be
291 high visibility of family activities so the bird can participate or withdraw from activities as it
292 feels fit (Brinker and Friedman, 1999). Placement of cages in front of windows may cause
293 startle responses and damage (Kalmar et al., 2007). Birds need to be provided with the
294 opportunity to engage with enrichment items as limited environmental stimulation is
295 proposed as a cause for aggression (Schmid, 2004) and suggested in the etiology of FDB
296 (Owen and Lane, 2006; Lumeij, and Hommers, 2008).

297 Bathing is one activity that parrots may initially dislike (Brinker and Friedman, 1999), but is
298 important for overall feather health. Schmid (2004) notes that captive grey parrots kept in
299 areas of high humidity (>60%) exhibited less FDB than those housed in areas of lower
300 humidity. Offering bathing opportunities such as shallow water bowls or misting with a spray-
301 bottle may raise ambient humidity and encourage preening behaviors (Kennedy and Draper,
302 1990). Spraying may also help with plumage regrowth following illness. Briscoe et al. (2008)
303 report that after spraying a body region previously infected with methicillin-resistant
304 *Staphylococcus aureus* (MRSA) in a grey parrot exhibiting FDB, the bird showed less
305 interest in chewing re-growing feathers once sprayed.

306 Social contact can also affect the development and maintenance of abnormal behaviors. van
307 Zeeland et al. (2013b) noted that after placing grey parrots in individual cages with visual
308 barriers between cages, one parrot developed mild FDB. This behavior ceased once a visual

309 barrier was removed to enable contact with a neighboring bird (van Zeeland et al., 2013b),
310 suggesting that some FDB may be due to changes in environment or social contact. Social
311 isolation can also negatively affect grey parrots at a cellular level since chronic stress is
312 associated with cellular senescence (Aydinonat et al., 2014). Comparison of telomere length,
313 the caps of eukaryotic chromosomes which control the stability of the chromosome and
314 dictate cellular senescence (Aydinonat et al., 2014), can be used to assess welfare in
315 management systems (Bateson, 2016). Aydinonat et al. (2014) explored the difference in
316 telomere length between pair-housed (n=26) and solitary-housed (n=19) grey parrots.
317 Results indicate that solitary-housed birds have significantly shorter telomeres than pair-
318 housed birds. Telomeres shorten with age, however the reduced length was observed in
319 birds of the same age from the two housing conditions. Shortened telomere lengths are
320 associated with age-related diseases in humans, negatively impact longevity in other
321 species and are indicative of chronic stress (Aydinonat et al., 2014). The findings from this
322 study suggest that solitary-housed birds aged nine years old had comparable relative
323 telomere length to pair-housed birds aged 32 years old.

324 Gaskins and Hungerford (2014) state that, of the non-medical causes for FDB, birds taken in
325 as rescue animals and birds which were uncaged for greater than 8 hours a day had higher
326 odds of showing FDB. The authors suggest that rehoming may cause separation-type
327 anxiety as seen in dogs, however it is not known whether the birds were showing FDB prior
328 to rehoming. It's also unclear whether uncaged bird were uncaged as part of the
329 management strategy to reduce FDB.

330 One factor which appeared to decrease the risk of FDB by nearly 90% was having a
331 minimum of 4 hours per day human-bird contact, with these authors suggesting that potential
332 owners who were unable to commit to this minimum contact time reconsider owning grey
333 parrots and opt for other species as a companion bird. Grey parrots were grouped with
334 other species and genera for this analysis, so it is unclear whether these factors are
335 indicative of this species.

336

337 Feeding

338 Wild parrots may forage for 4-8 hours each day (Magrath and Lill, 1985; Snyder et al., 1987),
339 with flight to, and between, feeding sites and the manipulation of food to extract edible
340 components contributing to the feeding time-budget. Food provisioned in bowls reduces total
341 feed time to generally < 60 minutes (van Zeeland, 2013b). Even with food freely available
342 grey parrots will still work to earn food (van Zeeland et al., 2009a), known as
343 contrafreeloading (Inglis et al., 1997), suggesting that foraging satisfies a behavioral need.
344 The activity of foraging for food material (the appetitive stage) as well as its consumption
345 (consummatory stage) has been shown to release opioids in other species, which are
346 associated with pleasurable feelings (Berridge, 1996). Changes in presentation of food has
347 been shown to improve the overall feather quality score in grey parrots with FDB. Lumeji and
348 Hommers (2008) replaced feeding bowls with feeding pipes where pelleted food had to be
349 manipulated from a small hole in a feeding tube. This strategy significantly increased
350 foraging time and feather quality improved significantly over the course of one month. The
351 authors propose that FDB in grey parrots may be mediated with appropriate devices which
352 prolong foraging and feeding behaviors.

353 van Zeeland et al. (2013b) explored a range of foraging enrichment devices (puzzle-feeders,
354 increased food size particles, multiple feeding-stations and feed mixed with inedible items) to
355 determine which type increased foraging time in grey parrots (n=12). Prior to enrichment
356 provision the caged birds spent on average 47 ± 18 minutes each day feeding from a food
357 bowl. The most successful of the devices increased this time 2.5 fold up to 123 minutes.
358 Foraging enrichment which enables parrots to tear and shred material (cardboard in this
359 case) are one of the preferred types of devices, as this is a natural foraging behavior
360 observed in wild grey parrots (May, 2001). Puzzle feeders and feeders with apertures with
361 holes only slightly larger than the pellets also increased time in accessing the food items
362 (van Zeeland et al., 2013b) Mixing food with non-edible items (marbles) increased search

363 time, and also provided additional play items, with the parrots manipulating the marbles with
364 beak and feet. Time spent consuming food was also increased by the provision of a
365 nutritionally balanced, berry-sized mix of compressed peanuts, seed, corn and pellets. This
366 option resulted in increased foraging times of >100 minutes each day.

367

368 Wing Clipping

369 Jayson et al. (2014) did not identify a relationship between wing-clipping and FDB in grey
370 parrots, and Gaskins and Hungerford (2014) state that the likelihood of FDB being seen in
371 grey parrots with clipped wings are similar to flighted birds. However Schmid et al. (2006)
372 found that wing-clipped grey parrots were five times more likely to show FDB than flighted
373 birds. Gaskins and Hungerford (2014) suggest that the effect of wing-clipping on FDB may
374 depend on several other factors including housing and rearing method. The variation in the
375 results support this notion, as all three studies focus on parrots kept in a diversity of home
376 environments and reared by different methods.

377 Owner Contact

378 Educating owners on their pet's needs, so that they can meet the bird's requirements may
379 address some of the behavioral issues that captive birds encounter. Grey parrots may
380 consider their owner a 'conspecific pair-mate' and form close bonds (Colbert-White et al.,
381 2011). Hand-reared grey parrots have a tendency towards selective preference over human
382 care-givers, and may attack other people out of perceived 'jealousy' (Schmid, 2004). Owner-
383 parrot interactions also need considering in the role of undesired reproductive and feather
384 damaging behaviors. Van Sant (2006) suggests that the physical contact between owner
385 and parrot, petting the tail and back for example, increases the likelihood of pair bonding,
386 and with it associated reproductive problems. In parrots, allopreening between breeding
387 pairs or preferred associates is often directed to areas which the recipient cannot reach,
388 such as the head, and serves to strengthen the bond between individuals (Seibert and Sung,

389 2010). Therefore pet owners may unconsciously be encouraging sexual responses, which in
390 turn may spur undesired behaviors such as rubbing of the cloaca or vent on the owner
391 (masturbation) and regurgitation of food.

392 Owners may also influence aggressive responses in their parrots. Schimid (2004) found that
393 owners who had an inappropriate reaction to unwanted behaviors (e.g., shouting at the bird,
394 throwing objects at the bird) or approached the parrots in an inappropriate manner, such as
395 ignoring signs of discomfort, resulted in birds exhibiting higher levels of aggression.

396 Yenkosky et al. (2010) suggest that drawing the attention of owners to the similarity between
397 human Post-Traumatic Stress Disorder and observed behavioral problems in companion
398 parrots should be a priority for those who work in the avian healthcare industry, so that
399 owner are aware of potential causes of 'behavioral problems'. By providing owners with
400 appropriate information and guidance the well-being of captive parrots can only be improved.

401

402 **Application of research to prevent and reduce abnormal behaviors in grey parrots**

403 From this review it can be said that there are no definitive solutions to preventing abnormal
404 behaviors, however there are results from studies which can be applied or considered which
405 may mediate the risks of them developing. The information can be used to provide guidance
406 to breeders, owners and clinicians on how best to reduce or prevent behavioral problems in
407 grey parrots.

408

409 **Breeders**

410 The rearing method has perhaps the greatest effect on the future physical and psychological
411 development of the grey parrot, since it is at this stage that the parrots appear to be most
412 susceptible to developing abnormal behaviors. To this end it is recommended that chicks are
413 left as long as possible in the natal nest and are not removed for hand-rearing until over 5

414 weeks old (Schmid et al., 2006). Once removed, it is suggested that the rearing environment
415 has reduced light levels (Wilson and Luescher, 2006). Chicks should not be sold prior to
416 weaning as they are particularly sensitive to change, and hand-rearing and weaning of
417 chicks can be difficult to achieve safely for the novice owner, due to improper heating or
418 hygiene of feeding equipment (Low, 1991, Anderson, 2014). Breeders should also ensure
419 that chicks have the opportunity to interact safely with other birds prior to sale (Schmid,
420 2004; Schmid et al., 2006), such as rearing chicks in groups (ideally of the same species)
421 and housing compatible species in weaning cages together (Silva, 1991). Given the needs of
422 grey parrots, and their propensity to develop behavioral problems in particular, breeders
423 should also ensure that potential purchasers are fully versed in the care requirements of
424 parrots.

425

426 Owners

427 It is advised that potential owners who are unable to provide a minimum of 4 hours each day
428 with their bird should not acquire a grey parrot (Gaskins and Hungerford, 2014). That the
429 demands of this species as a companion bird are high is illustrated by the fact that 22% of
430 owners would not have selected a grey parrot as a pet bird if they were aware of the needs
431 of the animal prior to purchase (Schmid, 2004). Ideally parrots should be pair-housed for
432 companionship (Aydinonat et al., 2014) however caution must be used when introducing
433 new individuals to households with established birds, as a strong pair-bond may exist
434 between the original parrot and owner (Welle and Luescher, 2006) resulting in antagonistic
435 reactions towards the newcomer. Environmental enrichment such as toys and foraging
436 devices are encouraged and a regular change of enrichment type or device, approximately
437 weekly, is advised to avoid habituation (van Zeeland et al., 2013b). Bathing/showering
438 opportunities should be provided frequently (Brinker and Friedman, 1999; Schmid, 2004),
439 and cage placement should be considered for the comfort of the parrot (Brinker and
440 Friedman, 1999; Kalmar et al., 2007).

441

442 Clinicians

443 It is suggested that clinicians review petting and handling strategies with owners (van Sant,
444 2006) so that parrot sexual behaviors are not inadvertently encouraged. Clinicians should
445 also develop knowledge of enrichment types and how they can be utilized in the prevention
446 and reduction of stereotypic or abnormal behaviors, in order to improve the general welfare
447 of their patients. Table 1 provides literature for consideration that explores positive effects of
448 enrichment on behavior. It is also recommended that skin biopsies are taken from grey
449 parrots showing FDB to identify whether lesions are inflammatory or traumatic in origin, so
450 that the cause may be determined. If the lesions are inflammatory, further investigatory work
451 can be undertaken as to the potential cause and treatment (Garner et al., 2008). However it
452 is important to note that this is not the sole route of diagnosis, and Nett and Tully (2003)
453 recommend specific dermatologic examination to determine presence of mites and to assess
454 for any skin abnormalities such as exudates and crusting. These authors also recommend
455 additional testing in some cases to explore viral, fungal and bacterial impacts. The first step
456 to addressing FDB is a full and competent veterinary evaluation.

457

458 Recommendations for future research

459 Grey parrots continue to be popular pets. To develop our understanding of their needs in
460 captivity we recommend that studies which span genera and species develop in depth
461 profiles at the level of species. We rarely group all rodents together in studies as they do not
462 exhibit homogenous behaviors across all species. Psittaciformes should also be considered
463 with the same respect for their diversity, ecology and behavior. Some studies reviewed in
464 this article further illustrate the difficulty in extracting species-specific data by mixing genera
465 and species in results.

466 As grey parrots show a high propensity for developing FDB, particularly prior to maturity,
467 greater exploration of the effects of early behavioral development are recommended.
468 Sensitive periods are not well defined in psittacines, unlike domestic cats and dogs, and
469 exploration of critical periods may aid in developing a more appropriate approach to the
470 rearing of grey parrots. Though rearing method has been explored in a few studies, looking
471 further at the environmental conditions of the rearing enclosure (e.g., light level, humidity,
472 diet, temperature, presence or absence of con-specifics) may help our understanding of FDB
473 etiology.

474 The effect of owner personality and beliefs on domestic canine and feline behavior is
475 frequently explored in the scientific press. Given the longevity of parrots and their individual
476 idiosyncrasies it would be useful to determine how owner personality and behavior affects
477 their well-being over time. Exploring the association between the owner-parrot bond and
478 aggression may aid in managing this behavior problem. Video-recording of parrot activities
479 when they are left alone and subsequent analysis will also help our understanding of daily
480 behavioral patterns, captive time budgets and indicate the presence of stereotypic behaviors
481 which may not be performed in the owner's presence.

482 Wild ecology and behavior requires further exploration, so that findings can be applied to
483 captive animals. Length of time spent with parents prior to independence, nest cavity
484 characteristics (such as humidity and light penetration), social interactions and hierarchies
485 may all yield applicable information.

486 We recommend continued exploration of the efficacy of different enrichment devices and
487 sharing laboratory-derived findings with parrot owners. Manufacture and commercialization
488 of appropriate enrichment devices may help improve the welfare of the captive parrot
489 population. Emphasis should be placed on foraging apparatus which, ideally, have an
490 element of shredding and increase foraging time to >60 minutes daily. Technological
491 advances may also yield further enrichment opportunities. For example Peron et al. (2012)
492 showed that grey parrots will use touch-screen computer devices which play either calming

493 or rhythmic music, depending on which icon they select on the screen. Grey parrots
494 demonstrated individual preferences and interacted with the devices when alone, suggesting
495 that such devices can be used as an enrichment strategy.

496 In conclusion grey parrots can be considered as a complex, intelligent and social species
497 which appears to be susceptible to developing abnormal behaviors when kept as a
498 companion animal. Abnormal behaviors, and in particular feather-damaging behavior which
499 is commonly noted in grey parrots, can be multifactorial in their etiology and clinicians should
500 consider the influence of environment, management, life history, personality and ecology, as
501 well as the potential medical elements of these behaviors.

502

503 **Ethical Considerations**

504 Approval for the study was not needed under the ASPA 1986 or the EU Directive 010/63/EU.

505 The study abided by the guidelines of the institutional Research Ethics Committee.

506

507 **Conflict of interest statement**

508 The authors have no conflicts of interest to declare.

509

510 **Authorship**

511 The idea for the paper was conceived by Phillip John Greenwell. The article was written by

512 Phillip John Greenwell and Victoria Tamara Montrose.

513

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Table 1: Enrichment strategies used in captive parrot husbandry

Enrichment option (from Bloomsmith et al., 1991)	Enrichment type	Behavior/ Problem targeted	Species studied	Reference
Nutritional; occupational	Foraging enrichment: pipe-feeder	Reduce / prevent pterotillomania	Grey parrots	Lumeij & Hommers, 2008
Nutritional; occupational	Foraging devices (varied)	Increase foraging time	Grey parrots	Van Zeeland et al., 2013b
Sensory; occupational	Music and touch-screen devices	General behavioral disorders.	Grey parrots	Péron et al., 2012
Social	Pair housing	Chronic stress indicators (telomere length) suggest that pair-housed birds face less stress.	Grey parrots	Aydinonat et al., 2014
Social	Pair housing	Prevention of stereotypy development	Orange-winged Amazon	Meehan et al., 2003b.
Nutritional; occupational	Foraging enrichment (varied)	Reduce locomotor and oral stereotypies	Orange-winged Amazon	Meehan et al., 2004
Nutritional; occupational; physical	Foraging opportunities and physical complexity of environment	Prevent and reduce psychogenic feather picking	Orange Winged Amazon	Meehan et al., 2003a
Occupational; social; nutritional; Physical; mixed	Psittacine Enrichment: review of available literature	Multiple	Multiple	Rodríguez-López, 2016
Nutritional; occupational	Psittacine diets and behavioral enrichment (varied)	General review of enrichment strategies in food provision	Generalised to multiple species	Bauck, 1998

- Grey parrots are prone to developing abnormal behaviors such as feather damaging behavior (FDB).
- Increasing diversity in time budgets and food acquisition appears to help mediate FDB.
- The role of breeders, owners, and clinicians are explored with regards to developing preventative strategies for FDB in grey parrots.

ACCEPTED MANUSCRIPT