



Changes in Behaviour of Laying Hens Following Beak Trimming at Hatch and Re-trimming at 14 Weeks

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ABSTRACT : For many years beak trimming has been a controversial subject, particularly since the 1980's when the practice came under close scrutiny by animal welfare groups. In Australia it is considered an essential practice, averting losses of AUD\$17.5m annually by reducing mortality from cannibalism. While mortality in flocks from cannibalism can be reduced from 25% of the flock to virtually nil, the beak trimming procedure is considered traumatic for the bird. This study examined if chronic pain in the beak was evident in birds 10, 20 and 60 weeks after being trimmed at hatch and in another group of birds, 8 and 52 weeks after being re-trimmed at 14 weeks. Chronic pain was assessed by measuring pecking behaviour and beak sensitivity responses. Pecking behaviour studies completed after beak trimming and re-trimming showed no evidence to indicate that birds were suffering severe chronic pain in the beak. Beak trimmed pullets pecked more at the cage and had more toe pecks, yet overall pecks made at the feed and the environment were no different than untrimmed controls. While the beak sensitivity studies provided evidence that the beak of birds trimmed at hatch and also re-trimmed at 14 weeks may be more sensitive there was no evidence that re-trimming resulted in a more sensitive beak than birds trimmed at hatch only. These studies have shown that birds which are beak trimmed and re-trimmed return to apparently normal feeding and pecking behaviour in the long term. However, there was limited evidence that beaks of trimmed birds have an altered threshold to potentially painful stimuli. (**Key Words :** Laying Hens, Beak Trimming, Behaviour, Pain)

INTRODUCTION

Beak trimming is performed early in the life of commercial hens to decrease injuries caused by cannibalism, bullying and feather and vent pecking (Savory, 1995). It involves partial removal of the upper and lower beak using an electrically-heated blade. It is generally accepted that when light intensity cannot be kept below or at 5 lux, our current laying stock is at risk of an outbreak of cannibalism if they are not trimmed when housed on the floor in large groups (Blokhuys and Wiepkema, 1998) or in cages (Glatz, 1990; Parkinson, 2005). Feather pecking can be more easily controlled in cages than in non-cage systems (Gregory, 2005), although there are still some risks, particularly in open-sided sheds (Savory, 1995). Objections to the use of beak trimming include the removal of sensory receptors

(Gentle et al., 1997), with a subsequent reduction in feed intake (Glatz and Lunam, 1994), pecking efficiency (Gentle et al., 1982), pecking preferences (Hausberger, 1992a, 1992b), permanent loss of temperature and touch responses (Gentle, 1986a) and behavioural evidence (hyperalgesia and guarding behaviour) for persistent pain (Duncan et al., 1989; Gentle et al., 1990). The adverse effects of beak trimming can be divided into a) acute pain while the procedure is performed (Grigor et al., 1995) until several days later (Lee and Craig, 1990), b) sensory deprivation during a large part of the animal's life (Hughes and Michie, 1982; Gentle et al., 1997), and c) chronic pain as a consequence of the forming of neuromas (Breward and Gentle, 1985; Gentle, 1986b). Traumatic neuromas in the beak stump after trimming have been implicated as a cause of chronic pain in commercial hens (Breward and Gentle, 1985; Gentle, 1986b; Lunam et al., 1996).

Nevertheless, the presence of neuromas is not evidence of chronic pain. Once neuromas resolve, random neural activity may cease in adult hens and normal feeding and pecking behaviour may be restored. On the other hand, it is possible that chronic pain may persist after resolution of

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neuromas as a result reorganisation of neural pathways within the spinal cord. To study the pain associated with beak trimming and neuroma-induced changes, pain thresholds can be measured and used as an indication of neural activity. In animals and man, it has been commonly found that thresholds to painful stimuli change in response to pain and that this change indicates alterations in nerve function or nociceptive processing at higher levels (spinal cord or cerebral cortex). The direction of change is generally a decreased threshold, indicating an increased sensitivity to the stimulus. For example, in sheep footrot causes decreased thermal and mechanical thresholds indicating a form of hyperalgesia (Ley et al., 1989; 1995). These alterations to the pain thresholds were found to persist for at least three months, long after any lesions had healed and the animals stopped showing any behaviours indicative of pain. Moiniche et al. (1993) found that cutaneous injury in humans leads to increases in thermal and mechanical sensitivity termed primary and secondary hyperalgesia. Primary hyperalgesia is defined as changes in the area of injury, while secondary hyperalgesia is changes to pain thresholds in the undamaged tissue surrounding the injury, which can become hypersensitive to touch (Campbell et al., 1988). Experimental studies have demonstrated that central sensitisation of dorsal horn neurones may outlast the peripheral injury (Woolfe, 1989; Ji and Woolfe, 2001). However, there can be circumstances in which pain thresholds are increased. It has been well documented that analgesia occurs in both animals and humans in response to pain and stress (Pieretti et al., 1991; Rushen and Ladewig, 1991; Schott, 2001; Walker, 2003), although the mediating pathways may not be the same. There is a substantial amount of literature indicating that diverse forms of stress activate intrinsic pain-inhibitory systems. This well-known phenomenon of stress-induced antinociception (SIA) has been widely studied in many species, particularly rodents (Pieretti et al., 1991; Pujol et al., 1993). Both opioid and non-opioid systems are involved in SIA; these systems will be differentially activated depending on the types of stressors involved and variables such as the intensity, duration and pattern of exposure to the stressors.

In Australia the majority of birds are beak trimmed within 5 to 10 days of hatching. Re-trimming is often performed at 8-12 weeks-of-age if the beak has grown back enough to cause damage. Although there is a move to alternative methods of beak trimming (e.g., infra-red, laser) that may replace hot-blade trimming in Australia, hot blade trimming is likely to remain the method of choice in a number of countries.

The aims of this experiment were to provide an assessment of long-term pain on the basis of changes in behaviour and pain thresholds in birds beak trimmed and re-

trimmed using a hot-blade.

MATERIALS AND METHODS

The methodology involved beak-trimming chickens at one day old. Research indicates that beak rimming at the earliest possible age minimises pain and long-term effects of beak trimming (See Cheng, 2005). Pecking behaviour studies commenced at 10 weeks of age. At the conclusion of these studies birds were assessed for sensitivity to temperature and pressure stimuli applied to the beak. Half of the pullets trimmed at day-old were re-trimmed at 14 weeks of age, which is the latest age this is done in the industry. Further assessments of pecking and beak sensitivity were conducted, commencing when pullets reached 20 weeks and 60 weeks of age. The birds were housed and beak-trimmed at the Pig and Poultry Production Institute, Roseworthy, SA where the pecking behaviour studies were conducted. The birds were then transported in broiler transport cages by car to the Department of Primary Industries Victoria at Werribee (about 800 km) for the beak sensitivity tests, after which they were returned to Roseworthy.

Beak trimming

Forty one-day-old commercial chickens (White Leghorn × Australorp) were beak trimmed, with 20 chickens designated to be re-trimmed at 14 weeks of age. Twenty control chickens were not beak-trimmed. Beak trimming was conducted according to industry standards for beak-trimmer accreditation (Bourke et al., 2002). A heated blade on a commercial electric beak trimming machine (Lyon Electric Companies) cut and cauterised half the upper beak and one-third of the lower beak for 2 s. At 14 weeks of age 20 chickens were re-trimmed using a heated blade that removed 2 mm of the upper and lower beak. The wound was cauterised with the heated blade for 2 s.

Housing and diet

Chickens were housed in a battery brooder for the first four weeks and transferred to rearing cages until they were 18 weeks old. They were then transferred to a climate-controlled room (20-25°C) and housed individually in layer cages (18"×12"×18") until the end of the experiment. Birds were fed a chick starter mash for the first 4 weeks, a pullet grower mash until they were 18 weeks old and layer mash until the end of the experiment.

Pecking behaviour tests

Pecking at a red cube : During the first 5 days of life, chicks were allowed 60 min daily to peck at a red plastic cube (13×3×3 cm). The cube was moved around in the brooder by a handler to encourage chickens to follow and

peck at the moving cube. Once weekly for 60 min thereafter throughout the experiment, the cube was placed in the food hopper to birds provide the opportunity to peck at the cube, and the number of pecks was recorded.

Feeding behaviour : To study the effects of beak trimming on feeding behaviour over time birds were tested at 10, 20 and 60 weeks of age after deprivation of feed for 1 h prior to testing. Individual birds were placed in a test cage (18"×12"×18") with a feed hopper attached. Pullets and hens had been previously placed in the test cages for three 30 min-training-periods prior to the test with feed available. Feed was weighed into a hopper and pecks at the feed and billings of feed were monitored for 30 min via a video record. In addition, bouts of pseudo dust bathing, number of head shakes and water-nipple pecks were recorded and feed pecks per gram eaten calculated.

Pecking behaviour : The same test was repeated but, after food deprivation, the red cube was placed in the bottom of the feed hopper with no feed provided. The number of pecks at the red cube, pecks at the feed hopper, toe pecks, pecks at the cage, pacing, attempts to escape from the cage, head shakes and preening bouts were subsequently calculated from 30 min of video records.

Beak sensitivity tests

Birds at 12, 22 and 62 weeks of age were subjected to several tests in a test cage to study the effects of beak trimming on beak sensitivity over time. The birds were placed individually in this test cage for 10 min on three separate days to familiarise themselves with the cage.

Drinking behaviour : Birds were deprived of drinking water for 15-16 h prior to testing to ensure that they were motivated to drink. Individual birds were placed in the test cage, in which a water bath (filled with water at room temperature) was placed. Drinking behaviour during 5 min was recorded on video. The behaviours that were analysed were: drinking (beak in water), swallowing (with beak up in the air) and head shakes. This test provides an indication of the effective use of the beak while drinking.

Sensitivity to temperature - drinking of hot water : The same test was repeated a few days later, after water deprivation, with water at 45°C. This temperature is around the pain threshold level and changes in behaviour during drinking of water at this temperature may indicate a change in the pain threshold of the beak. Particularly, an increase in head shakes would indicate a more sensitive beak (Gentle et al., 1990).

Sensitivity to pressure - force used to peck at food : Birds were deprived of food for 1-1.5 h prior to testing. Individual birds were placed in the test cage, which contained a pressure transducer (Dynamometer UF1, range -100 to +100 gram), which was calibrated to measure the pressure applied equal to the force used in grams. A small

bowl was mounted on top that contained a thin layer of food. The peak force (measured in grams) of a bird pecking at the food was recorded during the first 3 min after being placed in the cage. During the test, the bird was recorded on video to ensure that the peak force recorded coincided with a pecking event. This test provides an indication of the effective use of the beak while feeding. A decrease in force used when pecking at food may indicate a more sensitive beak.

Sensitivity to pressure-force used to peck at a red disc : Birds were placed in the test cage for three min, after they were deprived of food for 1-1.5 h. Pecking behaviour and peak pecking force (measured in grams) at a red disc attached to the pressure transducer were measured. Behaviour was recorded on video to ensure the peak force recorded coincided with a pecking event. This test provides an indication of the sensitivity of the beak and the use of the beak for exploration.

Statistical analysis

The effects of beak trimming on feeding and pecking behaviour of pullets were analysed using an analysis of variance procedure (using Base-SAS® software, 1988) for each age group separately. Least significant differences were used to separate means ($p < 0.05$).

Pain sensitivity data were analysed per behaviour test per age group with a one-way analysis of variance. This was considered the most appropriate way to analyse the data since changes in behaviour over time occur naturally regardless of treatment effects and are taken into account by comparison to a control group. Birds that did not perform in a certain test (i.e., did not peck at the water, food or the red disc) were not included in the analysis of that test.

RESULTS

Pecking behaviour tests

While there was no significant difference at 10 weeks in the total number of pecks between the control birds and the birds trimmed at hatch ($p > 0.05$), the beak trimmed birds had significantly more cage pecks ($p < 0.05$) and fewer head shakes ($p < 0.05$; Table 1).

At 20 weeks the incidence of head shakes ($p < 0.05$) and cage pecks ($p < 0.01$) were both higher ($p < 0.05$) in birds that were trimmed at hatch compared to the control birds (Table 1). The re-trimmed birds were intermediate to the trimmed birds and control birds for both variables. The incidence of toe pecks in birds that were re-trimmed at 14 weeks was significantly higher ($p < 0.01$) than in the control birds when tested at 20 weeks, while the birds that were trimmed at hatch only were intermediate between these two groups. However, there was no effect of treatment on the total number of pecks ($p > 0.05$) at 20 weeks. Pacing in the cage

Table 1. Effects of beak trimming on feeding and pecking behaviour (number of behaviours shown during test) in layers at 10, 20 and 60 weeks of age

Variable	10 weeks of age			20 weeks of age				60 weeks of age			
	Trim	Control	LSD	Trim	Re-trim	Control	LSD	Trim	Re-trim	Control	LSD
Feed pecks per g	138.6	98.2	47.31	108.2	146.3	178.6	96.20	101.6	69.8	69.8	48.84
Feed intake (g/bird)	3.1	3.3	1.38	2.4	2.7	2.9	1.46	2.71	3.3	2.8	1.95
Feed pecks	367.7	281.6	142.90	259.6	378.6	406.3	252.00	163.2	243.8	193.4	152.90
Feed bills	87.9	88.3	53.11	21.5	35.1	53.0	34.45	3.8	5.1	11.4	8.72
Dust bathes	17.4	7.9	12.11	1.9	0.5	3.0	5.00	0.0	0.0	0.3	0.25
Head shakes	1.1 ^a	2.8 ^b	1.33	4.9 ^a	3.4 ^{ab}	1.6 ^b	2.52	2.2	2.2	2.7	2.05
Peck nipple	-	-	-	4.2	2.6	3.8	3.83	2.8	2.1	1.7	4.30
Cage pecks	16.1 ^a	10.5 ^b	4.68	91.1 ^x	49.1 ^{xy}	21.8 ^y	43.67	10.7 ^{ab}	14.5 ^a	3.6 ^b	9.17
Hopper pecks	6.4	2.5	4.67	8.8	2.5	7.8	12.82	0.5	1.1	0.7	1.09
Toe pecks	0.7	0.3	0.66	56.9 ^{xy}	102.1 ^x	153 ^y	57.22	2.2	18.7	0.4	26.89
Pecks at red block	1.1	1.5	2.14	0.5	0.5	0.5	0.77	0.1	0.3	0.0	0.54
Preening bouts	12.8	10.0	10.40	45.6	49.7	53.3	22.14	8.9	8.9	7.0	6.35
Pace in cage	0	0	-	3.1 ^a	0.1 ^b	1.7 ^{ab}	2.30	0.2	1.1	1.3	1.51
Escape	3.9	6.3	5.66	4.2	0.7	1.5	3.13	0.3	1.2	3.1	2.53
Head flicks	0	0	-	2.5	3.2	2.0	1.54	4.1	5.4	3.8	3.71
Total pecks	479.8	384.5	197.20	442.4	570.4	508.4	223.20	183.2	285.4	211.1	102.30

^{a,b} Means within rows not followed by same letter are significantly different at $p = 0.05$.

^{x,y} Means within rows not followed by same letter are significantly different at $p = 0.01$.

LSD = Least significant difference ($p < 0.05$).

Table 2. Behaviour (number of behaviours during test) of birds at 12, 22 and 62 weeks of age presented with water at room temperature and at 45°C

Variable	12 weeks of age			22 weeks of age				62 weeks of age			
	Trim	Control	LSD	Trim	Re-trim	Control	LSD	Trim	Re-trim	Control	LSD
Water at room temp											
% of birds pecking	65	40	-	60	65	55	-	63	63	79	-
No. of pecks	17.7	14	10.79	26.6	21.3	21.6	11.69	20.1	23.1	21.0	11.81
No. of drinks	16.6	12.5	10.40	21.9	20.2	18.6	11.34	19.1	20.8	18.2	11.06
No. of drinks/peck	0.9	0.7	0.20	0.8	0.7	0.8	0.26	0.8	0.7	0.8	0.26
No. of head shakes	0.6	0.6	0.96	4.3 ^b	1.4 ^a	0.7 ^a	2.69	3.1	3.8	3.1	3.24
No. of head shakes/peck	0.1	0.1	0.17	0.2	0.2	0.0	0.21	0.2	0.2	0.1	0.20
Water at 45°C											
% of birds pecking	75	50	-	80	75	70	-	63	74	74	-
No. of pecks	10.5	10.0	8.20	23.4	19.3	25.4	13.26	20.8	18.9	20.1	12.63
No. of drinks	4.6	5.6	3.88	11.8	11.9	16.4	9.20	15.9	14.2	13.9	9.26
No. of drinks/peck	0.4	0.4	0.23	0.5	0.4	0.6	0.23	0.6	0.7	0.7	0.20
No. of head shakes	2.1	0.8	1.79	7.3 ^a	5.1 ^{ab}	2.9 ^b	4.35	6.1	4.4	4.1	4.24
No. of head shakes/peck	0.3	0.2	0.21	0.3 ^{ab}	0.4 ^a	0.1 ^b	0.20	0.3 ^a	0.3 ^{ab}	0.2 ^b	0.14

^{a,b} Means within rows not followed by same letter are significantly different at $p = 0.05$.

LSD = Least significant difference ($p < 0.05$).

was significantly higher ($p < 0.05$) in the birds trimmed at hatch compared to the birds that were re-trimmed.

When tested at 60 weeks, feeding and pecking behaviours were similar for all treatment groups (Table 1). Only cage pecks were higher ($p = 0.05$) in the group that was re-trimmed compared to the control group.

Beak sensitivity tests

Drinking behaviour : The number of birds pecking at water at ambient temperature ranged from 40 to 79% per treatment per age group (Table 2). There were no effects of treatment at 12 weeks of age in pecks and drinks at water ($p > 0.05$). However, there was a trend for birds trimmed at

hatch to have more drinks per peck ($p < 0.1$) than the control birds. This trend was not present in the older birds (Table 2). At 22 weeks of age the number of head shakes was significantly higher ($p < 0.05$) in the birds trimmed at hatch than control and re-trimmed birds (Table 2). There was a trend for a higher number of head shakes/peck in the two trimmed treatments compared to the control birds ($p < 0.1$). There were no treatment effects at 62 weeks of age.

Sensitivity to temperature-drinking of hot water : The number of birds pecking at hot water ranged from 50 to 80% per treatment for the three age groups (Table 2). There were no effects of treatment at any age in pecks and drinks at water. However, there was a trend for 22-week old birds

Table 3. Behaviour of birds at 12, 22 and 62 weeks of age presented with food or a red disc

Variable	12 weeks of age			22 weeks of age				62 weeks of age			
	Trim	Control	LSD	Trim	Re-trim	Control	LSD	Trim	Re-trim	Control	LSD
Pecking at food											
% of birds pecking	50	30	-	65	65	70	-	65	70	70	-
No. of pecks	29.0	18.2	27.95	34.0	26.9	28.4	21.23	32.4	27.8	30.1	20.14
Peak force used (g)	6.0	6.6	2.47	5.6	4.7	6.7	3.94	7.6	5.0	8.2	4.63
Pecking at red disc											
% of birds pecking	43	55	-	45	40	55	-	45	45	50	-
No. of pecks	4.2	6.7	2.88	8.2	10.6	8.9	8.11	8.5	9.2	9.0	8.25
Peak force used (g)	1.8 ^a	2.8 ^b	1.41	3.6	4.8	7.3	5.17	3.7	3.7	6.4	2.89

^{a,b} Means within rows not followed by same letter are significantly different at $p = 0.05$.

LSD = Least significant difference.

that were re-trimmed at 14 weeks to have fewer drinks per peck than the control birds ($p < 0.1$). Birds that were trimmed at hatch tended to show more head shakes at 12 weeks than the birds that were not trimmed ($p < 0.1$; Table 2). This difference was significant at 22 weeks ($p < 0.05$). There were more head shakes per peck at 22 and 62 weeks in both the re-trimmed birds (at 22 weeks, $p < 0.05$) and the birds trimmed at hatch (at 62 weeks, $p < 0.05$) compared to the control treatment (Table 2).

Sensitivity to pressure-force used to peck at food: The number of birds pecking at food in this test ranged from 30% in 12-week old non-trimmed birds to 70% in 22-week old non-trimmed birds (Table 3). There were no effects of treatment at any age in number of pecks at food and the force used to peck at food ($p > 0.05$).

Sensitivity to pressure-force used to peck at a red disk: The number of birds pecking at the red disk ranged from 40 to 55% (Table 3). At 12 weeks trimmed birds tended to direct fewer pecks at the red disk than birds that were not trimmed at hatch ($p < 0.1$). No difference was found between the treatments in older birds. Birds trimmed at hatch used significantly ($p < 0.05$) less force at 12 weeks when pecking at the red disk than non-trimmed birds. There were no differences between treatments at 22 weeks ($p > 0.1$), but there was a trend at 62 weeks for the trimmed groups to use less force than the control birds ($p < 0.1$).

DISCUSSION

If hens were experiencing severe chronic pain, it would be expected that they would peck less and use less force when pecking. However, there was no difference in the total number of pecks made by beak trimmed and control birds at any stage in the pecking tests at a red cube and food. In fact, beak trimmed birds pecked more at the cage and tended to have more pecks at the hopper 10 weeks after beak trimming compared to control birds, suggesting an absence of severe chronic pain. Beak trimming may alter the sensory perception of the bird (Gentle et al., 1982) but, contrary to a previous report (Gentle et al., 1990), in the present study there was an increase in pecks made at the cage by the

trimmed birds compared to the controls at 10 weeks of age. It should be borne in mind however, that Gentle et al. (1990) made their behavioural assessment of chronic pain 6 weeks after beak trimming, whereas the first observations in the present study were made at 10 weeks after beak trimming.

Examination of the beaks from birds in this study revealed that neuromas were present in the upper beak at 12, 28 and 66 weeks, although the extent and distribution of neuromas suggested that resorption had commenced by 28 weeks of age and in some birds had been completely resorbed by 66 weeks (Lunam, unpublished). Neuromas found in the lower beak were less extensive compared to the upper beak and had been fully resorbed by 66 weeks. After re-trimming there was a marginal increase in the extent of the neuromas at 28 and 66 weeks, suggesting minimal perturbation of nerves and general tissue structure caused by re-trimming (Lunam, unpublished).

There was no indication of a reduction in pecking behaviour in re-trimmed birds compared to both the control and once-only trimmed pullets at 20 weeks, suggesting an absence of severe chronic pain in the re-trimmed birds. In fact, re-trimmed pullets made more toe pecks than controls at 20 weeks, while the number of cage pecks in re-trimmed birds was significantly higher than control birds at 60 weeks.

Human amputees report not only phantom pain and stump pain, but also report phantom sensations, such as the feeling that the amputated limb is still present. (Jensen et al., 1984; Jensen and Rasmussen, 1994). Although there is no evidence from the data in this experiment that birds experienced chronic pain after beak trimming it is possible that birds may also experience phantom sensations. Perhaps the discrepancy of the sensations of the tip of an intact and a trimmed beak increases investigative behaviour. This may be a possible explanation for the significant increase in cage- and toe pecks in beak trimmed birds. Another explanation may be that beak trimming results in a mild irritation rather than severe pain. Mild irritation may result in a mild stimulation of the beak persisting at a low but detectable level (Broom and Johnson, 1993) and result in an increase in toe pecks and cage pecks. Alternatively,

according to the Gate Control Theory of Pain (Melzack and Wall, 1965), touching or rubbing a painful location may serve to mask a sensation of pain.

Although the data were not statistically significant, beak trimmed birds also tended to have more feed pecks per gram of food consumed and more pecks at the feeder than control birds at 10 weeks. Tanaka and Yoshimoto (1985) observed many feed pecks made by laying hens are without the actual intent to eat. They regarded all pecks at food without eating as play eating. An increase in play eating after beak trimming may possibly be explained as a result of phantom sensations or an increased stimulation of the beak. It is also possible that beak trimming may reduce the ability of the pullet to pick up food, as was found in another study (Workman and Rogers, 1990). The increased number of pecks per gram of food may indicate that beak trimmed pullets have reduced mechano-reception ability as a result of the altered beak shape, although a similar effect was not found after re-trimming.

Even though birds had gone through a familiarisation process prior to the commencement of the pain threshold and beak sensitivity tests, many birds did not perform during these tests. Although the test cage was within sight of the other birds, isolation from other birds probably caused some anxiety in these birds when in the test cage. Because the data could only be collected from a limited number of birds, this may have compromised the power of the statistical tests.

No significant differences between the treatments were found in the number of pecks at and drinks of cold and hot water at any age. Because of the 15-16 h water deprivation prior to these drinking tests birds were probably highly motivated to drink and the number of pecks at the water was similar in both the cold and hot water test. However, the number of drinks per peck was considerably less in the hot water test, indicating that this water was much attractive to drink. Indeed, the number of head shakes, and head shakes per peck, when drinking hot water showed significant differences between treatments. The temperature of the water (45°C) is around the pain threshold level and head shakes may indicate a pain response after the beak was submerged in hot water (Gentle et al., 1990). The group that was trimmed at hatch showed more head shakes at 12 and 22 weeks when drinking hot water compared to the control birds. A more accurate measure of the sensitivity of the beak is the number of head shakes per peck, to correct for the difference that may occur in the amount of pecking at the water. Control birds showed less head shakes per peck at 22 and 62 weeks than birds trimmed at hatch and re-trimmed birds. The difference between the treatments at 12 weeks showed a similar trend. These data suggest that birds trimmed at hatch only and birds that were re-trimmed at 14 weeks were more sensitive to pain than control birds

throughout their life. Although re-trimming takes place at an age when the incidence and persistence of neuromas is thought to increase compared to beak trimming at hatch only, no additional increase of the sensitivity of the beak was found compared to birds trimmed at hatch only. In experiments in many species it has been found that thresholds to painful stimuli generally decrease in response to chronic pain (Gentle et al., 1990; Moiniche et al., 1993). Whether the increased sensitivity to a painful stimulus as a result of beak trimming found in this study is a result of changes in threshold of the pain receptors per se or a result of chronic pain remains unknown. A reliable technique to measure chronic pain in animals is currently not available, although there has been developmental work to measure pain in sheep, based on EEG responses (Morris et al., 1997; Ong et al., 1997). This technique could be developed for poultry in the future.

The number of pecks and the force used when birds pecked at food was similar in all treatments at all ages. Because of the period of feed withdrawal the birds should have been highly motivated to feed, and because of the large reward of consuming feed, possible differences in sensitivity of the beaks between treatment may have been masked. Indeed the test with the red disc showed some differences between treatments in the number of pecks and the force used to peck the red disc, particularly at 12 weeks of age. At this age control birds tended to peck at the disc more often and used significantly more force when they did. At an older age the number of pecks at the disc was similar, but a tendency to use less force in trimmed birds persisted at 22 and 62 weeks. This may indicate that trimmed birds were more careful when pecking at objects in their environment due to a more sensitive beak and may be similar to beak guarding behaviour observed by Gentle et al. (1990). Alternatively, it may be a consequence of the beak being less effective in exploring the environment after beak trimming, as a consequence of reduced feedback from sensory receptors in the beak.

Several authors have reported greater inactivity in beak trimmed birds, possibly as a consequence of chronic pain (Duncan et al., 1989; Lee and Craig, 1990). In the present experiment, whether or not birds performed in a test probably had little to do with activity but more with anxiety after being separated from other birds. Nevertheless, no differences were found between treatments in the percentage of birds performing in any particular test. However, the reduced number of pecks at a red disc by 12-week old beak trimmed birds may also be an indication of reduced activity. No differences in the number of pecks at water and food were found in this age group, however, due to the deprivation of food or water prior to these tests, heightened motivation may have masked changes in activity.

The results suggest that the beaks of birds trimmed at

hatch only and those re-trimmed at 14 weeks may be more sensitive to pain than non-trimmed birds, as indicated by the amount of head shakes when attempting to drink hot water. This difference persisted throughout the testing period from 12 weeks to 62 weeks old. Force used when pecking at objects in the environment also appeared to be affected throughout the animals' lifetime, with less force being used in trimmed birds. Whether this is a result of reduced sensation in the beak (making exploration less rewarding), a learned response as a result of pain experienced in the past, or a more sensitive beak, remains unresolved. Irrespective of the cause of these changes in birds trimmed at hatch, re-trimming of birds at 14 weeks of age did not appear to have any (additional) adverse effects.

Changes in behaviour, were observed in beak trimmed birds, and these changes may be indicative of learned responses after pain experienced immediately after beak trimming. However it is more likely that considered with the histopathological findings of neuromas, these changes in behaviour indicate changes in sensory perception and changes in pain thresholds.

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Animal ethics

All procedures complied with the "Australian Code of Practice for the care and use of animals for scientific purposes" (Australian Agricultural Council, 1990) and the "Australian Model Code of Practice for the Welfare of Animals Domestic Poultry" (Standing Committee on Agriculture and Resource Management, 1995).

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