The impact of group size on damaging behaviours, aggression, fear and stress in farm animals

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Abstract

The aim of this review is to discuss the impact of group size on damaging behaviours, aggression, fear and stress in farm animals and to identify housing- and management options that can help to reduce problems caused by suboptimal group sizes. Increasing group size was found to increase the risk of damaging behaviour, such as feather pecking in laying hens and vulva biting in sows. Aggression does not appear to be a problem in large groups, because dominance relationships in these groups are not based on individual recognition, but based on other signals such as body size, avoiding costly fights. There is evidence for increased fear and stress levels in large groups compared with small groups, but fearfulness is also strongly affected by type of housing. To minimise problems in large groups, it seems helpful to offer separate functional areas and to provide cover, reducing disturbance between animals. To minimise the risk of damaging behaviour, such as feather pecking in laying hens and tail biting in pigs, stimulating foraging, exploration and manipulation behaviour by providing sufficient substrate (straw, wood shavings and sand) offers perspective. Rearing the animals in a system which allows the development of all these behaviours is very important. Other solutions can be found in optimising the diet and offering extra foraging opportunities. Furthermore, genetic selection against damaging behaviour seems promising. In conclusion, group size mainly has an effect on damaging behaviour and fear and stress in pigs and poultry. The effect on aggressive behaviour is limited. To reduce damaging behaviour, fear and stress, it is important to provide a complex environment with ample behavioural opportunities and separate functional areas.

Keywords: Group size; Aggression; Fear; Stress; Feather pecking; Tail biting

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1. Introduction

Group size may have a large impact on the behaviour of farm animals, especially in species where the natural group size is very different from the group size used on farms. In cattle, large group sizes are common in wild populations.

For poultry and pigs, however, the group size found in the wild is generally much smaller than the group size found under farming conditions (Collias et al., 1966; Gonyou, 2001). Large group sizes may lead to damaging behaviour, aggression and increased fear and stress levels. The aim of this review is to study the impact of group size on these parameters and to identify housing and management options that can help to reduce problems caused by increased group size.

2. Damaging behaviours

Group size can affect problematic behaviours, such as feather pecking and cannibalism in laying hens. Feather pecking is the pecking at and pulling out of feathers of conspecifics. It varies from gentle feather pecking to severe feather pecking or feather pulling (Savory, 1995). Feather pecking should not be confounded with aggressive pecking, which is used to maintain the dominance hierarchy. Feather pecking is a form of redirected pecking, originating either from food pecking (Wennrich, 1975), ground pecking (Blokhuis, 1986) or pecking during dustbathing (Vestergaard and Lisborg, 1993). Feather pecking is a multi-factorial problem affected by the availability of floor substrate (Blokhuis, 1986), nutrition (Van Krimpen et al., 2005), adequate lighting (Kjaer and Vestergaard, 1999), genetic background (Bessei, 1984; Kjaer and Sørensen, 1997; Rodenburg et al., 2003) and group size and stocking density (Allen and Perry, 1975; Nicol et al., 1999; Savory et al., 1999; Bilcik and Keeling, 2000; Zimmerman et al., in press). In studies on feather pecking, much attention has been given to the effect of group size, stocking density and their interaction. Allen and Perry (1975) found increasingly more feather pecking and cannibalism in groups of 3, 4 and 6 caged Babcock laying hens respectively, whereas stocking density (439 or 658 cm²) was found to be of lesser importance. For cannibalistic deaths, a trend was found for one death to be followed by more in the same cage. In a study by Savory et al. (1999) in young bantam birds in a rearing cage, it was found that pecking damage was influenced by the interaction between group size (10 or 20 birds) and stocking density (186, 372 or 744 cm²/bird). They found most feather damage in the larger group size at high stocking densities. Nicol et al. (1999) compared different stocking densities in a perchery. They manipulated stocking density by varying the group size (72, 168, 264 or 368 Isa brown birds) and found the worst plumage condition in the large groups of 264 and 368 birds with the high stocking density of 22 and 30 birds/m², respectively. Similarly, Bilcik and Keeling (2000) compared group sizes of 15, 30, 60 and 120 Hysex white birds in floor pens at a low stocking density of 5 birds/m² and found most feather pecking in the groups of 120 birds. These results confirm that the risk of feather pecking in laying hens increases with increased group size. Zimmerman et al. (in press), however, studied feather pecking under commercial conditions in group sizes between 2450 and 4200 Shaver birds and stocking densities between 7 and 12 birds/m². They found lower levels of feather pecking in the largest flocks compared with the smaller flocks. For cannibalism in laying hens, Koene (1997) found more cannibalism on commercial farms with large flock sizes, with flock sizes varying from 80 to 1500 birds. In this study, cannibalism due to vent pecking and cannibalism related with feather pecking were combined. Newberry (2003) reviewed the available studies on the effect of group size on cannibalism. She also reported more cannibalism in cages with groups of 6–8 birds than in cages with 3–4 birds. She found more cannibalism in
groups of 120 birds than in groups of 15–60 birds in floor pens, but reported that Gunnarsson et al. (1999) did not find a correlation between cannibalism and group size in large groups from 225 to 9954 birds, indicating that there may be an upper limit to the effect of group size on cannibalism, which may be similar to the effect on feather pecking found by Zimmerman et al. (in press). Pötzsch et al. (2001) studied the risk factors related with the incidence of cannibalism due to vent pecking on commercial farms and did not find an effect of group size.

In pigs, the risk of damaging behaviour may also be associated with increased group size. Group size was found to be a risk factor for the development of vulva biting in dry sows (Rizvi et al., 1998). Furthermore, the occurrence of vulva biting in this study was related to the occurrence of tail biting on the same farm. Tail biting in pigs is a multi-factorial problem, much like feather pecking in laying hens. Moinard et al. (2003) studied the risk factors for the development of tail biting on a farm and found that the availability of straw strongly reduced the risk of tail biting, whereas slatted floors, limited feeder space, high stocking densities and a large farm size increased the risk of tail biting. Group size was not identified as a risk factor for tail biting in this study (Moinard et al., 2003). Similarly, Schmolke et al. (2003) found no effect of group size on tail biting injuries, when comparing groups of 10, 20, 40 and 80 growing-finishing pigs.

3. Aggression

Aggressive behaviour is also affected by group size. In laying hens, Bilčík and Keeling (2000) found increased aggression with increased group size from 15 to 120 Hysex white birds. Nicol et al. (1999), on the other hand, found higher levels of aggressive pecking in small groups (72 birds) than in large groups (over 264 birds) of Isa brown birds. Similarly, Hughes et al. (1997) found low levels of aggression in large groups of laying hens with group sizes of 300 and 700 Isa brown birds. They found no increase in aggression when groups of 300 birds were mixed together or when sub-groups of six birds from different flocks were mixed. Lindberg and Nicol (1996) studied aggression in groups of Warren birds and also found lower aggression in birds kept in groups of 44 than in birds kept in groups of four, when these birds were tested in a T-maze test. Doug lis (1948) found that laying hens could recognıse and react to 27 conspecifics, whereas Guhl (1953) reported a dominance hierarchy in a flock of 96 birds. D’Eath and Keeling (2003) compared groups of 10 and 120 Lohmann Selected Leghorn (LSL) birds and showed that birds in the large groups used other signals to establish dominance relationships such as body size and comb size, the larger bird with the bigger comb being the more dominant. Similarly, in pigs more fights occurred after mixing in groups of 6 and 12 pigs than in groups of 24 pigs and the percentage of pigs not participating in fights was higher in the largest group (Andersen et al., 2004). Turner et al. (2001) showed that pigs from a group of 80 were less aggressive to unfamiliar pigs than pigs from groups of 20 individuals, while they could still recognise familiar pigs. There is evidence that such a strategy is more beneficial to an individual in a large group than to invest in costly dominance relationships (Pagel and Dawkins, 1997; Andersen et al., 2004). It may also be that animals form sub-groups in large groups. In pigs, Moore et al. (1993) found that, after joining a large group, the newly introduced sows form a sub-group during periods of resting for up to 21 days. It is not clear however, if these sub-groups also stay together during active behaviour and actually have territories (Gonyou, 2001). In poultry, Oden et al. (2000) found that animals have a preference for a certain location in the system, which may be an indication of the existence of sub-groups with separate home-ranges. Other studies, however, found no evidence for sub-group formation or the existence of territories (Preston and Murphy, 1989; Widowski and Duncan, 1995; D’Eath and Keeling, 2003).
In small and large groups of laying hens, aggression does not appear to be a problem. Intermediate group sizes of about 30 birds may constitute social problems that can affect production. Keeling et al. (2003) found that Hysex white birds from groups of 30 had lower body weight and lower egg weight than birds from groups of 15 or 60 birds. When the aggressive behaviour of these birds was studied, it was found that indeed less aggressive pecks were given in the larger groups of 60 and 120 birds (Estevez et al., 2003). However, they also found that the observed birds received more aggressive pecks in these large groups. Estevez et al. (2003) argued that a minority of birds in large groups may develop into despotic birds, directing aggression to all other individuals, whereas the majority of the birds shows little or no aggression. It may be that some individuals are more rigid in their aggressive behaviour. Bolhuis et al. (2005) compared aggressiveness and fighting strategies in pigs with different coping characteristics: either high resisting (HR) or low resisting (LR) pigs. In LR pigs a relationship was found between self-initiated fights and social rank, whereas in HR pigs this was not the case. HR pigs showed high levels of aggression regardless of their success (Bolhuis et al., 2005). It may be that such individuals cause problems in large groups, because they have difficulty in adapting their strategy, similar to the despotic birds described by Estevez et al. (2003). In cattle, large group sizes are common in wild populations. However, an increase in group size can lead to increased aggression in adult cows and bulls (Kondo et al., 1989; Price and Wallach, 1991). In the study by Price and Wallach (1991), increased aggression was related with increased competition between bulls over access to the cows. In calves no effect of group size on aggression was found (Kondo et al., 1989).

3.1. Fear and stress

The vocalisations of an animal can tell us something about its perceived welfare status. Koene, 2005; Koene et al. (submitted for publication) studied vocalisations in Lohmann brown laying hens with group sizes varying between 2 and 10 birds and stocking densities between one and 31.6 birds/m². They found that increasing group size led to a decrease in vocalisations, including gakel-calls which are indicative of frustration (Zimmerman and Koene, 1998). Increasing stocking density led to an increase in total vocalisations and a decrease of contact grunts, which are indicative of good welfare (Collias, 1987). In the small groups used in the study by Koene, 2005; Koene et al. (submitted for publication), increasing stocking density did seem to cause welfare problems as indicated by the birds’ vocalisations, whereas increasing group size did not have a negative effect on bird welfare. The authors argued that increasing the group size maintains or increases social support, whereas increasing the stocking density increases stress.

The duration of tonic immobility (TI) is a useful measure of the fear level of a bird immediately preceding its induction into TI and of its underlying fearfulness (Jones, 1990). Bilčik et al. (1998) studied the effect of group size on TI in laying hens in groups of 15, 30, 60 and 120 Hysex white birds. They found that duration of TI was longer in groups of 120 than in groups of 15 birds, indicating higher levels of fearfulness in groups of 120 birds, probably due to increased competition in large groups. Furthermore, a difference was found between testing the birds in their home pen and testing them in a separate room. In the separate room, durations of TI were longer and differences between group sizes were less pronounced, probably because the fear response of the birds was enhanced by isolation in the separate room. Fear has also been associated with feather pecking in laying hens (Hughes and Duncan, 1972); groups with high levels of feather pecking are considered as being more fearful than groups with low levels of
feather pecking. Hansen et al. (1993) compared TI durations of laying hens in cages (small groups) and in aviary systems (large groups). They found that there was no difference between systems at 30 weeks of age. At 70 weeks of age, however, birds in cages showed a longer TI duration than birds in aviaries. The TI duration did not correlate with plumage condition, except for a longer TI duration with poorer plumage in aviaries at 30 weeks of age. They concluded that fearfulness of birds in cages increased considerably over time, whereas the lower fearfulness of birds in aviaries suggests that freedom from fear is more secured in this system.

Increasing group size may also have positive effects. In calves, Takeda et al. (2003) found evidence that a larger group size may help to reduce emotional stress. In a series of novel object-, fear- and frustration tests, calves that were housed in a group of five were calmer than calves housed in pairs. Similarly, in pigs, Barnett et al. (1986) found higher cortisol levels in pigs housed in pairs than in pigs housed in groups of 4 or 8 individuals with the same space allowance per pig. Furthermore, pigs that were housed in pairs were more frequently observed to be lying alone, without physical contact with the other pig, than the pigs in the other treatments. Possibly also the fact that groups of 4 or 8 individuals had more space as a group contributed to the lower cortisol levels than in pigs housed in pairs, as they had more opportunities to avoid aggression.

3.2. Housing- and management options to minimise problems

Larger group sizes can lead to higher levels of damaging behaviours and increased fearfulness and stress in pigs and poultry. The effect on aggression seems to be limited, as the social structure of large groups is different from small groups. Improvement of housing and management may help to minimise problems. If we look at fearfulness, for instance, birds in large groups are more fearful than birds in small groups (Bilčik et al., 1998), but at the same time birds in cages are more fearful than birds in large group housing systems (Hansen et al., 1993). This paradox shows that other factors than group size affect fearfulness. In aviary systems, the birds have more space as individual and as a group and have ample opportunities to avoid negative social interactions. Furthermore, functional areas such as perches, nests and litter are more separated in aviary systems than in cages, so that birds that perform different types of behaviour do not disturb each other. By offering vertical panels and artificial cover in poultry houses, birds could be provided with extra possibilities for shelter, protection from predators and from aggressive conspecifics (Cornetto and Estevez, 2001). In broilers, Cornetto and Estevez (2001) found that the panels were used extensively for shelter, leading to a better distribution of the broilers over the house. Supplying artificial cover also reduced disturbance of resting animals, but did not help to reduce aggression (Cornetto et al., 2002). In pigs, providing shelter after mixing did help to reduce aggression (McGlone and Curtis, 1985). Other modifications to the housing system may also help to reduce problems. Simonsen (1990) described a so-called multi-activity pen for pigs, with feed trough partitions, straw racks and biting/levering logs. This type of pen was successful in reducing aggression in large groups of pigs kept at a high stocking density (range of 4.5–0.8 m²/animal).

3.3. Reducing damaging behaviour

Damaging behaviour is one of the major problems in large groups. Especially feather pecking and cannibalism in large groups of laying hens has received much attention. In practice, beak trimming and dimming the light are used as tools to minimise problems in case of an outbreak of feather pecking. Beak trimming (Glatz, 2005) involves the removal of part of the upper and/or lower beak. The procedure in itself is painful and if it is not performed properly it can lead to
formation of neuromas and to chronic pain (Gentle, 1986). Dimming the light or using red light instead of white light is used to calm the birds and to avoid that the birds can detect contrasts, for instance between white feathers and a red wound. Kjaer and Vestergaard (1999) showed that severe feather pecking is more frequent under high light intensities than under low light intensities, whereas gentle feather pecking is more frequent under low light intensities. The problem of keeping laying hens at low light intensities can be that birds cannot see and recognise each other and cannot navigate in their environment. Light colour also plays a role here, as birds can better recognise other birds in white light than in blue light and red light is worst for recognition (D’Eath and Stone, 1999). This implies that a new welfare problem may be introduced when dimming the lights or changing the colour. Both beak trimming and dimming the light are not real solutions to the problem of feather pecking but are used for damage control in practice. Other strategies may offer more lasting solutions to reduce the risk of feather pecking.

As feather pecking is thought to originate from ground pecking behaviour, it seems likely that stimulating ground pecking helps to reduce feather pecking. Bestman and Wagenaar (2003) studied feather pecking on organic farms and found that a high percentage of hens using the outdoor run helped to reduce problems with feather pecking. Green et al. (2000) identified risk factors for feather pecking and found that limited use of the outdoor run, a large number of diet changes, inspection of the flock by only one person, absence of loose litter at the end of lay, low temperatures in the house, increasing light intensity during inspection and the use of bell drinkers were all factors that increased the risk of feather pecking. They concluded that factors such as limited use of the outdoor run and absence of loose litter inhibited foraging and dustbathing behaviour, whereas other factors, such as diet changes and variation in light intensity, might increase competition or frustration and that both types of factors can lead to feather pecking. Interestingly, Zimmerman et al. (in press) showed that adapting farm management according to such a risk factor analysis actually is effective. They compared standard management (bell drinkers, light in nestboxes) with modified management (nipple drinkers, no light in nestboxes) and found a marked reduction in feather pecking and aggression in the flocks with modified management. Rearing also plays an important role in reducing feather pecking. Huber-Eicher and Sebő (2001) showed for instance that chicks that had access to litter from one day of age spent more time foraging and less time feather pecking at five and at 14 weeks of age than chicks that had access to litter from two weeks of age. Similar results were found by Nicol et al. (2001). They showed that early experience with litter reduced the risk of feather pecking in later life and stimulated ground pecking and dustbathing. Apart from stimulating foraging behaviour, also nutritional changes can help to reduce the risk of feather pecking. Van Krimpen et al. (2005) reported that too low mineral, protein or amino acid levels in the diet can lead to feather pecking. Furthermore, more feather pecking may occur when the diets are fed restrictedly, fed coarsely ground or fed as pellets. On the other side, feeding high-fibre diets, low energy diets or roughage can help to reduce feather pecking, as can provision of grain or straw in the litter in adult laying hens (Van Krimpen et al., 2005).

Another strategy to reduce feather pecking in laying hens is through genetic selection. Feather pecking has been found to be heritable, with heritabilities ranging from 0.07 to 0.56 (Cuthbertson, 1980; Bessei, 1984; Kjaer and Sørensen, 1997; Rodenburg et al., 2003). Direct genetic selection has been shown to be feasible, using individual selection against feather pecking (Kjaer et al., 2001; Su et al., 2005) or group selection against mortality (Craig and Muir, 1993). Studies that focus on the genetic relationship between feather pecking and other behavioural traits (Hocking et al., 2004; Rodenburg et al., 2004), health traits and production traits (Buitenhuis et al., 2004) inform us what effect selection against feather pecking will
have on these traits. Furthermore, these studies may present us with predictors of feather pecking.

Rodenburg et al. (2004) studied the genetic relationships between fear and feather pecking and found that birds that are fearful in an open-field test at young age were likely to show high levels of pecking behaviour as adults. This type of relationships can be useful in selection against feather pecking. Currently, the breeding companies are taking a large effort to include reduction of feather pecking in their breeding programs (Albers and van Sambeek, 2002; Preisinger and Schmutz, 2002; Besbes, 2002).

For tail biting in pigs, docking the tails helps to reduce tail biting (Bracke et al., 2004), but tail docking is not a structural solution similar to beak trimming in laying hens. Other important factors that help to prevent tail biting are a good diet (sufficient iodised salt and protein) and supplying substrate (straw, compost; Bracke et al., 2004). Schröder-Petersen and Simonsen (2001) also suggested other stimuli that may help to reduce tail biting: iron chains, car tyres, pieces of wood, ropes or an ‘udder substitute’ after weaning. As mentioned previously, slatted floors, limited feeder space, high stocking densities and a large farm size are other factors that can lead to tail biting (Moinard et al., 2003). Adapting the management according to these risk factors may help to avoid problems. Similarly, avoiding keeping a boar with the sows and supplying ample opportunities for drinking, feeding and foraging can help to avoid vulva biting in sows (Rizvi et al., 1998). For tail biting, Breuer et al. (2003) showed that there are also breed differences, so there may also be possibilities for genetic selection against tail biting in pigs. Tail biting was found to be unfavourably genetically correlated with leanness, so it may be that part of the problems were also created by selection for lean meat (Breuer et al., 2005). Fulfilling the animals behavioural needs, enriching the environment, allowing the animals sufficient space and genetic selection offer perspective to prevent tail biting.

4. Conclusion

In conclusion, group size mainly has an effect on damaging behaviour and fear and stress in pigs and poultry. The effect on aggressive behaviour is limited. To reduce problems with damaging behaviour, fear and stress, it is important to provide a complex environment with ample behavioural opportunities and separate functional areas.

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