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Stereotypic behaviour in cattle, pigs and horses – a review

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There are biological and environmental factors which lead to stereotypic behaviour in humans and animals. Abnormal, functionless repetitive behaviour may have a genetic or epigenetic background; however, in the case of farm animals it is often linked with maintenance in a barren environment. Stereotypies have been considered as an indicator of poor welfare. They may occur in chronic stress situations as an animal's way of coping. Stereotypies are often noticed in cattle, pigs and horses kept individually. This form of behaviour is generally associated with the situation when an animal cannot satisfy its natural needs. Taking into consideration the currently increasing concern about maintaining proper husbandry conditions, especially in intensive breeding systems, the environmental improvement has become an important issue. The objective of this review is to present a characteristic of stereotypies in cattle, pigs and horses and to show various methods of reducing the frequency of this behaviour.

KEY WORDS: animal welfare / housing system / livestock / neurophysiological mechanism

Adverse factors may change the animal's mental state, which is manifested by the onset of various forms of behaviour. The factors may be both biological and environmental [Péter *et al*. 2017]. These changes can assume pathological forms

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and deviate from normal, species- and sex-specific behaviours, which are considered model (i.e. deliberate and necessary) behaviours due to their role in normal functioning of both a single animal and a herd.

Currently the aspect of farm animal welfare is an increasingly important issue. Thus an enriched animal housing characterised by spacious and cage-free maintenance is required, as reflected in the opinions of consumers of animal origin products [Spain *et al*. 2018]. Improper breeding conditions themselves are a major factor affecting physiological and behavioural disorders in farm animals [Ventura *et al*. 2013]. One of the consequences of keeping animals in poor welfare conditions is connected with the development of stereotypic behaviour. Based on one of the definitions of this pathology it may be stated that stereotypies are repetitive behaviours induced by frustration, repeated attempts to cope, and/or central nervous system dysfunction [Mason and Rushen 2006]. It is worth stressing that these repetitive or ritualised movements have no obvious purpose and do not meet the body's physiological needs [Cronin and Wiepkema 1984, Graybiel and Saka 2002]. The tendency to perform different types of stereotypies (e.g. locomotive or oral) varies among animal species. The etiology of these behaviours may also vary depending on the species, biological or environmental factors.

The aim of this article is to present a characteristic of stereotypies in cattle, horses and pigs and to show various possibilities to reduce the occurrence of this behaviour and thus to improve animal welfare.

Etiology of stereotypic and redirected behaviours in animals

Genetic and environmental background

The genetic and epigenetic background of stereotypies has been confirmed in animal studies [Mostard 2011]. For example, earlier research results showed that thoroughbred bloodline horses were more likely than others to express stereotypic behaviour [Vecchiotti and Galanti 1986]. Human studies have focused on detecting both inherited and spontaneous (*de novo*) mutations, which may lead to the discovery of the gene responsible for this phenomenon [Péter *et al*. 2017, Fernandez et al. 2019]. Generally it may be stated that the DNA based methods may shed light on the biological mechanisms of stereotypies in both humans and animals and there is a justified need for development of this scientific area.

In spite of the complex etiology associated with the occurrence of stereotypies in animals, the situation of fear, stress and frustration linked mainly to poor housing conditions is an typically issue taken into consideration [Mason *et al.* 2007]. In studies conducted on animals such as cattle, horses and pigs concerning the occurrence of stereotypies, a barren environment, space restrictions, limited contact with other herd members, early weaning as well as feed restriction were the environmental factors which have been mostly investigated.

In a barren environment the quantity and quality of stimuli drastically decrease, which prevents animals from satisfying their natural instincts and urges. After a critical level of motivation has been reached, abnormal behaviour is an attempt to reduce tension. In such a situation, under stress conditions and when adaptive homeostatic processes are inefficient, stereotypies serve as a physiological safety mechanism. They reduce emotional arousal and prevent endocrine reactions [Dantzer 1991], which decreases the physiological cost of adaptation to adverse environmental conditions and reduces the risk of psychosomatic disorders. Therefore, some stereotypic behaviours may be an attempt to reduce the physiological signs of stress and to cope with captive conditions, in which case they are adaptive responses. This was seen, for example, in research on ruminants [Bergeron *et al*. 2006]. In this study the heart rate decreased immediately after the onset of stereotyped movements. In turn, Webb *et al.* [2017] found no differences in cortisol level between stereotyping and normal behaving calves. Similarly, some research on cortisol in horses with oral stereotypies showed a lower level of this parameter after the onset of the stereotypy than before [McBride and Cuddeford 2001]. Thus stereotypic behaviours may be a means of reducing arousal, may lower responsiveness to external stimuli and pain, and focus attention away from the source of conflict [Mason 1991]. However, it is worth adding that this type of adaptation is considered to result from poor welfare. Broom [2011] presented an opinion that even if an animal is able to adapt to improper conditions, it may still suffer or be frustrated.

Impact of housing conditions. Discussing the impact of animal surroundings it needs to be mentioned that stereotypies were first reported in wild animals living in zoos. The development of stereotyped behaviour in captive animals translates into a gradually decreasing ability to interact with the environment, thus the behaviour takes on a mechanical character. The development of a stereotypy may be the result of a gradual consolidation of abnormal behaviour. Animals with stereotypies show a general decline in the diversity of behaviours [Mason and Rushen 2006]. Stereotypic movements can also be based on a motivational conflict between avoiding and approaching [Wechsler 1991]. Situations in which an animal is motivated to perform a behaviour pattern, but is unable to do so, are frustrating and may lead to displacement activities or stereotypies [Mason 1991].

Farm animal housing conditions often inhibit the natural need of movement, spatial exploration, social interactions with herd mates and procreation. In cows it was observed that stereotypic behaviour decreased when the animals were moved from tether stalls to loose housing [Redbo 1992]. Moreover, cattle almost always stop performing stereotypies after they have been released onto pasture, while they resume high levels of stereotypies after re-tethering post-grazing [Redbo 1990, Redbo 1992]. The same holds for horses, as they are herbivores and in the wild they spend roughly half of the day feeding. The second largest amount of the daily time budget is spent on resting, with locomotion ranking third. In feral horses this category mainly includes walking to forage, but also trotting, galloping, jumping, swimming and, in the case

of especially young horses, playing. Stallions are much more active than mares due to herding. It is also worth noting the many interactions between members of feral horse bands, with social behaviour taking a wide variety of forms in feral horses, including mutual grooming, resting together and playing [Ransom and Cade 2009]. In turn, in a human-created environment animals no longer have to face challenges such as predators or the need to forage for food, but they may still be unaware of this fact, which explains their need to respond to environmental conditions. One of the most popular types of horse management is stabling in individual box stalls, where contact with other animals is limited [Cooper and Mason 1998] and daily exercise is often restricted to training or short stays in paddocks. When kept in box stalls for a long time, horses are insufficiently stimulated by external cues and thus cannot express their natural behaviours, leading to growing frustration and the development of abnormal behaviours in the form of stereotypies [McBride and Long 2001].

The barren environment impacts the welfare also in pigs. These animals are highly curious of their surroundings and have a natural rooting instinct. It was shown that pigs kept more freely spent 75% of their active time foraging and eating [Stolba and Wood-Gush, 1989]. No stimuli in pig surroundings may lead to an increased level of mainly aggressive forms of behaviour, such as tail biting [Silva *et al*. 2017]. The stereotypic behaviour is very common in farrowing lactating sows kept individually. It is worth adding that before farrowing, females show natural nest-building behaviour. Especially in intensive production systems, economic considerations prevent provision of conditions that allow these animals to fully express most of their natural behaviours. In particular, the widespread individual housing of sows (during farrowing and lactation) and thus limited space represent a high adaptation challenge to this group of pigs. As the Scientific Veterinary Committee, Animal Welfare Section [1997] pointed out, stereotypies in stall-kept sows constitute one of the most important welfare problems; the others are seen in weakened bones, overgrown hooves, poor social interaction or lameness.

Impact of feed restriction. Infrequent administration and inadequate composition of the feed is another important factor which may determine stereotypies in all discussed species. Feeding diets high in concentrates and low in roughages decreases the amount of feed offered, which considerably reduces the duration of feeding and gut fill [Veissier et al. 1998]. This is in conflict with the natural instinctive feeding pattern, which makes animals consume greater amounts of less valuable feed [Seo *et al*. 1998].

Regardless of the discussed species stereotypic behaviours were most often observed after the provision of a concentrated diet with little forage, which, as it is suggested, compensates for low gut fill and reduced consummatory behaviour [Redbo 1990, Terlouw *et al*. 1993].

Under natural conditions, cattle spend their active time foraging, feeding and chewing [Houpt and McDonell 1993]. Similarly, some nutritional deficiencies, such as sodium chloride, induce a reflex and subsequently a fixed stereotypic behaviour of licking the pen or random objects [Phillips et al. 1999]. Stereotypic behaviours in

heifers peaked during the first 2-4 h following feeding and were found to be correlated negatively with duration of feeding [Redbo 1990]. Redbo *et al.* [1996] observed that restricted feed amounts considerably increased the number of stereotyping cows compared to ad libitum feeding. The relation between restricted feed amounts and stereotypies has been proposed to be an effect of the thwarting of feeding and foraging behaviours occurring in tether stalls for cattle [Redbo 1992].

The frustration caused by feed restriction has also been noticed in horses. In spite of the fact that stabled horses are provided with concentrate feeds, they still express motivation to forage. Moreover, it was shown that oral stereotypies in this species are often linked with higher stomach acidity [Hothersall and Nicol 2009]. Forage provided regularly at pasture leads to buffering of stomach acid. It is linked also with higher amounts of produced saliva. When horses are fed most of their daily intake by concentrated grain-based rations, they may suffer from excessive fermentation and other digestive tract disorders, including also colic [Harris and Arkell 2005]. Expression of some oral stereotypies may be an attempt to alleviate this discomfort [Hothersall and Nicol 2009].

To avoid excessive fatness and reduced reproductive performance, sows are provided a diet with sufficient nutrients (partially during a day); however, the feeding motivation still remains high, similarly as it was shown before also in other species [Lawrence *et al*. 1988]. Moreover, keeping farrowing sows in a poor environment and no possibility to forage additionally make this situation worse [Lawrence and Terlouw 1993]. As studies showed, a high fibre diet may contribute to reduced expression of stereotypies, as it prolongs the feeding time, causes a feeling of satiety and increases sow activity [Bergeron *et al*. 2000].

Impact of weaning. Separation is a difficult moment for both dams and their offspring [Hopster *et al.* 1995]. Keeping animals (foals and calves) in individual pens after weaning together with a strong suckling motivation may be leading factors determining stereotypic and redirected behaviour.

In modern dairy farms, calves are most often separated from their mothers immediately after birth with no further contact. Under natural conditions, the cow-calf bonding develops soon after birth and usually persists for at least one year [Mahmoud *et al.* 2016]. Therefore, stereotypic and redirected behaviours appear in calves mostly during the first period after weaning. Additionally, due to short suckling bouts and consumption of inadequate amounts of milk the sucking need is not satisfied [Brake *et al.* 1982]. This may lead to the development of e.g. cross-suckling, which can be performed within the weaning period, but also at later stages of animal life [Keil and Langhans 2001].

In foals the stereotypic behaviour is performed during the first 9 months after weaning and similarly to cattle, establishment of an improper behavioural pattern during this period may have a long-term impact, for example seen in lower trainability and disorders in subsequent maternal behaviour [Waran *et al*. 2008]. As has been shown, the housing system affects stereotypies in foals. Generally in

terms of reduced stereotypic behaviour it is better to keep young horses in groups rather than individually, but maintaining with other individual(s) may lead also to higher motivation of presented aggressive forms of behaviour [Waran *et al*. 2008]. It was proved that naturally weaned foals kept on the grass are characterized with a lowest frequency of performing stereotypies and redirected behaviour (attempting to redirect sucking behaviour towards the genital regions of conspecifics) compared to individuals kept indoors [Waters *et al*. 2002].

In pigs kept under natural conditions the weaning process takes from 14 to 22 weeks, but this duration cannot be observed for farmed animals. The stress and strong suckling motivation in weaned piglets (especially early weaned) are expressed, among others, in performing a stereotypic behaviour called belly nosing, in which one piglet rubs another's belly with rhythmic movements of the snout [Fraser 1978].

The most common forms of stereotypic behaviour in cattle, horses, pigs and their consequences

Stereotypies in cattle

In cattle, the most common stereotypies include a repeated rolling of the tongue, mostly outside, but occasionally inside the animal's open mouth. Some cattle may perform also stereotyped biting or licking of stall equipment such as tether chains or partitions [Redbo 1990]. Calves after weaning showed tongue playing, inserting the tongue into the nostrils, as well as licking and sucking of protruding objects. An unsatisfied suckling motivation in young cows often results in pathological sucking of pen objects or cross-sucking of calves [Phillips *et al*. 1999]. Moreover, self- and cross-sucking of heifers or cows is a frequent problem in dairy herds and may lead to udder damage, mastitis, milk loss and culling of breeding animals.

Stereotypies in horses

Horses are most often affected by oral stereotypies (crib-biting, drinker-biting, wood-chewing, wind-sucking) and locomotor stereotypies (box-walking, stepping from one foot to another, neck-bending, self-mutilation). Crib-biting is one of the most frequent stereotypies in horses: 2.4-8.3% in Europe and Canada [Mc Greevy *et al.* 1995] and 4.4% in the United States [Albright *et al.* 2009]. Cribbing is a behaviour, in which a horse grasps horizontal objects with its incisors (e.g. crib, fence or other stall structures) while bending its neck and wind-sucking [Wickens and Heleski 2010]

Wood-chewing involves tearing away wooden parts of stall beams or walls, spitting them out or chewing and swallowing. Depending on the context in which it occurs, wood-chewing is considered a stereotypy or an attempt to satisfy nutritional needs [Nicol 1999]. Wind-sucking is a stereotypy, in which a horse is sucking air into the esophagus through the open mouth, bends its neck and tenses the muscles. In some cases, it is combined with crib-biting. However, it can only take place if the horse can lean on a stable structure (e.g. a fence pole) to support its incisors [McGreeve *et al.*

1995]. Weaving is a locomotor stereotypy, in which a horse swings its head, shakes its head from side to side while shifting its weight from one to the other front foot without moving. Stereotypical circling occurs when it is repetitive and relatively long [Dodman et al. 2005]. Many horses show a spontaneous circling behaviour in the stall, next to the gate when feeding, or when another horse is taken outside. Horses with this stereotypy can circle for hours in both directions while showing no interest in what happens outside the stall.

Self-biting, kicking or deliberate pushing at the stall structures, when prolonged, cause skin damage, hard-to-heal wounds and a general decline in body condition [Marsden 2002]. Three types of self-mutilation are distinguished: the first type is a response to continuous physical discomfort; the second type occurs in stallions and is associated with self-directed intermale aggression; and the third type involves methodical behavioural sequences of a stereotypy, resulting in injury, for example nipping at various areas of the body or kicking against an object [McDonnell 2008]. Wind-sucking or crib-biting horses run a greater risk of colic [Malamed *et al.* 2010]. Regular and frequent shifting of the weight from one leg to the other may lead to uneven hoof wear or cause damage to joints and tendons, thus eliminating the horse from further breeding or sport [Cooper *et al.* 2000]. Prolonged self-mutilation results in badly healing wounds. The incidence of stereotypy makes horse management and use much more difficult. It is also an indicator of the welfare levels, which are associated not only with improper management conditions, but also with failure to satisfy the animal's mental needs [Cooper and McGreevy 2007]. Moreover, horses with a high level of stereotypy are unsuccessful in the learning task, or require a longer time to perform the task [Hausberger *et al*. 2007].

Stereotypies in pigs

In sows frustration due to restricted movement is reflected in bar licking and bar biting, pushing or hitting with the snout against solid objects, sham chewing, bar rubbing, sitting on hind legs [Zhou *et al.* 2015]. As has been observed, stereotypic behaviour is performed more by sows than gilts. Moreover, some authors have claimed that a high frequency of showing stereotypic behaviour in older females may be evidence of the animal's strong resistance to changes of environment [Lawrence *et al.* 1988]. Chapinal *et al*. [2010] and Zhou *et al*. [2015] reported that stereotypies such as sham-chewing, non-feeding oral activities and sitting are considerably more frequent in sows restricted in movement; in turn, group-housed sows often perform agonistic behaviour, which consists of activities needed to establish a dominance hierarchy, or many forms of non-agonistic social interactions such as nose-to-nose contact or mounting.

Widowski *et al*. [2008] described in detail various aspects of belly nosing in weaned piglets. As noted before, one of the causes for this phenomenon is early separation from the sow. This behaviour may also reflect the general stress situation experienced by the young. The authors also presented some evidence for the conjunction of drinking,

feeding and suckling. These are the motivational systems interacting in ways that may cause some difficulties in establishing independent ingestion in early weaned pigs, with these mechanisms leading to belly-nosing. The occurrence of such behaviours may have a genetic background, as evidenced by a study, which showed that breeds vary in the degree of aggression and belly-nosing [Breuer *et al*. 2003].

Another problem in pigs is tail biting, which may be induced by many factors such as improper diet, an absence or delay of food provision, gastrointestinal discomfort, poor health, genotype, overstocking and unfavourable microclimate conditions. According to Taylor *et al.* [2010], this behaviour may also be identified as a form of stereotypy. It is in the case when tail biting is mainly represented by one or a few individuals in the herd; these animals seem to be concentrated on the tail and continuously look for another one to bite.

Tail biting may have serious consequences in terms of animal productivity; however, there are limited data available, which showed directly that expression of oral stereotypic behaviour in pregnant/lactating sows (similarly as in lactating cows) may impair production parameters. A recent study of Tatemoto *et al*. [2019] showed no difference in the weight of sows at the end of gestation or in lactation and there was no difference in the number of weaned piglets, piglet mortality or piglet weight between sows expressing low or high level of stereotypies. However, according to the authors it may be a result of genetic improvement (characteristic of modern? pigs) which leads to the situation that even when the housing conditions are not optimal, sows exhibit high productivity indexes.

Stereotypies determined by neurophysiological mechanisms

Taking stereotypies into consideration, it is worth mentioning that the basis for the complex psychological phenomena is a complicated network of connections between neurons at different levels of the nervous system [Walsh 2000]. Much attention in the etiology of stereotypy has been given to the function of the basal ganglia [Langen *et al*. 2011], as their disorders are reflected in abnormal movement and a number of neuropsychiatric problems [Afifi 2003]. Briefly, the basal ganglia structures are a set of interconnected subcortical nuclei in the midbrain. Their structure includes the striatum composed of the putamen and the caudate nucleus, globus pallidus (which is functionally divided into the internal and external segments), the pars compacta and the pars reticulata of the substantia nigra, and the subthalamic nucleus [Afifi 2003, Mostard 2011, Simonyan 2019]. The basal ganglia are involved in motor and non-motor activities. Nowadays more attention is being paid to the role of these structures in controlling emotions, the working memory, language, decision making and procedural learning [Simonyan 2019]. In human research the knowledge of the basal ganglia function is gaining in importance in the context of diseases such as Parkinson's disease, obsessive-compulsive disorder, the Tourette syndrome or autism spectrum disorder [Singer 2009, Simonyan 2019].

The most important issue for the basal ganglia role is their integration with the cortical neurones. This connection is modulated by numerous neurotransmitters, such as γ-aminobutyric acid (GABA), glutamate, dopamine, serotonin, acetylcholine and opiates [Afifi 2003, Mason and Rushen 2006, Harris et al. 2016]. Mental activities through cortical-subcortical loops highly depend on the proper functioning of all structures included in these loops [Brown *et al*. 1997]. The cortical-striatal-thalamo-cortical brain circuit seems to be mainly involved in the manifestation of motor stereotypies; however, functions of the other brain regions may also underlie this pathology [Gao and Singer 2013, Péter *et al*. 2017]. Generally the loop function is based on direct and indirect ways, which normally are balanced. Briefly, it may be stated that wanted forms of behaviour are managed by the direct pathway, while the indirect pathway leads to inhibition of unwanted activities. It may also be stated that the occurrence of stereotypies is induced by suppression of the indirect pathway [Langen et al. 2011].

As the regulation of the basal ganglia function is modulated by endogenous neurochemistry, numerous publications regarding both human and animal research have shown that improper behaviour may be induced by an imbalance in the neurotransmitters level [Langen *et al*. 2011, Aliane *et al*. 2011, Harris *et al*. 2016]. Dopamine and serotonin are thought to be mainly implicated in repetitive behaviours, which have been studied in animal models with the use of some pharmaceuticals [Mostard 2011, Aliane *et al.* 2011, Lutz 2014]. However, Harris *et al*. [2016] showed that GABAergic dysfunction may also be a factor contributing to the onset of motor stereotypies. Moreover, some other studies have proven that both increases and decreases in acetylcholine signalling are linked to the induction of stereotypic behaviour [Aliane *et al.* 2011, Crittenden *et al*. 2014].

Role of environmental enrichment

Both human and animal research has indicated that environmental enrichment plays an important role in reducing stereotypic behaviour [Schneider and Przewłocki 2005, Lutz 2014]. The term was elaborated primarily for laboratory animals. Currently, a great deal of attention is being paid to improving the environment of farm animals [Mandel *et al*. 2016, Godyń *et al.* 2019]. As the review of Bayne [2018] showed, there are plenty of positive aspects to improving the environment in the case of rodents, as reflected in their brain structure and functions. Keeping animals in richer surroundings had a great impact on their cerebral weight and length, while it also contributed to an increase of cortical depth. It was also well documented that rodents kept in enriched cages had a higher level of the brain-derived neurotrophic factor (BDNF) and the nerve growth factor (NGF). Studies carried out on animal behavioural changes showed that animals kept in enriched surroundings are more active, they explore more and express their natural behaviour [Mandel *et al*. 2016, Bayne 2018]. They also play more, which is considered as an important indicator of animal well-being [Boissy *et*

al. 2007]. Generally, the enrichment in an animal's surroundings may be provided by occupational, physical, sensory and nutritional factors or by improvement of social conditions [Bloomsmith *et al*. 1991]. Some of these solutions implemented in the surroundings of cattle, horses and pigs were found to reduce stereotypic behaviour [Bench and Gonyou 2006, Jensen and Weary 2013].

Mandel *et al.* [2016] carried out a reliable review of different methods of environmental improvement in cattle, which lead to better biological functioning of these animals, an increase of coping ability, as well as helping to fulfil an animal's natural needs. Taking into consideration social enrichment (which may be provided by keeping animals in larger groups), it may be stated that especially in calves it leads to better social skills in later stages of their lives. Through increasing suckling time and environmental enrichment with objects that satisfy the natural suckling need, cross-suckling in calves can be largely reduced [Appleby *et al.* 2001, de Passillé *et al.* 2001]. One of the enrichments in calf surroundings which may lead to reduced cross-suckling behaviour is to provide a rubber nipple, especially when it is used as a way of feeding [Jensen and Weary 2013]. Additionally it has been suggested that rearing in contact with the mother during the first 12 weeks, even if very limited, may have a positive effect on the behaviour of a heifer when introduced into the dairy herd, as various non-nutritive abnormal oral activities, including self-grooming and tongue playing and cross-sucking have been found to occur in calves fed with a bucket or reared in individual pens [Pempek *et al*. 2011, Wagner *et al.* 2012, Webb *et al.* 2015].

In horses stereotypies can be reduced through various types of stall enrichment or by providing a more fibrous diet [Henderson and Waran 2001, Thorne *et al*. 2005, Jørgensen *et al*. 2011]. A special feeding device has been used in stabled horses and the results showed that it was effective in reduction of stereotypic behaviour. The idea of using this 'toy' was that through playing (rolling or spinning the device) pelleted food became available for a horse [Henderson and Waran 2001]. As these studies proved, increased feeding time may be one of the most important factors in preventing equine stereotypies. Sarrafchi and Blokhuis [2013] discussed various methods of environmental enrichment preventing the occurrence of this pathology. Except for foraging enrichment, such solutions as providing a mirror or even image of a horse in a stall may lead to a decrease of motor stereotypies [McAfee *et al*. 2002, Mills and Riezebos 2005]. Generally it worth mentioning that in the case of weavers, the stall box should be designed so as to enable the horse better observation of the surroundings as well as interaction with horses in adjacent stalls [Cooper *et al.* 2000].

Not only a later weaning period in piglets, but also environmental enrichment may have positive effects in preventing belly nosing behaviour. Cox and Cooper [2001] found a lower level of this phenomena both in piglets reared outdoors and those kept in an enriched environment. The frequency of belly-nosing, tail-biting, ear-chewing, licking, biting and nosing was much lower for piglets that had access to straw. Among various ways of enrichment for weaned piglets, Bench and Gonyou [2006] found a positive effect of a foam rubber mat attached to the wall in reducing belly-nosing

behaviour. Nevertheless, other methods of distracting piglets from performing this type of behaviour did not produce expected results. Similar conclusions were reached by Jönson [2012], who used toys in the form of a rope and an activation ball in pens of weaned piglets. The piglets' interest in these objects had a positive effect on reducing the incidence of tail-biting and ear-biting, but the effect was not long-lasting. The frequency of belly-nosing did not decrease either.

It is worth mentioning that in 2016, the Commission Recommendation (EU) 2016/336 on the application of the Council Directive 2008/120/EC laying down the minimum standards for the protection of pigs regarding the measures needed to reduce the need for tail-docking was released. The document, among others, includes descriptions of enriching the pigs' environment and characterises various categories of materials that may be used to improve animal welfare. As the document states, the access to edible, chewable, investigable and manipulable materials such as straw is the best solution to ensure for pigs' comfort. As it was mentioned above, tail biting may have vary in its various ethology. However, regardless of the form of this pathology, some studies show a significant impact of environmental enrichment on reduction of tail biting among pigs. Individuals which had access to straw or pieces of freshly cut birch trees showed a lower tendency to perform this behaviour [Day *et al.* 2002, Telkänranta *et al*. 2014]. It is worth adding that there are different categories of materials used for pigs. They may be optimal such as straw provided as bedding, suboptimal like straw in racks, wood, natural ropes, but there are also materials of marginal interest such as chains, plastic and rubber toys. As the review of Godyń *et al.* [2019] showed, all of the materials used in pig surroundings may have some positive impact on the welfare of both younger and older pigs.

There are relatively few publications regarding environmental enrichment for individually housed sows. One way of reducing the frustration of females is to provide them with a nesting substrate [van de Weerd and Day 2009]. Racks with straw can be used in small pens. This solution and feeding females high fibre diets may reduce the frequency of stereotypies [Stewart et al. 2011]. The currently proposed systems for group housing of sows with piglets permit greater freedom of movement for the sows, as well as better adaptation of piglets to the post-weaning environment [van Nieuwamerongen *et al*. 2014]. Karlen *et al.* [2007] claimed that these types of systems ensure improved social interactions and lead to a reduction of stereotypies. Apart from providing a larger space, social enrichment or straw in racks, simple solutions such as a chain mounted close to the floor may also have some positive effects in reducing stereotypic behaviour [Van den Berg 2014]. Silva *et al*. [2017] also found that pregnant sows which were kept (first individually and then in group pens – depending on the pregnancy stage) were characterised by a lower frequency of stereotyped behaviour when they were provided with classical music.

Conclusion

One of the indicators of poor welfare is provided by animal behaviour. Unfavourable environmental conditions may increase difficulties linked with the animal's ability to cope. Long-term stress may lead to the development of an adaptive mechanism, which in some situations leads to the occurrence of stereotypic behaviour. As the different studies in farm animals showed, stereotypies are mainly linked with a barren environment and social isolation. Limited space, an inadequate amount of roughage in the surroundings, early isolation from the dam all play a large role in inducing stereotypies in cows, horses and pigs. The role of the breeder or producer is to closely observe the animals in order to identify, counteract and prevent these abnormalities. Environmental enrichment currently has been a very important issue, especially in intensive production systems. Provision of a high fibre diet, various types of "toys" in animal surroundings or less stressful management practices may bring considerable benefits in terms of animal welfare. Moreover, studies on genetic and epigenetic etiology of stereotypies are also of great significance. Research on an animal model linked to brain function in terms of stereotypic behaviour may provide insight into matters related to the occurrence of neurological diseases in humans.

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