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ScienceDirect
Applied Animal Behaviour Science 115 (2008) 138–148
APPLIED ANIMAL BEHAVIOUR SCIENCE
www.elsevier.com/locate/applanim

Music during play-time: Using context conditioning as a tool to improve welfare in piglets

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Accepted 21 April 2008
Available online 3 June 2008

Abstract

In this experiment, we investigated whether music can facilitate play behaviour in piglets after weaning, when that music had been presented preweaning as a contextual cue associated with access to a playroom. One group of piglets was given daily access to a playroom preweaning while music was played during the entire play period (Playroom group, $n = 6$ pens). The control group was daily exposed to the music as well, but this group was not given access to the playroom (NO Playroom group; $n = 6$ pens). It was hypothesized that replay of music post weaning (on post-weaning days W2, W3 and W6) would facilitate play behaviour above and beyond the previously reported effects of preweaning playroom exposure per se. The results confirm that music replay post weaning does facilitate play behaviour in the Playroom group. The results also showed that playroom exposure preweaning reduced the number of injuries post weaning (W1, W2 and W3). In contrast with our expectations, music replay also facilitated play behaviour in the control group, although significantly less so than in the Playroom group. The results are discussed in relation to the possibilities to use music as a tool to improve welfare in animal husbandry systems.

Keywords: Pigs; Context conditioning; Music; Weaning; Welfare; Behaviour; Play

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0168-1591/$ – see front matter
doi:10.1016/j.applanim.2008.04.009

1. Introduction

It is generally agreed that the welfare of pigs in conventional production systems may benefit from a challenging environment that includes substrate to forage, possibilities to play and more space to move (Beattie et al., 1995; Spĩnka and Newberry, 2001; Bolhuis et al., 2006). However, in conventional pig husbandry systems, such environments may be costly and improvements in animal welfare may therefore be difficult to accomplish.

One way to improve the quality of the housing environment with relative limited space expansion is to introduce a 'playroom' for pigs, which can be used alternately by different groups of pigs during a limited amount of time. Indeed, ' *a playroom as a novel swine enrichment*' was recently described for pigs kept for laboratory purposes (Casey et al., 2007). These authors described 'beneficial effects' of playroom exposure with a frequency of exposure as low as once a month. However, in this particular study the nature of these beneficial effects remained unclear.

Beneficial effects of repeated (daily) playroom exposure of young piglets were also reported by other authors, including ourselves. Thus, elevated levels of play behaviour (Donaldson et al., 2002) and decreased levels of aggression and decreased number of injuries post weaning (Dudink et al., 2006) were reported after daily playroom exposure preweaning. An interesting aspect of the Dudink-study was that the beneficial effects of early playroom exposure could be enhanced by announcement (by a discrete acoustic cue) of the piglet's access to the playroom (Dudink et al., 2006). It was concluded by the authors that conditioned stimuli (CS) presented contingent upon playroom exposure could be further developed as a potential tool to decrease weaning stress related behaviours in piglets.

Weaning in conventional husbandry systems appears to be a particular stressful event that is associated with behavioural problems such as belly nosing (Worobec et al., 1999), increased fighting (Puppe et al., 1996; Cox and Coopert, 2001), as well as skin damage, weight loss and endocrine and immune alterations (Blecha et al., 1985; Carroll et al., 1998; Lewis and Southern, 2001). Many different studies have therefore focused on procedures that may alleviate weaning stress. Thus, beneficial effects on weaning-stress induced behaviours were previously pursued by mixing piglets before weaning (Pitts et al., 2000; Weary et al., 2002; D'Eath, 2005; Parrat et al., 2006), by giving piglets playroom experience (Donaldson et al., 2002; Dudink et al., 2006) or by introducing more space and/or environmental enrichment before or after weaning (Blackshaw et al., 1997; Hill et al., 1998; Chaloupkova et al., 2007). However, although each of these procedures may reduce weaning stress, our results suggest that the effectiveness of management procedures to reduce weaning stress may be enhanced by the use of ''cognitive tools'' (CS contingent upon reward) (Van der Harst et al., 2005; Dudink et al., 2006).

Our results thus far showed that repeated playroom exposure of young piglets before weaning can improve welfare by decreasing negative behaviours (aggression) and facilitating positive behaviours (play) in the first week after weaning. Moreover, we showed that the deliberate delivery of discrete stimuli contingent upon playroom exposures can be used to enhance these beneficial effects. In the present experiment, we wanted to extend this point further by offering a contextual acoustic cue (music) contingent upon the daily 15 min playroom exposure. Contextual cues differ from discrete cues in that they are present throughout the entire learning session. Contextual cues may be visual, auditory or olfactory cues associated with the room or place where the learning session takes place. ''Context conditioning'' refers to the phenomenon that contextual cues in a classical conditioning paradigm, may gain associative strength comparable to the way in which discrete stimuli gain associative strength (Bouton, 1993; Maes, 1993, 2002; Maes et al., 1998; Rescorla et al., 1985). In our experiment, music was used as a contextual cue

presented contingent upon access to a playroom and it was our hypothesis that replay of this contextual cue after weaning would facilitate play behaviour after weaning, above and beyond the previously described beneficial effects of preweaning playroom exposure per se. As a contextual cue, classical music was played, one piece from Bach (prelude cello suite no 1) and two pieces from Sir Edward Elgar (cello suite and nimrod).

2. Material and methods

2.1. Experimental groups

Two experimental groups participated in this experiment. The first group consisted of 6 pens with about 23 weaned piglets each. Before weaning, these piglets (which came from two different litters for each pen) had been given access to a playroom daily during 15 min while music was playing (Playroom; $n = 6$) (see Videoclip 1). The second group also consisted of 6 pens of about 20 weaned piglets each. These piglets had also been daily exposed to music preweaning. However, piglets from this group had no access to the playroom during music exposure (NO Playroom; $n = 6$). After weaning, experimental and control piglets were re-exposed to music during 3 days (post-weaning days W2, W3 and W8) and behavioural recordings were made. In addition, behavioural recordings were made *without* music exposure on W1, i.e. on the first 4 h of mixing in the weaner unit. Finally, weight development was registered and injury scores were made.

2.2. Housing of the animals

All animals were housed in the experimental pig farm ''de Tolakker'' (Utrecht, the Netherlands). One week before farrowing, sows were moved to nursery units, each containing two rows of 5 farrowing pens (1.75 × 2.4 m) with half concrete, half slatted floors, each row bordering on a hallway of 1 m × 10 m (the 'playroom'). Within the farrowing pens, sows were confined in crates to prevent crushing of piglets. A total of six nursery units were used in this experiment. In each of these units, one litter was selected as an experimental and one as a control litter on each side of the unit (2 experimental and two control litters in total). This selection attempted to achieve low variance in litter size (range 10–13 was achieved) and sex ratio (range 0.27–0.65 male: female was achieved) and gilts with their first litter were not included. Litters from one unit were always born within the same week. Standard procedures, like ear tagging, tail clipping, castration of the males and iron injections were done in the first week after the piglets were born. One week old piglets were provided with starter pellets mixed with milk powder solution, followed by grower pellets. Water was always available ad libitum. During 9 h per day lights were on (from 7 a.m. till 4 p.m.) and temperatures in these nursery units were maintained at 20 °C.

Approximately four weeks after the piglets were born (range: 23–30 days), the sows were removed from the piglets (day weaning = W0). The day after removal of the sows, the piglets were moved to the weaner units (W1). These units consist of four pens each (3.8 × 2.2 m) and have a partly slatted floor. In the weaner units food and water were also available *ad libitum* and temperatures were maintained at 25 °C. The two experimental litters from each unit were always grouped together in one pen of the weaner unit and the two control litters in another pen. Each nursery unit used in the experiment therefore provided one experimental and one control pen after weaning. The six nursery units therefore provided one experimental group of 6 pens (Playroom; $n = 6$) and one control group, also of 6 pens (NO Playroom, $n = 6$). Group size in the weaner units varied from 21 to 25.

2.3. Experimental procedures and parameters

2.3.1. Access to the playroom before weaning

The playroom consisted of a hallway of 1 m × 10 m covered with fresh straw (500 g) and supplied with a handful of chicken feed (20 g) daily. The piglets were released in this playroom for the first time 14 days

before weaning (W-14) according to procedures previously described by Dudink et al. (2006). In short, the door of the farrowing pen, which opened directly to the playroom, was opened remotely by the experimenter from outside the nursery unit. Opening of this door was announced by a discrete sound cue (electrical doorbell). During the two weeks the play procedure was performed, a delay between the discrete cue (ringing of the bell) and the opening of the door was gradually increased from 0 to 30 s. Previous experiments revealed that this play procedure effectively induces play behaviour (unpublished results): more in particular it was observed during the last 5 sessions of the daily play procedures that 98% of the piglets entered the playroom within 3 s after opening of the door, and that 95% of the piglets are involved in at least one bursts of locomotor and/or social play during the subsequent 15 min of playroom access.

In addition to the standard play procedure as previously described by Dudink et al. (2006), music as a contextual cue was played in the present experiment during the entire 15 min that the piglets stayed in the playroom. When the doors opened, the music was turned on. When the music finished the piglets were gently driven back into their pen. Classical music was used, one piece from Bach (prelude cello suite no 1) and two pieces from Sir Edward Elgar (cello suite and nimrod), always played in the same order and with the same volume. From W-14 till day W-8 the piglets were released twice daily, with a minimum of 1.5 h between the two times. In the second week (W-7 till W-1) the piglets were released on the hallway only once a day.

The two experimental litters from one nursery unit were housed opposite each other in the nursery unit and were released at the same time, each to their own playroom. The control litters heard the music while the experimental piglets were playing on the hallway, but were not released into the hallway. The play procedure was only performed on working days (5 times a week). Speakers, connected to an mp3-player outside the unit, were installed in the middle of the nursery unit so that the sound of discrete cues and contextual cues was equally spread across the nursery unit.

2.3.2. Post-weaning procedure

On W1 all piglets were moved from the nursery units to the weaner units. The two experimental litters from one nursery unit were placed together in one pen in the weaner unit (Playroom group) and the two control litters from one nursery unit were placed in another pen (NO Playroom group). The animals were then left undisturbed during the following 4 h. Behaviour during that time was videotaped by camera's connected to two (Sanyo, time lapse) video recorders.

On days W2, W3 and W6, the piglets in the nursery unit were re-exposed to the music during 15 min on each day. Video recordings were made from the behaviour of the piglets during 30 min before re-exposure to the music, during the 15 min that the music was replayed and during the 30 min after re-exposure to music. The re-exposure procedure took place between 8.30 and 10.00 a.m. The same music was played as before weaning.

2.3.3. Behavioural recordings

The four hour videotapes, made on W1, were analysed with instantaneous sampling with a sample interval of 5 min (total of 48 samples). The videotapes made on W2, W3 and W6 were also analysed with instantaneous sampling, only now a sample interval of 1 min was used before (30 samples) during (15 samples) and after (30 samples) playing the music. The number of piglets performing one of the behavioural categories specified in Table 1 was noted for each sample point.

2.3.4. Scoring of injuries

On W1, W2 and W3 the injuries on the bodies of all piglets were determined. This was done right after the behavioural recordings. A score of severity of the wounds was given on different body parts according to procedures previously described in Dudink et al. (2006). The body was divided into ears, head, shoulders, tail, hind and remaining part of the body. For every part a severity score was given ranging from 0 to 4. This score was zero when there were no fresh wounds, a score of one was given when there were one or two light fresh wounds, two was given when there were one or two severe fresh wounds, a score of three when the

Table 1
Ethogram

Behavioural categories	
Rest	Lying with eyes open or closed and not performing any of the of following behaviors
Aggression	Any behaviour indicatives of social conflict such as chasing, biting, parallel pressing, head-to-head knocks, levering. The interaction may result in injuries on the body of one or both piglets and is never accompanied with a play marker (see play)
Play	Hop, scamper, pivot, paw, flop and head toss alone or in combination while running or standing[a,b]
Social manipulation	Belly nosing, tail biting and mounting
Eating/drinking	Eating, drinking
Other active	All other not mentioned behaviours other than resting

[a] Newberry et al. (1988).
[b] Donaldson et al. (2002).

amount of wounds was between two and five, and a score of four was given when there were more than five fresh wounds on the specific body part.

2.3.5. Weighing of the piglets

On W-14, W0, W3 and W9, all piglets participating in the experiment were weighed and ear tag numbers and sex were noted.

2.3.6. Statistical analysis

All statistical tests were performed with the software package SAS 9.1. Behavioural data, weight data and injury scores were analysed using Generalized Mixed Models (GLIMMIX procedure from SAS). Goodness of fit-tests (maximum likelihood ratio) showed that weight data and behavioural data best fitted a normal distribution, while the data on injury scores were best fitted by a quadratic link function. Behavioural data from W1 did not meet the critera of normal distribution and were fitted with a double logarithmic link function.

2.3.7. Ethical considerations

All experiments were approved by the local ethical committee of Utrecht University. Daily veterinarian inspections were made on all animals. In case of veterinarian treatment, animals were excluded from the experiment.

3. Results

3.1. Behaviour on W1, W2, W3 and W6

Behavioural data of the piglets were first calculated as the number of piglets (calculated as a % of the total number of piglets present in the pen $\times$ the total number of time samples in that observation period) performing a specific behaviour. The percentage of piglets performing a behaviour was taken as the parameter for further analysis. PLAY and SOCIAL MANIPULATION were excluded from the behavioural analysis on W1 (directly after mixing), because of extremely low occurrence.

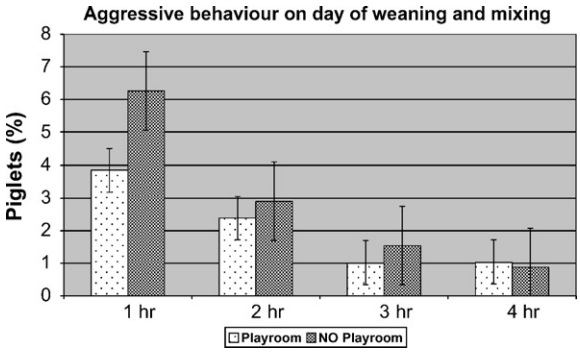

Fig. 1. Mean (±S.E.M.) percentage of piglets per time sample showing aggressive behaviour on W1 during 4 consecutive hours. W1 is one day after weaning when the piglets are mixed and transported to the weaner unit. Playroom: piglets exposed to music during playtime preweaning. NO Playroom: piglets pre-exposed to music, but without access to the playroom.

For analysis of the behavioural data on W1 (Fig. 1) the model included the fixed effects TIME (4 levels), GRP (Playroom versus NO Playroom; 2 levels) and TIME × GRP. STALL (nursery unit) and PEN were included as random factors in the model. The analysis revealed a significant effect of TIME on aggression ($F(3,30) = 20.5$, $p < 0.0001$), and on resting ($F(3,30) = 18.77$, $p < 0.0001$), indicating that the number of animals showing aggression decreased over the first 4 h after weaning, while the number of animals resting increased during that same time (from 19.3% to 62.1%). However, no significant effect of GRP or TIME was found. Also for the other behavioural parameters, no significant effects were found (data not presented).

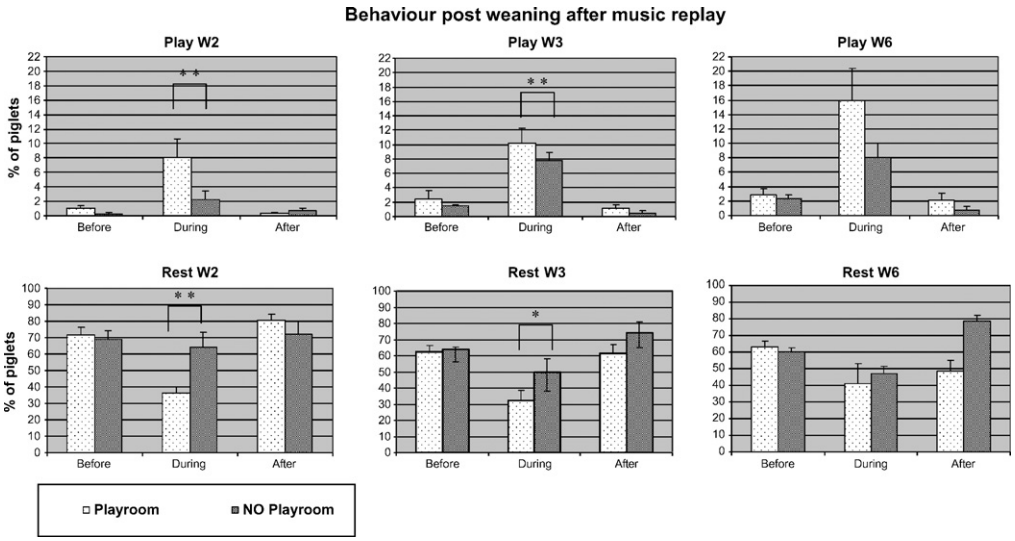

Fig. 2. Mean (±S.E.M.) percentage of piglets per time sample playing (above) and resting (below) after re-exposure to music. Behavioural tests were run on post-weaning days W2, W3 and W6 and before music re-exposure (30 min), during music re-exposure (15 min) and after music re-exposure (30 min). Using a generalized model, significant two-way interaction effects were found for TIME (3 levels) × GRP (2 levels) indicating that groups reacted differently to re-exposure of music. Significant contrasts are indicated by asterisks ($^{*}p < 0.05$; $^{**}p < 0.005$). Playroom: piglets exposed to music during playtime preweaning. NO Playroom: piglets pre-exposed to music, but without access to playroom.

For analysis of the behavioural data on W2, W3 and W6 (Fig. 2) the model included the fixed factors DAY (3 levels), TIME (nested within DAY, 3 levels) and GRP (2 levels), GRP × DAY, GRP × TIME and GRP × TIME × DAY. STALL and PEN were included as random factors in the model. Analysis revealed a significant effect on the parameter PLAY for the factor GRP ($F(1,80) = 5.81$, $p < 0.05$), DAY ($F(2,80) = 8.30$, $p < 0.005$), TIME ($F(6,80) = 21.38$, $p < 0.00001$) and GRP × TIME ($F(8,80) = 2.06$, $p < 0.05$). Visual inspection of the data (see Fig. 2) confirmed that the total amount of animals playing increased over subsequent testdays and and that play increased during re-exposure to music in both groups. In addition, the interaction effect suggested that re-exposure to music facilitated play more in the Playroom group than in the NO Playroom group. Indeed, contrast analyses confirmed that piglets from the Playroom-groups played more during music exposure on W2 ($F(1,80) = 13.03$, $p < 0.005$) and W3 ($F(1,80) = 5.17$, $p < 0.05$) (but not on W6) than the NO Playroom animals.

Analysis of the parameter RESTING (Fig. 2) on W2, W3 and W6 revealed similar results as PLAY, though in opposite direction. Thus, significant effects were found for GRP ($F(2,80) = 6.32$, $p < 0.005$), TIME ($F(6,80) = 13.85$, $p < 0.0001$) and GRP × TIME ($F(8,80) = 2.28$, $p < 0.05$) were found, indicating that piglets from the Playroom group rest less after re-exposure to the music than the NO Playroom group. Indeed, contrast analyses confirmed that piglets from the Playroom groups rested less during music exposure on W2 ($F(1,80) = 13.03$, $p < 0.005$) and W3 ($F(1,80) = 5.17$, $p < 0.05$) (but not on W6) than the NO Playroom animals.

Analysis of the parameter Aggression (AGG) revealed only a significant main effect of DAY ($F(2,80) = 6.32$, $p < 0.005$), indicating that the average % of animals per time sample showing aggression in general decreased over the three testing days (from 0.91 on W2 to 0.57 on W6). No significant effects of TIME, GRP, or TIME × GRP were found ($p > 0.05$). Analyses of other behavioural parameters on W2, W3 and W6 revealed no significant results (data not presented here).

3.2. Injury scores and weight gain

The injury scores for the whole body were summed for each piglet for W1, W2 and W6 separately and mean injury scores per group were taken as a parameter for further analysis

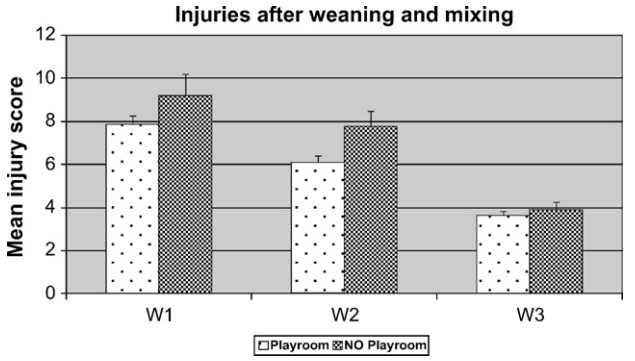

Fig. 3. Mean (±S.E.M.) injury scores of piglets on W1, W2 and W3 after weaning. Using a generalized model, a significant effect of DAY (4 levels) and GRP (2 levels) was found, indicating that piglets pre-exposed to music and a playroom, had fewer injuries than controls ($p < 0.02$). Playroom: piglets exposed to music during playtime preweaning. NO Playroom: piglets pre-exposed to music, but without access to playroom.

(Fig. 3). Injury scores were again analysed using a Generalized Model, now with a quadratic link function, including the factors DAY, GRP and DAY × GRP. PEN was included as random factor in the model. This statistical analysis revealed a significant effect of both DAY ($F(2,20) = 43.86$, $p < 0.0001$) and GRP ($F(1,20) = 6.30$, $p < 0.02$), but no significant interaction effect. Results therefore show that the number of fresh injuries is in general lower in the Playroom group than in the NO Playroom group. In addition, it shows that injuries decline from day 1 to day 3 after weaning and mixing.

Finally, weight development of piglets on W-14, W0, W3 and W9 was analysed.The factors DAY (4 levels), GRP (2 levels), SEX (within GRP; 2 levels) and its 2- and 3-way interaction effects were included as main effects in the model.The factors SUBJECTS, LITTER and STALL were included as random effects. The results on WEIGHT only showed a significant effect of DAY ($F(3,527) = 912,33$, $p < 0.005$) and SEX ($F(1,939) = 6.698$, $p < 0.005$), but no other significant main or interaction effects ($p > 0.05$; results not presented here).

4. Discussion

It was shown in the present experiment that exposure to music facilitates play behaviour in piglets post weaning, when these piglets had been daily pre-exposured to music preweaning while playing in a playroom. This experiment therefore confirmed our hypothesis that context conditioning can be used as a tool to facilitate positive, rewarding behaviours like play and that music can be used as an effective contextual cue in this respect. During music exposure post weaning, no other behavioural parameters were affected, except the parameter ''resting''. It therefore appears that music re-exposure post weaning selectively affected play behaviour (at the cost of resting), but did not stimulate other ''unwanted'' behaviours such as aggression or social manipulation (see Table 1 for description of behaviours).

In contrast to our predictions, piglets pre-exposed to music without access to a playroom (NO Playroom), also showed a facilitation of play behaviour post weaning although the increase was significantly less than in the Playroom group. One possible explanation for this effect may be that the NO Playroom group was housed in the same nursery unit as the Playroom group. The NO Playroom group must therefore have heard the excitement of the piglets playing in the neighbouring playroom during music exposure and it is not unlikely that such excitement might have stimulated the NO Playroom group to play more during music exposure as well, although play was obviously restricted to their home cage. Recent experiments in our lab confirm such an explanation, because it was shown that animals playing in the playroom indeed stimulated piglets housed in neighbouring cages to play (Dudink et al., in preparation). The same effect might also have occurred in the post weaning phase in which the experimental and controls were also housed and exposed to music in the same stall. However, although music did facilitate play behaviour in the NO Playroom group to a certain extent, the facilitating effects were significantly less than those observed in the Playroom group.

We also predicted that replay of music would facilitate play behaviour post weaning, above and beyond the previously described beneficial effects of preweaning playroom exposure per se. Although we did not find the expected facilitation of play behaviour or reduction of aggression behaviour in the Playroom group on W1 (when no music had been replayed yet), we did find a reduced injury score on W1 and on the following days. It therefore appears that the playroom exposed group did show some decrease in aggressive tendencies, although the magnitude of the effect seems less than previously reported (Dudink et al., 2006). Again, this smaller effect may be explained by the fact that our controls may have received more play experience through exposure to playing piglets in the neighbouring playroom, than the controls used in the Dudink-study.

Effects of music exposure on behaviour and/or welfare of animals have been poorly investigated, but experiments thus far report both positive and negative effects or no effects at all of music exposure on behaviour. Thus, classical music facilitated resting behaviour and decreased barking behaviours of dogs in a shelter (Wells et al., 2002). In addition, Papoutsoglou et al. (2007) reported that carps would grow faster when daily exposed to classical music and the authors suggested that music might have both positive and negative effects on welfare. Others (Uetake et al., 1997) reported a positive effect of classical music on approach behaviour of cows to a milking parlor but hens tended to react more fearful after music exposure (Campo et al., 2005). One study in which the effects of music were investigated in weaned piglets, reported no beneficial effects of music on vocalisations of piglets during stressful events like castration and weaning (Cloutier et al., 2000). Newberry (1995) in a review on environmental enrichment, stated in this respect that "*A common shortcoming of attempts at environmental enrichment is the provision of toys, music or other stimuli having little functional relevance to the animals*." and she underlined this statement by arguing that the majority of studies investigating the potential benefits of music on welfare lack biological relevance, functional meaning or behavioural control and cannot be adequately interpreted for that reason.

However, although we may agree with the critical comments made by Newberry, we think our study fundamentally differs from the above cited studies, because we deliberately choose to use music as a contextual cue associated with a pleasurable event and we used that association to evoke behavioural patterns (play), the stimulation of which we assume to be beneficial for welfare. Through these associative processes, classical music acquired both a "biological relevance" and a "functional meaning" and we think that such associative processes might be essential in order for music to become an effective tool in improving animal welfare. In fact, some of the previously described beneficial effects of music on welfare might be attributed to such, sometimes unforeseen, associations: thus, it may for instance be suggested that beneficial effects of music in barns are associated with the positive effects of music on the mood of caretakers.

In our experiment, music has been presented preweaning as a contextual cue associated with access to a play room. The results of our experiment suggest that subsequent replay of music post weaning has beneficial effects on welfare. The nature of these beneficial effects may be described in terms of three different mechanisms: first, since music as a contextual cue has been associated to a reward (access to a playroom), it can be regarded as a secondary reinforcer; i.e. a previously neutral stimulus that has gained reinforcing properties by its association with primary rewards, as expressed in terms of both behaviour (Williams et al., 2004) and brain reward systems (Everitt et al., 1989; Spruijt et al., 2001; Fields et al., 2007). Second, since music as a contextual cue has a duration of 15 min, replay of music will have reinforcing properties longer than for instance the presentation of discrete stimuli as secondary reinforcers (Williams, 1970). Finally, music in this experiment had been associated with the execution of play behaviour in the hall room preweaning and replay of music again elicited play behaviour post weaning. Play behaviour has been considered a "positive welfare indicator", because play behaviour is sensitive to adverse environmental and physical conditions (Newberry et al., 1988; Lawrence and Appleby, 1996), because play is intrinsically rewarding (Vanderschuren et al., 1995) and because play will only occur when major stressors are absent and primary needs fulfilled (Spĩnka and Newberry, 2001). In conclusion, this study shows that music, when associated with the appropriate positive events, can be used as a tool to improve welfare. However, the present study was limited in time and it remains to be investigated whether positive events of music remain to be seen, also when music is repeatedly replayed without associated rewards. Whether music can be effectively applied in

conventional production systems to improve welfare also on a long-term basis, remains therefore to be investigated.

Acknowledgements

We wish to thank Teunis Mul and Jan van Mourik for their for their helpful comments and dedicated care for the experimental piglets and Pim Kuurman for his help with the statistical analyses.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.applanim.2008.04.009.

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