Juvenile farmed mink (Mustela vison) with additional access to swimming water play more frequently than animals housed with a cylinder and platform, but without swimming water

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Abstract

The opportunity to perform play behaviour may be an important ontogenic activity that stimulates behavioural variability and may enhance an individual's coping capacity later in life. Play behaviour in juveniles may be enhanced by the presence of cage enrichments relevant to the animal's motivations and natural behavioural repertoire. The present study aimed to investigate play behaviour in juvenile farmed mink reared and housed with the cage enrichments standard for the Dutch housing system (ie a cylinder and platform) and in an experimental group of animals with the same standard enrichments but with additional access to swimming water. Juvenile mink with access to swimming water played significantly more in the main cage than mink reared and housed with the cylinder and platform but without swimming water. The results suggest that swimming water presents the animals with biologically relevant stimuli that directly or indirectly influence the development of play behaviour. Specific implications for the animals' long-term welfare are discussed. Future studies should elucidate the effects of juvenile play on the occurrence of abnormal behavioural patterns in adulthood more precisely and more thoroughly.

Keywords: *animal welfare, coping capacity, enrichment, mink, needs, play behaviour*

Introduction

Juvenile mink, like other Mustelidae, are generally known for frequent playful behaviour patterns. Kuby (1982) and Jonasen (1987) studied the development of play behaviour in juvenile mink in semi-natural cages. Play behaviour is first observed during the socialisation phase at 5½–8 weeks old (Jonasen 1987), and starts with social inhibited biting play, followed by solitary play patterns such as tail-chasing, playing with objects and locomotor play. Later the juveniles start to chase each other and develop rough-and-tumble play and hide-and-seek play. After ten weeks, Kuby (1982) described that the play behaviour patterns resemble more closely the adult sexual and predatory behaviours.

In general, play behaviour in juveniles can be seen as preparation for the development of motor and cognitive skills, social functioning, and fight/flight and predatory behaviour (eg Morgan 1973; Fagen 1981; Bekoff & Beyers 1998; Hall 1998; Siviy 1998; van den Berg 1999; van den Berg *et al* 1999; Špinka *et al* 2001). Play behaviour may, therefore, enhance the animals' adaptive capacity later in life. As an example of how animals' adaptive capacity may be altered, van den Berg (1999) showed that isolation during the play period in juvenile rats affected motivational aspects of social and non-social incentives in maturity: play-isolated rats showed a decreased motivation for social contact and for sucrose drinking in adulthood.

It is assumed that animals play because of surplus energy, arousal or just because of the 'pleasure' it brings (eg Grier & Burk 1992; Bekoff & Beyers 1998). The rewarding properties ('pleasure') of play behaviour patterns can be explained by the involvement of opioid systems (see VanderSchuren *et al* 1995a,b). The main characteristics of play behaviour patterns are (1) that they are easily interrupted by other behavioural patterns that have a higher priority at that moment (eg by flight, foraging and mating), (2) that they are mostly displayed under familiar and relaxed motivational conditions (Fagen 1981; Grier & Burk 1992; Broom & Johnson 1993), and (3) that they do not occur when animals are under severe stress (Hinton & Dunn 1967; McCune 1992). Hence, with regard to the assessment of animal welfare, the investigation of juvenile play behaviour during ontogeny can be interesting for at least three reasons. First, play may enhance animals' adaptive abilities in adulthood (allowing them to 'cope better'). Second, play behaviour occurs under relaxed conditions and its display might therefore indicate that the animals' most urgent needs have been met. Third, play behaviour may have rewarding properties itself, and may, therefore, serve to counteract a lack of other (rewarding) stimuli in the animals' cage environment.

The present study was designed to investigate and describe the occurrence of play behaviour in juvenile farmed mink

reared and housed with cage enrichments standard for the Dutch housing system (a cylinder and platform; see Vinke *et al* 2002) and in an experimental group with the same standard enrichments but with additional access to swimming water. In a previous study of farmed mink, it was found that mink housed in the presence of a cylinder and platform showed increased levels of social interaction and play behaviour: a minimum of 1.8% of the total observation time in the absence of a platform and cylinder, versus a maximum of 6.6% in the presence of a platform and cylinder (Vinke *et al* 1998, p 35). In the present study, swimming water was chosen as the additional enrichment, as swimming water is part of the mink's biotope (natural habitat; see Dunstone 1993) and is the most highly debated need of farmed mink (see Skovgaard *et al* 1997a,b; Hansen & Jeppesen 2001; Mason *et al* 2001). Because additional swimming water presents more and/or other stimuli to the animals than does the standard environment, it was expected that mink reared and housed with access to swimming water would play more frequently than control animals housed with the platform and cylinder but without access to swimming water.

Materials and methods

Subjects, housing and experimental conditions

Fifty-six wild coloured American mink (*Mustela vison*) families were reared and housed under the conditions of the standard Dutch mink farming system (for a detailed description, see Vinke *et al* 2002) at the research centre Het Spelderholt in Beekbergen, the Netherlands. These mink were housed in wire-mesh cages and reared in family groups (ie mother and kits). As soon as the kits were born, each family was housed in three connected standard cages (each cage measuring 85 × 30 × 45 cm, length × width × height) with, in each cage, one straw-filled nest box (15 × 15 × 15 cm), one platform (30 × 10 cm), and one plastic cylinder (diameter 12 cm, length 15 cm). Juveniles were weaned at the age of fourteen weeks when they were fully milk-independent (therefore, weaning was not begun until after the observation period of this study). Drinking water was available *ad libitum*, and all mink families were fed twice per day at 0800h and 1530h with commercial mink food (Flevo BV, Putten, The Netherlands). As a standard procedure, the kits were vaccinated in their seventh and twelfth weeks, respectively, against botulism (BioCom-P®) and distemper (Distemink®).

For the experiment, twenty-eight families were reared and housed in the presence of swimming water, cylinders and platforms. A control group of twenty-eight families was housed as described above with cylinders and platforms, but without swimming water. The extra facilities of the water baths were connected to the standard cages when the kits were about six weeks of age (the age at which mink kits start to leave the nest and explore their surroundings; see Kuby 1982). The swimming facilities were created in fourteen aluminium baths. Two wire-mesh cage constructions (each measuring 103 × 75 × 75 cm) were placed next

to each other in each bath, with partitions between the wire-mesh cages. The water level in each bath was 45 cm high. The mink families could not see each other, as the partition (screen) visually separated the families. Mink were given access to the baths via a wire-mesh tunnel approximately 40 cm in length, and an entry platform. For hygiene purposes, the water contained five chloride tablets (Henkel-Ecolab BV, Nieuwegein, The Netherlands) and was refreshed every two or three weeks.

The groups with and without swimming water are henceforth referred to as the W-group and the C-group, respectively. The mean litter size for the W-group and the C-group was 6.10 (± 2.39 standard deviation [SD]) and 6.25 (± 1.71 SD) kits, respectively. The mean ambient temperature during the whole observation period was 24.0°C (± 3.8 SD).

Behavioural observations

Observations were carried out between 0900h and 1500h when the kits were aged 7–11 weeks, giving a total of five observation weeks. There were 56 families and 348 kits in total — about six kits per family. The behaviour of each kit was scored using a scan sampling method (see Lehner 1996). Data were collected during three sessions per day (session 1, 0900h–1030h; session 2, 1100h–1230h; session 3, 1300h–1430h) on three days per week. A circulation scheme was used to randomise the order of the observations over the 56 families for each observation session. Completing one set of scans of one family took 1 min 30 s on average, about 15 s per kit. One observer carried out all observations.

The kits were observed from the central path between the two parallel rows of cages in the shed. If the animals were disturbed by the presence of the observer, the start of the observation was postponed until the animals stopped paying attention to the observer. An observation was scored as a disturbance by the observer when the kit was disturbed for longer than 2 min. The ethogram is presented in Table 1. The observed behavioural patterns were mutually exclusive.

Data analysis and statistics

The scores of the behavioural patterns of the kits were pooled by family and the total group means of each family were used for further statistical calculations. All means presented were corrected for the litter sizes of each family, including the mortality during the five weeks of observation. So that direct comparisons could be made of frequencies of behaviour patterns in the main cage (by correcting for the water-directed activities of the W-group), statistical calculations of play patterns were conducted using relative mean percentages of the patterns performed on the cage floor only. The mean percentages of behaviours performed in the main cage were expressed as one hundred per cent for each experimental group. The data for behaviour in and around the water bath were presented separately from the data for the other behavioural patterns.

Percentages of the mean group frequencies are presented with standard errors (± SEM) unless mentioned otherwise. All data were tested non-parametrically (Siegel & Castellan 1988) using SPSS for Windows (version 9.0). To test for

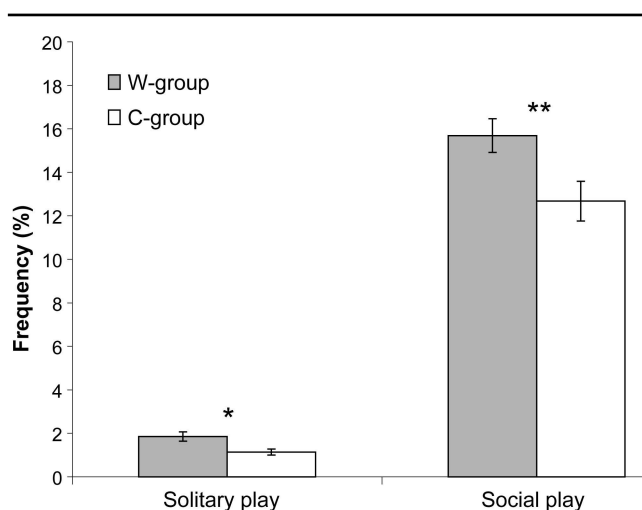**Table 1   Ethogram used for the observation of the mink kits.**

Behaviour pattern	Contains	Description
Solitary general		
Solitary active	Walking	Ambulatory locomotion at slower speeds such that all four feet are on the cage floor at times
	Running	Ambulatory locomotion at faster speeds such that all four feet are simultaneously off the cage floor at times
	Climbing	Animal moves up onto the ceiling and/or side walls of the cage without contacting the cage floor with any of its feet
	Eating	Animal eats some food distributed on top of the front of the cage
	Drinking	Animal drinks water from the nipple drinkers at the back of the cage
	Defecating	Animal walks to the back of the cage, turns around, walks back and urinates or defecates through the wire mesh
	Being alert	Animal actively observes its surrounding
	Grooming	Animal licks and/or rubs its pelt with forepaws and tongue
Solitary inactive	Sleeping/lying	Animal sleeps or lies solitarily on the floor of the cage or in the nest box
Social general		
Socially active	Mouth licking	Animal licks with its tongue the mouth of another animal
	Sniffing	Animal sniffs with its nose a body part of another animal
	Suckling	Animal sucks milk from its mother
	Grooming	Animal licks and/or rubs the pelt of other animal(s) with forepaws and tongue
Socially inactive	Sleeping/lying	Two or more animals sleep together, lying beside or on top of each other
Play behaviour		
Solitary play	Solitary running play	Animal runs across the cage floor with occasional jumping, all four feet losing contact with the cage floor
	Solitary tail-chasing	Animal chases its tail actively, with forepaws and/or mouth touching the tail and animal turning in circles
	Solitary rough-and-tumble play	Animal turns on its back on the cage floor or in the nest box and/or spins on its axis (somersaulting), etc
	Solitary play plus manipulation of object	Animal actively engaged with an object (ie cylinder) using its forepaws or teeth: biting, rolling, shoving, twisting, scratching, etc
Social play	Social biting play	Animal bites/chews in an inhibited manner a body part (mostly neck or tail) of another animal
	Social chasing play	Animal chases with high speed (running) one or more animals across the cage floor (sometimes involving biting the tails of the others)
	Social rough-and-tumble play	Animal turns on its back on the cage floor or in the nest box and/or spins on its axis (somersaulting), together with one or more other animals
	Social play plus manipulation of object	Together with one or more other animals, actively engaged with an object (cylinder) using their forepaws or teeth: biting, rolling, shoving, twisting, scratching, etc
Water-directed behaviour		
Behaviour in and around the swimming bath	Exploration	Animal stands along the water side and sniffs and looks around, but does not enter the water
	Head dip	Animal puts its head under the water and looks around
	Swimming	Animal enters water and swims with movements of all four feet, holding its head above water
	Diving	Animal enters the water and swims under water for a while
	Solitary water play	Solitary play in the water (eg chasing tail with circular motions)
	Social water play	Social play in the water (eg tail-chasing, chewing)
Other behaviour		
Stereotypical behaviour		Invariable repeated behavioural patterns; three repetitions for movements orientated in one position in the cage, and two repetitions for movements over the full length of the cage
Agonistic behaviour	Aggression	Violent body contact of two animals with fierce biting, sometimes loud screams and hissing vocalisations
	Prey shaking	Animal bites a body part of another animal and shakes violently with the head up and down and right to left
	Flight	Animal moves away from another animal usually at high speed; sometimes high-pitched vocalisations can be heard
Looking at observer		Animal alertly watches the observer (in case of disturbance)

Figure 1
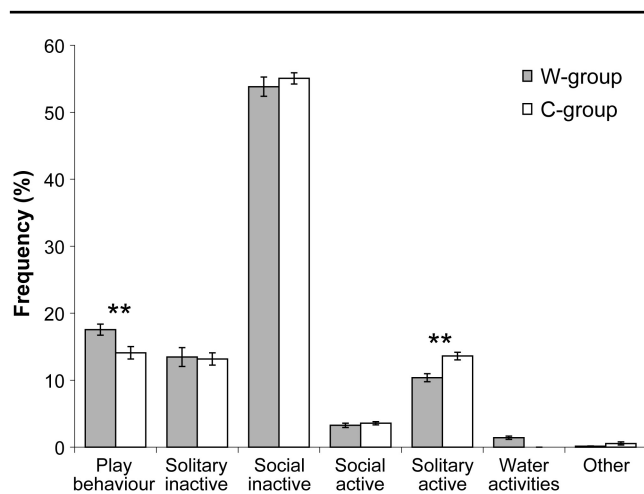
The mean percentages of frequencies (± SEM) of seven behavioural patterns, including play behaviour, during the five-week observation period in the W-group (n = 28) and C-group (n = 28). Significant differences between groups (MWU): ** $P < 0.01$.
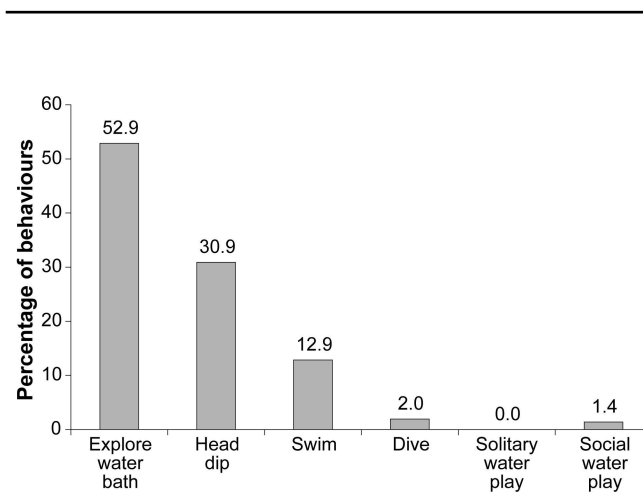
Figure 2

Six behavioural patterns in the W-group (n = 28) expressed as mean percentages of the total scored behavioural patterns in and around the water.

Figure 3

Total mean percentages of frequencies (± SEM) of solitary and social play in the W-group (n = 28) and C-group (n = 28) during the five-week observation period. Significant differences between groups (MWU): ** $P < 0.01$, * $P < 0.05$.

Figure 4

The total mean percentages of frequencies (± SEM) of eight play patterns in the W-group (n = 28) and C-group (n = 28) during the five-week observation period. Significant differences between groups (MWU): ** $P < 0.01$, * $P < 0.05$.
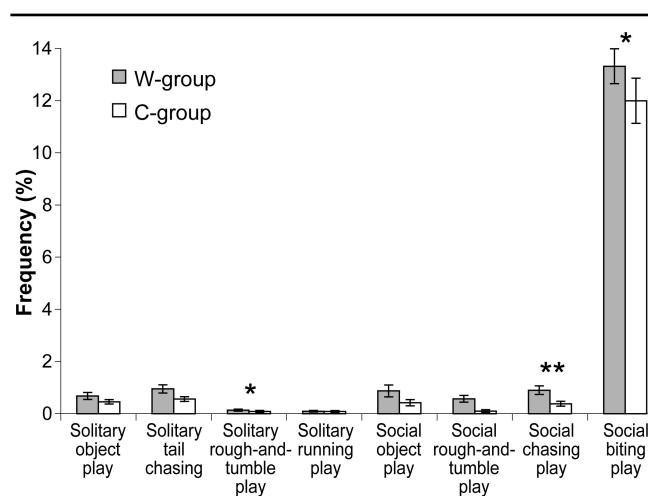
overall differences between the two experimental groups, data from the five observation weeks were summed and averaged per family. Statistical calculations were performed using two-tailed Mann-Whitney U tests (MWU) to reveal differences between the two groups. Friedman tests were used to assess overall significances of the different behavioural patterns over the five weeks of observation. When overall significant differences were found, Wilcoxon matched-pairs signed-ranks tests were performed to test for differences between two separate weeks. Differences were considered to be significant if $P \leq 0.05$. A trend was considered where $0.05 \leq P \leq 0.1$. Results were non-significant (NS) when $P > 0.10$. All tests performed were two-tailed.

Results

Behaviour of mink kits in the two groups

Figure 1 shows the percentages of the group means (± SEM) of the total scored frequencies in both experimental groups, divided into solitary and social activity, solitary and social inactivity, water activities, play behaviour, and other behavioural patterns such as agonistic behaviour, stereotypical behaviour and looking at observer. On average, the subjects housed in the W-group and the C-group were inactive (ie solitary and social inactive) for 67.3% (± 2.0 SEM) and 68.2% (± 1.3 SEM) of the total scored frequencies, respectively. No significant difference existed between the groups

Table 2   Total mean percentages of frequencies (± SEM) of the eight types of play behaviour in the main cage in the W-group (n = 28) and C-group (n = 28).

Mean % (± SEM)	Solitary object play	Solitary tail-chasing	Solitary rough-and-tumble play	Solitary running play	Social object play	Social rough-and-tumble play	Social chasing play	Social biting play
W-group	0.7 ± 0.13	1.0 ± 0.16	0.13 ± 0.04*	0.09 ± 0.03	0.9 ± 0.23	0.6 ± 0.13	0.9 ± 0.16**	13.3 ± 0.67*
C-group	0.5 ± 0.08	0.6 ± 0.09	0.09 ± 0.04*	0.08 ± 0.04	0.4 ± 0.12	0.1 ± 0.05	0.4 ± 0.09**	12.0 ± 0.85*

Significant differences between the W- and C-groups (MWU): ** $P < 0.01$, * $P < 0.05$

for solitary and social inactive behaviour (MWU: $U > 375.0$, NS). Mink kits housed in the C-group spent significantly more time carrying out solitary active behaviour (13.6% ± 0.6 SEM) than kits housed in the W-group (10.4% ± 0.6 SEM) (MWU: $U = 177.0$; $P \leq 0.01$; n = 56). No significant differences were found between the groups for social active behaviour and 'other behaviour' (MWU: $U > 310.0$, NS).

On average, mink kits housed in the W-group showed more play behaviour (17.5% ± 0.8 of the total scored frequencies) than kits housed in the C-group (14.1% ± 0.9), a difference which was significant (MWU: $U = 230.5$; $P \leq 0.01$; n = 56). As mink were inactive for a substantial proportion of the day, an additional second analysis was run in which play behaviour was calculated as a percentage of the total active time (see also Figure 5). On average, mink kits housed in the W-group played significantly more during their total active time (56.0 % ± 1.8) than kits housed in the C-group (44.2 % ± 2.1) (MWU: $U = 149.5$; $P \leq 0.01$; n = 56).

Activities in and around the water bath

Of the total scored frequencies, the subjects in the W-group spent 1.4% (± 0.2) in and around the swimming water. To give an insight into the behaviour of the kits in and around the water facilities, the mean percentages of the different behavioural patterns directed at the water were calculated as a percentage of the total number of scored behavioural patterns in and around the water (Figure 2). Of the total scored frequencies in and around the water, 53% were exploration behaviour, 31% were head dips into the water, and 13% and 2% were swimming and diving, respectively. 1% was social water play. During the five-week observation period, exploration of the water bath, head dipping behaviour and swimming increased significantly over time (Friedman test: $\chi^2 > 15.03$; $df = 4$; $P \leq 0.01$; n = 28).

Play behaviour on the cage floor

In total, eight different types of play patterns were observed in the main cage (see Table 1). First, solitary and social play patterns were summed and calculated separately for an overall insight (see Figure 3). Mink kits in the W-group showed significantly more solitary play and social play patterns than kits in the C-group (MWU: $U > 233.0$; $P \leq 0.05$; n = 56).

Table 2 and Figure 4 present the percentages of the total mean frequencies (± SEM) of the eight separate play

Figure 5
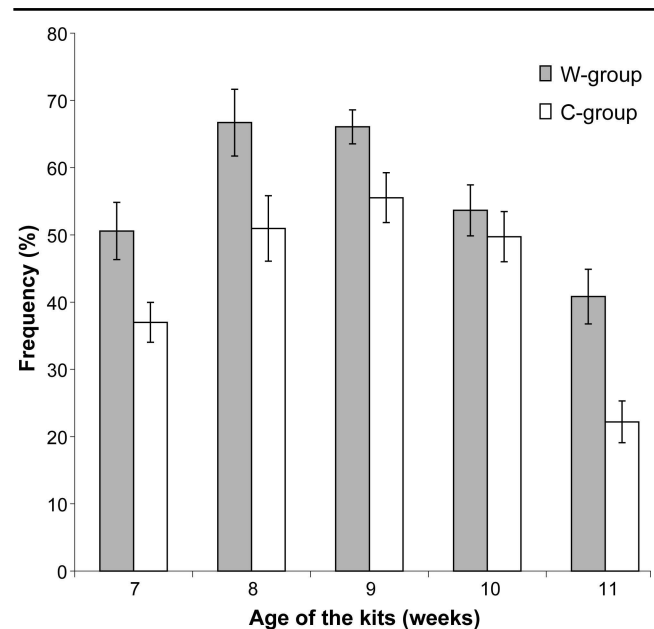
Play behaviour expressed as the mean percentages of the frequencies (± SEM) of the total active time per observational week (ie age of the kits) in the W-group (n = 28) and C-group (n = 28). There was an overall significant difference in the occurrence of play behaviour over time for both the W-group and the C-group (Friedman test): $P \leq 0.01$.

behaviour patterns of both groups during the five weeks of observation. Overall, mink kits were mainly engaged in social biting play. Solitary tail-chasing play was the second highest behaviour. Mink kits housed in the W-group showed significantly more solitary rough-and-tumble play, social chasing play and social biting play than kits housed in the C-group (MWU: $U > 226.0$; $P \leq 0.05$; n = 56).

To give an insight into the differences in play behaviour in both the W-group and the C-group over the observation period (ie kits aged 7 to 11 weeks), all play patterns were expressed as the mean percentage of the frequencies (± SEM) of the total active time per observation week (see Figure 5). An overall significant difference in the occurrence of play behaviour was found over time (from 7 to 11 weeks) for both the W-group and the C-group (Friedman test: $\chi^2 > 29.66$; $df = 4$; $P \leq 0.01$; n = 56). The highest levels of play occurred when the kits were 8–9 weeks of age.

Table 3   Mean percentages of frequencies (± SEM) during two observation weeks for solitary tail-chasing play, social rough-and-tumble play, social chasing play and social biting play in the W-group (n = 28), and for solitary running play and social biting play in the C-group (n = 28). Significant differences between two weeks of observation (kit age) (Wilcoxon signed-rank test): ** P < 0.01, * P < 0.05. Only the significant differences are presented.

Play behaviour, W-group	Kit age (weeks): Week X compared to week Y	Mean (± SEM) X	Mean (± SEM) Y
Solitary tail-chasing play	7–8	0.8 ± 0.26*	2.10 ± 0.62*
	8–10	2.1 ± 0.62**	0.3 ± 0.14**
	8–11	2.1 ± 0.62*	0.5 ± 0.24*
Social rough-and-tumble play	9–10	0.1 ± 0,08**	1.3 ± 0.35**
	7–10	0.0 ± 0.0**	1.3 ± 0.35**
	8–10	0.2 ± 0.2*	1.3 ± 0.35*
	9–11	0.1 ± 0.08*	1.2 ± 0.47*
Social chasing play	7–9	0.1 ± 0.11*	1.2 ± 0.47*
	7–10	0.1 ± 0.11**	2.2 ± 0.5**
	8–9	0.2 ± 0.14*	1.2 ± 0.47*
	8–10	0.2 ± 0.14**	2.2 ± 0.5**
	10–11	2.2 ± 0.50*	0.8 ± 0.36*
Social biting play	7–11	14.2 ± 1.4**	8.8 ± 1.27**
	8–11	14.2 ± 1.6**	8.8 ± 1.27**
	9–11	15.9 ± 1.22**	8.8 ± 1.27**
	10–11	13.5 ± 1.36*	8.8 ± 1.27*
Play behaviour, C-group	**Kit age (weeks): Week X compared to week Y**	**Mean (± SEM)**	**Mean (± SEM)**
Solitary running play	7–10	0.3 ± 0.14*	0.0 ± 0.0*
	7–11	0.3 ± 0.14*	0.0 ± 0.0*
Social biting play	7–9	12.0 ± 1.38**	17.9 ± 1.77**
	8–9	10.0 ± 1.27**	17.9 ± 1.77**
	8–10	10.0 ± 1.27*	14.6 ± 1.34*
	7–11	12.0 ± 1.38**	5.4 ± 0.79**
	8–11	10.0 ± 1.27**	5.4 ± 0.79**
	9–11	17.9 ± 1.77**	5.4 ± 0.79**
	10–11	14.6 ± 1.34**	5.4 ± 0.79**

When the eight play patterns were analysed separately over time, significant overall differences were found for solitary tail-chasing play, social rough-and-tumble play, social chasing play and social biting play in the W-group (Friedman test: χ^2 > 14.13; df = 4; $P \leq 0.05$; n = 28). For the C-group, significant differences over time were found for solitary running play and social biting play (Friedman test: χ^2 > 14.33; df = 4; $P \leq 0.05$; n = 28; see Table 3). Solitary tail-chasing play was constant over the five observation weeks for both the W- and the C-group, but for the W-group a peak was found during week eight. Social rough-and-tumble play increased for both groups in the last two weeks of observation, but particularly in the W-group. Social chasing play behaviour peaked for both groups in weeks nine and ten and decreased in the eleventh week of age; this peak was higher in the W-group. Overall, social biting play behaviour was the most frequently observed play behaviour; a peak was found in the ninth week of age. Some solitary running play was observed during the seventh week in the C-group, but the pattern decreased in the tenth and the eleventh week.

Conclusion and discussion

The present study was designed to investigate and describe the occurrence of play behaviour in juvenile farmed mink reared and housed with a cylinder and platform as the standard cage enrichments (standard Dutch housing system) and in an experimental group with additional access to swimming water. The results of the present study indicate that mink kits reared and housed with access to swimming water play more frequently in the main cage than kits reared and housed without access to swimming water. The results

suggest that swimming water may present some relevant stimuli that directly or indirectly influence the development of play behaviour in mink.

During the observation period, the frequencies of play behaviour showed a bell-shaped curve for both experimental groups, with a maximum at the age of 8–10 weeks. This indicates that the observations covered the most important period of development of play in mink. However, an additional observation week at six weeks of age might have given additional information, as suggested by the finding that play behaviours had already begun at the start of the observations in the seventh week, particularly in the W-group. This suggestion is supported by Jonasen (1987), who mentioned that play behaviour in mink can first be observed between 5½ and 8 weeks when kept in a semi-natural cage.

The results of the present study showed a higher frequency of juvenile play behaviour in the main cage when the kits had access to swimming water. If young mink spent much of their time in and around the swimming bath, this would be at the expense of play behaviour and other behavioural patterns in the main cage, in which case it would be expected that mink with access to swimming water would show less play behaviour and other active behavioural patterns in the main cage than mink kits without access to swimming water. However, in this study the juvenile mink spent a relatively small percentage (1.4%) of the total scored frequencies in and around the water; hence, the majority of behavioural patterns were performed in the main cage. This finding suggests that the presence of and/or the relatively brief contacts with the water are sufficient to effect changes in minks' behaviour in the main cage. According to Bakken *et al* (1994), the value of the presence of enrichments might be (additionally) found in the animal's awareness that it has a specific place to go (its choice), irrespective of whether it actually visits that place frequently.

It might be argued that juvenile mink with access to swimming water also have more available space, which is inherent in a design with a water bath. However, the effect of extra space on the behaviour of farmed mink is not entirely clear from the literature (see eg Hansen 1988, 1998; Hansen *et al* 1992, 1994; Nimon & Broom 1999; Jeppesen *et al* 2000), and we do not expect that cage size was the main influencing external factor in the present study. The mink kits in the C-group had three standard cages as well, which is relatively large for a family containing six kits on average. An additional experimental group housed with access to an empty bath could be used in a future study to control for the effects of space. Another explanation for the increased levels of play behaviour in the W-group that cannot fully excluded is that the partitions between the swimming baths excluded visual stimuli but not acoustic or olfactory stimuli; thus, kits in the W-group might have influenced each other with acoustic and/or olfactory stimuli, resulting into higher levels of play. However, the kits spent only 1.4% of their time in and around the swimming bath, which may be too little time for a prominent effect.

Two aspects in this study should be considered cautiously in the light of animal welfare. First, increased levels of play may contribute to the juveniles' well-being in the short-term, but lower levels of play in the behavioural repertoire does not necessarily mean poor welfare. To test for a causal relationship, a clearer relation should be sought between the level of juvenile play behaviour and the occurrence of abnormal behaviours (eg stereotypical behaviour) in adulthood. In a preliminary pilot study, we found an overall significant negative correlation between the frequencies of juvenile play behaviour and stereotypical behaviour in adulthood (Spearman's rank correlation: $\rho = -0.27$, $P = 0.05$), suggesting that kits reared in families with higher frequencies of play behaviour, which were kits with access to swimming water in this study, showed less stereotypical behaviour in adulthood. However, juvenile play behaviour and stereotypical behaviour did not significantly correlate when tested for each of the two experimental groups separately (Spearman's rank correlation: $\rho < 0.27$, NS). Future studies should elucidate the effects of juvenile play on the occurrence of abnormal behavioural patterns in adulthood more precisely and more thoroughly.

Second, the present study shows that additional access to swimming water stimulates the occurrence of play behaviour. Although the higher frequencies of play behaviour in the presence of swimming water confirmed our expectations, the results do not exclude the possibility that other attractive cage enrichments also have the potential to stimulate juvenile play behaviour. We expect stronger effects when the cage enrichments are more relevant to the species' natural behavioural repertoire.

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