

## The concept of behavioural needs in contemporary fur science: do we know what American mink (*Mustela vison*) really need?

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### Abstract

This paper discusses the ethical implications of applying the concept of behavioural needs to captive animals. This is done on the basis of analysing the scientific literature on farmed mink and their possible need for swimming. In the wild, American mink (*Mustela vison*) are semi-aquatic predators, lending initial support to the claim that captive mink with no access to adequate swimming facilities experience a thwarted behavioural need. Scientific studies show a disparate picture. Consumer-demand experiments, where the animals have been conditioned to work for environmental resources, consistently show that mink place high value on swimming water, whereas other studies indicate the opposite, which has led scientists to question whether this preference constitutes a genuine behavioural need. In this paper, we take a methodological turn and discuss whether the oft-used concept of behavioural needs provides the best possible account of what is indispensable to an animal. Seen from a more complex understanding of behavioural needs, we suggest that lack of swimming opportunities for farmed mink constitutes a welfare problem. Further, it is argued that the decision of which paradigm to use in research on animal needs has not only ethical consequences, but is in itself a value-based choice.

**Keywords:** American mink, animal housing, animal welfare, behavioural needs, ethics, swimming

### Introduction

Much regulation of animal welfare, such as The European Convention for the Protection of Animals kept for Farming Purposes, Articles III, IV, and V and many guidelines such as The Five Freedoms (Farm Animal Welfare Council [FAWC] 1993) and Welfare Quality® emphasise that captive animals should have the freedom to fulfil a series of species-specific behavioural needs (Botreau *et al* 2007). Although the concept of behavioural (ethological) needs is often employed with no clear indication of its meaning (Dawkins 1983) it can be broadly characterised as behaviours that are important for animals to perform, even when their physiological needs have been met (Jensen & Toates 1993). These behavioural needs are considered ‘necessities’ as opposed to mere ‘luxuries’ (Dawkins 1983).

The concept of behavioural needs can be traced back to the psycho-hydraulic model of motivation proposed by Konrad Lorenz (1950), who believed that action-specific energy would build up in an animal, if deprived of releasing stimuli. However, several authors have contributed to the theory’s further development (eg Hughes 1980; Dawkins 1983; Hughes & Duncan 1988; Friend 1989; Jensen & Toates 1993). In recent decades, the ethological concept of behavioural needs has been coupled with affective neuroscience (Panksepp 1998; Spruijt *et al* 2001; Boissy *et al*

2007). It has therefore been suggested that a mechanism of endogenous reward systems in the limbic forebrain has evolved to ensure that animals perform behaviour patterns with long-term adaptive value by associating the behaviour pattern itself with feelings of pleasure, rather than the fulfilment of short-term physiological needs (Friend 1989; Boissy *et al* 2007). Behavioural needs are often related to foraging, reproduction, or grooming. Depriving an animal of the opportunity to perform such displays would therefore result in reduced welfare. But how does one distinguish the indispensable from the ‘luxuries’?

The academic discussions of behavioural needs have implications both for animal production in general since legislation is partly based on scientific findings (Yeates *et al* 2011), and for the case of mink farming, as an opportunity for swimming is more likely to become a requirement if this is perceived as indispensable to the mink.

In this paper we will analyse the most frequent definitions of behavioural need in order to scrutinise how they are methodologically used in scientific studies on mink behaviour. Therein, we will examine arguments for and against providing a pool or pond for farmed mink as found in the animal welfare science literature, with reference to behavioural needs (Hansen & Jeppesen 1999; Vinke *et al* 2008; Møller *et al* 2011). We begin by outlining the charac-

teristics of the classical definition of behavioural needs based on various accounts in the literature, including some potential problems with the model of motivation upon which it is based. Subsequently, we proceed to discuss the individual criteria of this classical definition in relation to the empirical findings on swimming behaviour in captive mink. Furthermore, the various definitions and applications of the concept of 'behavioural needs' warrant an analysis of how values enter experimental methodology and conclusions drawn from the obtained data. Hence, a second aim is to examine the value basis of the research upon which recommendations are made.

### The classical conceptions of behavioural needs

What specific animal behaviours that should be considered as a 'need' is not self-evident. The following criteria or characteristics are frequently mentioned in the discussion as decisive for the evaluation of the behaviour as a 'need' or not in the literature on behavioural needs (Hughes & Duncan 1981, 1988; Dawkins 1983; Friend 1989; Jensen & Toates 1993; Jensen 2000; Vinke *et al* 2008):

- All members of the species, in context of gender and age, must perform the behaviour pattern;
- Deprivation of the behaviour leads to chronic stress (eg Friend 1989; Broom & Johnson 1993);
- The behaviour pattern is mainly caused by internal factors (eg hormone levels) and not elicited by cues in the environment (Friend 1989);
- The tendency to perform a behavioural pattern gradually accumulates if the animal is deprived of the opportunity to perform it. This is also known as 'rebound effect' or 'damming up' (Vestergaard 1980; Friend 1989); and
- The mere performance of the behaviour pattern is rewarding to the animal, so the animal will attempt to perform the behaviour regardless of whether the environment affords it and regardless of the functional consequences of the activity (Panksepp 1998; Spruijt *et al* 2001; Boissy *et al* 2007). Vacuum activities might also be observed in the absence of appropriate environmental stimuli.

The classical definitions have, however, been subject to criticism from some researchers (Hughes & Duncan 1981, 1988; Dawkins 1983, 1988; Friend 1989; Jensen & Toates 1993, 1997; Jensen 2000). The criteria regarding internal motivation and motivational accumulation postulate an underlying model of motivation that still resembles the original psycho-hydraulic model and some have argued that these criteria are too rigid (Jensen & Toates 1993) and have obscured the diversity of motivational mechanisms underpinning animal behaviour (Dawkins 1983). We consider this criticism a valid point of departure for elaboration on the most frequently used components of behavioural needs.

### Is the motivation to perform essential behaviours always internal and accumulating?

According to Jensen and Toates (1993), there is little evidence to support the claim, made by many scientists (eg Duncan & Poole 1990), that behavioural needs must always be characterised by motivational accumulation or a 'rebound effect'. Although some behaviours are expressed in a manner consistent with this pattern, others are not. Some species of rodent regularly patrol their environment in a manner that seems intrinsically hard-wired (Kavanau & Rischer 1968), as does dust-bathing in fowl (Vestergaard 1980). However, at other times, the motivation to perform behaviour can decrease when the circumstances change or be overshadowed by other needs.

The distinction between internally and externally motivated behaviour is central to the classical definition. This presupposes that a meaningful dichotomy exists between the two (eg Hughes & Duncan 1988; Friend 1989; Duncan 1998). However, such a dichotomy has been criticised for being inadequate at explaining the complexities of animal behaviour and for ignoring the functional role of goal-representation (Jensen & Toates 1993, 1997; Jensen 2000). Goal-representation is commonly defined as an internal state that depicts the world as the agent would have it be (for discussions about internal representation in animal cognition, see Davidson 1975; Stich 1978; Dennett 1995; Saitel 2009). Research indicates that many behaviours normally thought to be elicited by variations in the animal's internal state can in fact also be released by external stimuli. If the internal state of an animal is profoundly intertwined with external factors, a model of motivation must reflect this in order to be adequate in explanatory terms. For instance, 'satiated' pigs begin feeding upon seeing conspecifics eating, and although the animals will subsequently compensate for the additional intake, the response is apparently elicited by external stimuli (ie social facilitation) (Hsia & Wood-Gush 1983). Physiological stress in food-deprived monkeys has been demonstrated to be caused not by food deprivation *per se*, but rather the combination of food deprivation and seeing conspecifics eating (Mason 1975). Female porcine nest-building is a complex behaviour previously thought to be controlled mainly by elevated levels of plasma prolactin prior to farrowing (Widowski *et al* 1990), but it also appears to be influenced by the availability of nesting materials (Jensen 1993, 2000, 2002; Jensen & Toates 1993, 1997; Damm *et al* 2000; Wishcner *et al* 2009). Correspondingly, some behaviour patterns usually thought controlled by external factors, such as aggression (eg in territorial birds; Hinde 1970), can sometimes be governed by, what appears to be, internal factors (Jensen & Toates 1993).

The dichotomy between external and internal motivational states should be applied with caution in explaining animal behaviour and deciding which behaviour patterns are essential. Although some behaviour is apparently triggered

regardless of the environment, many basic behavioural patterns cannot be attributed to a unitary 'cause' or 'drive'. If the dichotomy of internal and external motivation is abandoned, 'needs' become situation-specific (Jensen & Toates 1993), eg farm animals that are frightened by a feature of their artificial environment might experience an urgent need to perform anti-predator responses etc. The restricted conditions of captivity might even create a new brand of behavioural needs not experienced by wild animals, such as a need for novel stimuli. In spite of the criticisms of the classical conceptions of behavioural needs, described above, a definition of 'need', resembling the classical psycho-hydraulic model, has in the recent decade been applied in the ethological literature, arguing that minks' motivation to swim is probably not a genuine behavioural need (eg Vinke *et al* 2008; Møller *et al* 2011). In concurrence with the original criticism raised by Jensen and Toates (1993), we find it important to stress that the use of a strong dichotomy between external and internal motivational states to limit the amount of essential behaviours in an animal is problematic. The scientific evidence points to a more complex understanding, which opens up a wider interpretation of what is essential to mink. The presented studies show this complexity and, as it is difficult to interpret and compare results, we argue this scientific uncertainty can be best met by an ethically founded 'benefit of the doubt' approach.

### Measuring behavioural needs or motivational strength

The studies of behavioural needs generally fall into three categories: comparing the behaviour of captive species with that of their wild counterparts (eg Jensen 2002); consumer-demand experiments, which are inspired by human micro-economics (Dawkins 1983; Mason *et al* 1997, 1999; Cooper & Mason 2000, 2001); and deprivation studies, that compare the biological responses of animals, which can then be interpreted in terms of welfare, in the presence or absence of the resource in question (eg Skovgaard *et al* 1997b; Vinke *et al* 2006; Mononen *et al* 2008). In this paper, we will focus primarily on the latter two. Consumer demand studies seek typically to elucidate the animal's preferences by imposition of costs through an operant task (such as lever-pressing) to gain access to resources. The amount of work that animals are willing to perform, in order to gain access to a resource, is interpreted as a measure of the priorities of the animals themselves. If animals consistently show willingness to work for a resource during increased cost or with decreased time available, it is interpreted as an indication of strong motivation (Dawkins 1983).

Deprivation experiments, on the other hand, compare the welfare parameters of animals with or without an enrichment resource (eg swimming water, social contact, toys) or by blocking access to a previously available resource. The methodological drawback of some experimental approaches, in relation to the classical conceptions of behavioural needs, is that the subjects are sometimes exposed to the resource (the 'priming effect'), and therefore responses can alternatively be interpreted as deriving from incentive-induced

motivation instead of genuine behavioural needs (Warburton & Mason 2003; Mason & Burn 2011), in the sense described above. In other words, it is uncertain whether the need was induced by interaction with the resource and not as a result of intrinsic propensity. Some researchers have avoided the problem of 'priming' by adding control groups without the opportunity to perform a certain behaviour or access a resource or by eliminating cues (olfactory, visual or auditory) in the environment that might otherwise elicit or enhance the animal's motivation to interact with a resource. The drawback of observing the behavioural repertoire of wild animals is that it still remains an open question which behaviours should be regarded as indispensable.

Based on this general description of ethological methods we will turn to the specific case of behavioural studies of mink.

### Is swimming a behavioural need for American mink (*Mustela vison*)?

In their natural habitat mink are semi-aquatic predators with a diet consisting of 30–70% aquatic prey (Dunstone 1993; Jedrzejewska & Jedrzejewski 1998; Vinke *et al* 2008). From an evolutionary point of view, the ability to supplement the diet with crustaceans and fish could give mink an edge when terrestrial prey is scarce (Dunstone & Birks 2009). Hence, aquatic exploration and predation are likely to have long-term adaptive value and could be governed by a mechanism of endogenous reward systems as described above. The behaviour of wild mink supports the contention that swimming should be considered a behavioural need (Nimon & Broom 1999; European Commission 2001), because it is a prominent feature of their natural feeding regime.

In spite of the semi-aquatic ecology of mink, a number of reports and opinions on housing and management conditions have concluded that the practice of fur farming (where swimming water is not available) meet the most essential needs of mink, such as natural reproduction, nursing, nesting etc (Wiepkema 1994; Vinke 2001; Mason 2008, Møller *et al* 2011). On the other hand, The European Commission (2001) has reviewed a very broad selection of scientific studies and expressed concerns over the compatibility of farming conditions of mink with the animals' behavioural and physical needs. All animal rights and protection organisations criticise fur farming, stating that it does not provide mink with the opportunity to perform their species-specific behaviours and that this leads to severe welfare problems (Linzey 2003; Born Free USA 2009). This pronounced disagreement between some of the scientific experts and between groups of stakeholders illustrates the significance of clarifying how to judge what counts as behavioural needs.

In this paper, we focus almost exclusively upon the narrow issue of potential harm associated with the deprivation of swimming opportunities for farmed mink. However, this is not to imply that this discussion exhausts the topic of behavioural needs of captive mink. The behavioural repertoire of wild mink includes a wide range of behavioural patterns relating to foraging or reproduction that cannot be performed under commercial conditions. The farm environment differs



markedly from the original ecological niche of mink, in terms of rearing kits, the proximity to conspecifics, opportunities for roaming, exploring, and occupying multiple dens etc (Nimon & Broom 1999; European Commission 2001). Even more subtle forms of deprivation may contribute to reduced welfare. Research on rodents kept in standard laboratory cages, suggests that traditional caging interrupts social dynamics (Balcombe 2006). Artificial environments may also impinge negatively on brain development and sensory systems of both rodents (Rao 1991; Burn 2008) and ferrets (*Mustela putorius furo*) (Apfelbach 1996), the latter of which is a close relative of mink.

### Welfare problems in farmed mink

Farmed mink are typically kept in batteries of wire cages in long sheds (mostly with wire floors). Large farms hold many thousands of individuals in small cages in close proximity. Cage measurements in Scandinavia are approximately 0.255m<sup>2</sup> × 45 cm (area × height); with additional 0.085m<sup>2</sup> for each animal above two, nest-boxes in solid material, tunnel or a shelf and straw (Finley *et al* 2012).

Widely acknowledged welfare problems have been observed in such fur-farming production systems, including the occurrence of maladaptive behaviours, such as self-mutilation, pelt gnawing and stereotypic behaviour (Nimon & Broom 1999; Møller *et al* 2011). The full extent of stereotypic behaviour in fur farming remains disputed. Danish studies estimate that 15.8% of the animals perform stereotypies (Bildsøe *et al* 1990), while others estimate that as many as 65 to 85% (Mason 1993, 2008; Nimon & Broom 1999; European Commission 2001; Axelson *et al* 2009) engage in stereotypic behaviour. The variation in percentages can perhaps be attributed to differences in breeds and/or sampling methods, definitions of stereotypic behaviour, demands on housing systems, and season (as female mink selected for breeding are restrictively fed during the winter which has been correlated with stereotypies) (Hansen *et al* 2011). Although stereotypic behaviour is, to some extent, genetically affected (Svendsen *et al* 2007), it is undoubtedly also triggered by the barren cage environment as stereotypies rarely, if ever, occur in the wild or in semi-natural environments (Nimon & Broom 1999). Experience and research suggest that enriching the cage environment (in a relevant way) is the most effective way of reducing, or even preventing, development of abnormal behaviour in captive animals, including mink (Mason & Latham 2004; Hansen *et al* 2007; Mason 2008). Some recent studies report additional, presumably positive, effects in environmentally enriched mink, such as enhanced copulatory performance in males (Diez-Leon *et al* 2013) and an increase in behavioural flexibility (Campbell *et al* 2013).

### Cage enrichment for mink

Behavioural scientists generally agree that animals have a certain degree of behavioural plasticity, allowing them to adapt to new environments, even to captivity. Nonetheless, the expression of natural species-specific behaviours in captivity is best encouraged by introducing crucial features of the animal's natural habitat into the captive environment (Blanchard & Blanchard 2003; Baumans 2005). In trying to determine what type of enrichment is biologically relevant to mink, researchers have tested the minks' reactions to a variety of objects including table-tennis balls for playing, plastic cylinders that can be used as tunnels, ropes for chewing and tearing, straw, shelves, and swimming water (see Jeppesen & Falkenberg 1990; Cooper & Mason 2001; Jeppesen 2004; Hansen *et al* 2007).

Although most consumer-demand experiments, run primarily in Oxford, UK using only wild-type, British farmed mink, show that mink work harder for access to swimming water than any other enrichment resources (eg toys or social contact), except nest-box and food, and seem to experience stress when access is blocked (Cooper & Mason 1997, 2000, 2001; Mason *et al* 1997, 1999, 2001; Warburton & Mason 2003), deprivation experiments have not found a consistent trend (Skovgaard *et al* 1997a,b; Hansen & Jeppesen 2001a, 2003; Pedersen & Jeppesen 2001; Korhonen *et al* 2003; Jeppesen 2004; Vinke *et al* 2006; Mononen *et al* 2008; Ahola *et al* 2011). It is difficult to integrate the results produced by the two methodologies, as consumer demand studies measure the strength of the animal's motivation in a very direct way, whereas deprivation studies usually record standard welfare indicators, changes in physiology and/or behaviour, as indirect measures. Both methodologies imply interpretation of measurements in relation to welfare.

In short, at first glance despite consumer-demand studies appearing to suggest that mink seem highly motivated to swim when water is available, they may not need it in the sense that they suffer when it is not possible. Thus, mink, according to this research approach, appear to have no behavioural need to swim (Vinke *et al* 2008; Møller *et al* 2011). On the other hand, it is also difficult to overlook the strong motivation to swim as well as minks' natural adaptation to a semi-aquatic environment. Some authors have argued that motivation, natural adaptation and measuring of welfare indicators should all be considered in order to identify behavioural needs (Bracke & Hopster 2006). However, such gaps need to be sorted out in order to make statements on mink welfare and needs in captivity, and in the following sections this apparent gap between research paradigms or assessment schemes, on the one hand and statements on behavioural needs on the other, will be elaborated in further detail.

### The case against swimming as a behavioural need

Vinke *et al* (2008) concluded that swimming should not be considered a behavioural need, but rather an activity that induces its own incentive. Their arguments can be summarised as such:

- Studies have shown that although most mink interact with swimming water when it is available, some individuals never do (Skovgaard *et al* 1997b; Mohaibes *et al* 2001; Mononen *et al* 2008);
- The introduction of swimming water does not appear to consistently reduce stereotypic behaviour and there does not appear to be a clear difference between mink with access to water and those without, when compared using commonly used indicators of stress, (eg levels of corticosteroid metabolites in urine or faeces, stereotypies, blood counts of eosinophilic leukocytes etc);
- Minks' demand for swimming water appears to presuppose prior experience, indicating that swimming is not internally motivated; and
- There does not appear to be an accumulation in the motivation to swim, if the access to swimming water has been temporarily blocked.

These arguments correspond closely with the first four criteria of the classical definition. Note that the fifth criterion (on rewarding effect) is left out, as many authors agree that mink generally seem to value swimming (Cooper & Mason 1997, 2000, 2001; Mason *et al* 1999, 2001; Mononen *et al* 2008; Mohaibes *et al* 2009).

### Do all members of the species perform the behaviour pattern? (the first criterion)

In their natural habitat, wild mink are skilled hunters of terrestrial prey, yet they always set up territory along water and there are no reports of wild mink thriving as completely terrestrial (Dunstone 1993; Mononen *et al* 2008). In addition, feral populations of American mink in northern Europe (descendants of farmed mink) show ecological behaviour similar to their wild ancestors (Niemimaa 1995; Hammershøj 2004). This suggests that the tendency to seek out water is a 'hard-wired' behaviour that has not been significantly altered by a century of breeding in captivity.

Vinke *et al* (2008) emphasise that a number of experiments have shown that not all mink with access to water use it for swimming (Hansen & Jeppesen 2001a; Mohaibes *et al* 2001, 2002, 2003). The authors reviewed 20 studies and compared swimming behaviour.

Only eight of the studies reported how many subjects actually swam. Three reported that all animals swam (Cooper & Mason 2000; Mason *et al* 2001; Warburton & Mason 2003). Four of the 20 reviewed studies found that at least 80% of the mink swam (de Jonge & Leipholdt 1994; Hansen & Jeppesen 2001b, 2003; Vinke *et al* 2005). One study found that only 65% (26/40) swam (Skovgaard *et al* 1997b). As the 20 studies were performed in different conditions, a more detailed analysis is required to evaluate their comparability, and to evaluate whether the lack of use of water is a result of poor design of the bath or fear for novel objects, sub-dominance, or breeding etc (for a review, see Ahola *et al* 2011).

### Why are some mink non-swimmers?

In three experiments, Mononen *et al* (2008) explored individual differences in swimming patterns, the heritability of the propensity to swim, as well as the effects of access to swimming water on stereotypic behaviour. In the first experiment, 18 juvenile mink, naïve to water, were given access to a swimming bath for ten days (behaviour was sampled on day 1, 2, 10), in order to examine how quickly and consistently they used it. All animals were observed to swim at some point and 12 swam on all three observation days. The naïve, juvenile animals would establish their swimming pattern faster than naïve adults, which confirms previous observations (Poole & Dunstone 1976), suggesting that the age of experimental subjects ought to be taken into account when interpreting test results.

The second experiment compared naïve and experienced adult mink as well as their offspring in order to explore the significance of prior experience with water and of a possible heritable component. The experienced adults swam most frequently, but the naïve adults gradually increased their time in the water as the experiment progressed. All experienced subjects swam, whereas some naïve adult subjects never did. Mononen *et al* also detected a moderate correlation between the frequency of swimming bouts in the dams with that of their kits, suggesting that the motivation to swim is affected by the age of exposure to water as well as by genetic disposition.

Mononen *et al* found that mink with access to water exhibited fewer stereotypies, which linked swimming water with improved welfare, but the studies also revealed that a variety of factors influenced the minks' disposition to swim. The time and season of sampling also appear to influence results, as mink are reported to increase interaction with swimming baths during winter (Mohaibes *et al* 2003) and primarily swim prior to feeding. Mononen *et al* recorded behaviour 24 h a day and could therefore include nocturnal activity. The physical properties of the swimming bath itself might also affect the motivation to swim, as some studies indicate that mink have preferences in regards to the shape and dimensions of the baths (Hagn 2009).

Does the fact that a certain number of animals fail to exhibit swimming during a short observation period necessarily imply that it is not a species-specific behaviour and therefore not a behavioural need? An animal cannot be expected to express its needs continuously or at very specific times as its motivation or willingness could depend on a number of factors. Further, if the motivation to swim is partly hereditary in mink, it could have been affected by a century of breeding as this particular trait would not be adaptive in a farm environment. Finally, the mink reacting most negatively to the lack of access to swimming water would probably have been culled and/or not gone into breeding programmes, which also might explain why some studies have reported an occurrence of non-swimmers. If the disposition to swim could be eliminated entirely, eg through selection, it would no longer qualify as a behavioural need in the classical sense. It has been argued by Mason and Burn (2011), that genuine genetic

differences between local populations could account for the varying results obtained from similar run studies in Denmark (eg Skovgaard *et al* 1997b) and Finland (eg Mononen *et al* 2008; Mohaibes *et al* 2009). However, it is unknown whether the level of domestication/motivation for swimming or subtle differences in experimental design/sampling methods, are responsible for these discrepancies.

It has been argued that the domestication process does not delete behaviours but rather affects the threshold to perform them (Price 1997; Jensen 2002). Farmed mink have a very short history of domestication, but changes have been demonstrated in brain regions associated with movement and activity (mesencephalon and cerebellum) (Kruska 1996). The intra-individual consistency in swimming patterns of mink in accordance with previous studies (Hansen & Jeppesen 2001b; Korhonen *et al* 2003; Mononen *et al* 2008) would seem to support a 'domestication hypothesis' and help explain why some mink swim more rarely than others.

Although it is possible that the relaxation of selective pressures has decreased the tendency towards swimming in some individuals, it is important to remember that the studies clearly demonstrate the majority of mink to be motivated swimmers. Finally, it is an open ethical question whether this possible reduction of motivation to use a bath for swimming through breeding is a justification for depriving all mink of this opportunity. This, and other impacts of the conclusions based on the behavioural research, are discussed in the last sections of the paper.

### **Does deprivation of behavioural needs lead to stress? (the second criterion)**

It is commonly agreed that an animal deprived of the opportunity to act according to its behavioural needs will enter a state of stress. The concept of stress and its practical application in animal welfare science are debated contentiously. Researchers tend to sample hormonal stress-markers or behavioural welfare indicators without reference to a unifying theory of stress, integrating psychological and physiological symptoms (for reviews, see Mason 1975; Jensen & Toates 1997; Vessier & Boissy 2007).

However, some studies of mink housed both in the presence and absence of a water-bath, have reported little or no reduction in stress-markers (such as urinary cortisol levels, reproductive failure, or stereotypic behaviour) from access to swimming water (Skovgaard *et al* 1997a; Hansen & Jeppesen 2000a,b; Vinke *et al* 2006) and some found that blocking access did not correlate with an increase in indicators of stress (Hansen & Jeppesen 2000a; Vinke *et al* 2006). Other studies, though, have linked swimming with a reduction in stress indicators (Mohaibes *et al* 2006, 2009; Mononen *et al* 2008; Ahola *et al* 2011). Mason *et al* (2001) found that deprivation of swimming water for 24 h induced an elevation in urinary cortisol levels similar to the levels found when mink were denied food for the same length of time, even though faeces are the predominating excretory route of cortisol in female mink (and possibly males)

(Malmkvist *et al* 2011), this is interpreted as suggesting that denied access to swimming affordances was a main source of frustration in farmed mink.

It has been suggested that the rise in cortisol levels could be attributed to decreased water intake since mink prefer to drink from an open-water resource (Hansen & Jeppesen 2003), but although restricted water intake and ambient temperature can affect urinary cortisol levels (Tauson 1999), other studies have shown that the motivation to swim is unaffected by the presence of a drinking bowl (Mason *et al* 1999; Warburton & Mason 2006). This suggests that hydration cannot explain the minks' preference for a swimming bath. Mononen *et al* (2008) hypothesised that the water-bath helped alleviate frustrations associated with the farm environment, and it appeared to interrupt the development of maladaptive behaviours: the latter is also hypothesised by Ahola *et al* (2011). The authors attributed the contradiction with other experiments to differences in methods used to analyse data as well as the age of the experimental subjects. Most of the aforementioned studies used adult mink that might already have developed established stereotypies, resistant to cage enrichment (Mason 1993; Latham & Mason 2004; Axelson *et al* 2009; Dallaire *et al* 2012).

### **The significance of swimming water for social play and stress reduction**

Play behaviour is perceived as an important welfare indicator, since such behaviours are generally thought to be suppressed during periods of reduced fitness as well as enhanced during favourable conditions (Broom & Johnson 1993). Play behaviour is also self-rewarding, involving endogenous opioid and dopamine systems, possibly resulting in immediate and long-term welfare benefits (Boissy *et al* 2007; Held & Spinka 2011). A small number of studies have examined the expression of social play in juvenile mink with access to swimming baths (Erlebach 1993, 1994; Vinke *et al* 2005). Vinke *et al* (2005) found that adding water-baths to standard cages would increase play behaviour in juvenile mink, but the authors did not detect a significant decrease in stereotypies in adulthood. Erlebach (1993, 1994) observed that mink in semi-natural enclosures (8 × 5.5 × 2.5 m; length × width × height) and with swimming water (2 × 2 × 0.6 m) played 13.8% of the time they were observed, whereas cage-enclosed mink played dramatically less (1.7%), although it should be noted that the two environments varied on many more factors other than this. Furthermore, no stereotypies developed in the semi-natural environment, whereas all cage-enclosed animals developed running stereotypies. The play behaviour of juvenile mink was affected considerably by the husbandry systems, but despite it being difficult to separate the effects of the multiple sources of enrichment in Erlebach's experiments (soil, vegetation, bath), the results of Vinke *et al* (2005) identify swimming water as the source of enhanced play behaviour. Taken together, these results lend support to the contention that swimming water reduces stress and increases play behaviour in mink.



### Is the behaviour pattern mainly caused by internal factors as opposed to environmental stimuli? (the third criterion)

Warburton and Mason (2003) have examined mink preferences for resources without visual, olfactory and auditory stimuli. Environmental cues may influence experiments by acting as eliciting stimuli increasing motivation, or by decreasing motivation by supplying information about the resources so the animal will not have to investigate for itself. If motivation occurs in the absence of environmental cues it can then be argued that it is a product of changes in the animal's internal state, in accordance with the characteristics of behavioural needs cited above.

Warburton and Mason (2003) found that eliminating sensory cues with opaque plastic screens did not affect the minks' motivation to swim whereas responses to other resources, such as toys and social contact, changed when sensory cues were eliminated. The authors tentatively hypothesised that the motivation for swimming originates from an internal drive, but of course the role of prior experience could not be eliminated.

It has been argued that mink will not miss swimming if they have no prior experience, the so called 'deprivation dilemma' (Vinke *et al* 2008). Some studies with control groups that have never encountered a water-bath do report a reduction in markers of stress which seem to indicate the need is not an induced incentive (eg Ahola *et al* 2011), but whether this constitutes evidence of a thwarted need for a specific resource (ie swimming water) remains unknown. Farm-bred minks' aquatic predation is sequentially organised (peering their heads under water, surface swimming and diving), and has been described both as an 'innate pattern' (Kuby 1982) and as an acquired pattern that has to be taught (Poole & Dunstone 1976). Poole and Dunstone's findings seem to suggest that swimming should be considered an induced behaviour pattern, but similar findings have also been reported in American river otters (*Lutra canadensis*) (Shannon 1989), another mustelid species with a pronounced semi-aquatic ecology. In any case, it might prove challenging to demonstrate experimentally which activities are 'missed' in the absence of eliciting stimuli.

Even if farmed mink in standard cages cannot possibly possess a concept of swimming, they might still experience a need to perform a particular locomotive pattern associated with swimming, affording perhaps certain kinaesthetic sensations as well as exercise and exploration. This does not necessarily pre-suppose a concept of swimming water (for a discussion of a non-conceptual format for animal cognition, see Proust 2009), but rather suggests that animals might have the ability to recognise the affordances (opportunities for perception and interaction [Gibson 1979]) provided by the environment as well as those that are missing.

### Does the tendency to perform a behavioural pattern gradually accumulate if the animal is deprived of the opportunity to perform it? (the fourth criterion)

A study that analysed statistically the lengths of swimming bouts for individual mink found them to be Poisson distributed which suggests that the length of swimming bouts are independent of the length of the previous bout (Hansen & Jeppesen 1999). This does not seem compatible with the classical definition which predicts that the tendency to swim should gradually accumulate as a function of time since the last swimming bout. However, consumer-demand studies have revealed that increased 'cost' of access to water causes mink to reschedule and intensify interaction with the water-bath (Cooper & Mason 2000). This rather suggests a so-called rebound effect compatible with the classical definition. Overall, the accessibility of swimming water seems to influence minks' demand for it, suggesting that the relationship between availability and motivation is not straightforward and interpretations should be made with caution.

## Discussion

### What is the significance of swimming water to a mink?

The results of mink swimming behaviour studies are only partly compatible with the classical definition of behavioural needs, in spite of the well-established positive effects of swimming on the welfare of farmed mink (Erlebach 1993, 1994; Cooper & Mason 2000; Mason *et al* 2001; Mohaibes *et al* 2002, 2003, 2009; Vinke *et al* 2005; Mononen *et al* 2008), ie the positive welfare implications are not captured by the classical definition. This can be interpreted in at least three ways: either there are methodological problems, as similarly run studies have yielded different results, the definition is too rigid, as it excludes a behaviour that is both natural and reinforcing to the animals or, finally, that swimming is simply not a behavioural need.

Throughout this paper we have advocated a cautious approach when ranking the behaviour of animals using the framework of the classical definition. It seems unconcerned with the significance of behaviour, ie what are the animals trying to achieve? Needs might arise both from hard-wired behavioural 'programmes' consistent with the criteria of the classical definition, but they might also arise from an animal's attempts to reduce the discrepancy between its goals and its environment. Any conclusions about the needs of animals with respect to their behaviour must, therefore, be based on a thorough understanding of function and motivation, basically answering the question: 'What is the 'role' of swimming for mink?'

Little is currently known about what governs swimming and diving behaviour in mink, but it is commonly assumed to be an appetitive phase (foraging and hunting) of the mink feeding regime (Wiepkima 1994; Vinke *et al* 2008), since most other motivational causes, such as thermoregulatory

mechanisms, have been ruled out (Hansen & Jeppesen 2003). This hypothesis is strengthened by the fact that mink tend to interact with water prior to feeding, consistent with predatory hunting or exploration (for a review, see Mason *et al* 2007). In addition, the motivation to swim is not influenced by the availabilities of other resources (Hansen & Jensen 2006a,b), eg a running wheel, does not seem to affect the subjects demand for water which would suggest that swimming covers another need than the need to exercise.

One might speculate that the water in itself is secondary and merely a substrate affording a release for innate predatory behaviour, as some studies and anecdotal accounts suggest that the act of killing is highly reinforcing to some species (Mason & Burn 2011). Van Hemel (1972) found that some rats (*Rattus norvegicus*) were highly motivated to kill mice (*Mus musculus*) and Macdonald (1987) described surplus killing in foxes (*Vulpes vulpes*) as playful and non-aggressive. Preventing carnivores from performing predatory behaviour might also constitute behavioural deprivation. However, this hypothesis is currently difficult to investigate as no experiments are available in mink, eg with live prey that discerns the motivation to kill from the motivation to swim.

Foraging is often associated with behavioural needs and endogenous reward systems (Boissy *et al* 2007) and disruption of an animal's feeding regime is considered a main cause of stereotypic behaviour in a variety of animal species (Mason & Mendl 1997). The fact that satiated and hydrated mink will work for access to a water-bath (Mason *et al* 2001; Warburton & Mason 2006) suggests that swimming is, in itself, reinforced by positive experiences independent of the consummatory element for which the behaviour presumably evolved (aquatic predation).

In spite of this, some authors (Wiepkema 1994; Vinke *et al* 2008) have argued that the opportunistic nature of mink would allow them to go beyond their natural feeding regime and be able to cope in the absence of water, if the housing system provided enough and adequate stimuli.

### Implicit values in animal welfare science

In this paper we have shown that the literature contains conflicting empirical data on the subject of swimming water for mink and, hence, conclusions both for and against swimming as a behavioural need can be drawn. Some have argued that since mink grow and reproduce without swimming one can probably rule it out as a behavioural need (Skovgaard *et al* 1997a; Vinke 2001; Vinke *et al* 2008; Møller *et al* 2011). Other reviewers and researchers have found significant welfare benefits of swimming (Mohabes *et al* 2002, 2003, 2009; Mononen *et al* 2008; Ahola *et al* 2011).

Some have argued that incidences of maladaptive behaviour suggest that the welfare on farms is generally poor and have identified the absence of swimming water as one of the main problems (Rådet for Dyreetikk 1994; Nimon & Broom 1999; European Commission 2001), whereas others have judged the welfare of mink to be relatively good, compared to other intensively farmed animals (eg Wiepkema 1994; Mason 2008). The contrasting opinions indicate that judgements are not made on the basis of factual information

alone, but also reflect implicit, normative attitudes towards what animal welfare actually is, which is a general feature of the debate in animal welfare science according to a number of authors (Tannenbaum 1991; Sandøe & Simonsen 1992; van Lijmbach 1998; Vessier *et al* 2011; Yeates *et al* 2011; Rollin 2015). According to these discussions, values inevitably enter animal welfare science, as the parameters that scientists choose to measure (heart rate, adrenal response, behaviour, mental experiences, comparing with behaviour in the wild etc), already imply a theory of animal welfare, and results are interpreted within the framework of such theories. According to some philosophers, such interpretations should be openly recognised and amenable to discussion (van Lijmbach 1998; Rollin 2015).

Welfare is a complex phenomenon and different paradigms of animal welfare can be found in the literature (for an introduction, see Dawkins 2006). The functioning-based (Broom 1991), the feelings-based (Dawkins 2004; Duncan 2004), and the natural living-based (Rollin 2004). Very briefly they can be characterised as follows:

- The functioning-based paradigm focuses on the health and functioning of the biological systems of the animal. Welfare issues are indicated by disease, low growth rates, poor reproductive success, stress, etc (eg Broom 1991);
- The feelings-based paradigm focuses subjective experiences of the animals. Welfare is seen as being free from suffering in the sense of pain, fear, hunger, and other negative states. Some authors also stress that positive experiences, such as comfort, contentment and pleasure are relevant for the evaluation of the welfare (eg Duncan 1994); and
- The natural-living paradigm emphasises the possibility for the animal to perform species-specific behaviour in an environment to which it is biologically adapted. According to this view, each species has its own inherent and partly genetically determined nature (*telos*), whereby good welfare implies that the animal can live according to this nature (Rollin 2004).

As noted above, these positions are not mutually exclusive and several suggestions have been made as to how to combine them (eg Fraser *et al* 1997). Relating these definitions to research on mink welfare and water, the question arises as to whether interpretation of results regarding minks' access to swimming water depends, to some extent, on a choice of welfare paradigm. Looking back at the literature discussed in this article, it seems fair to say that those who deny the importance of swimming water to mink lean towards the first welfare paradigm, whereas the latter are leaning more towards 2 or 3, or a mixture of them.

Given that a combination of welfare paradigms mirrors common sense on what is relevant for an animal (Fraser *et al* 1997; Vanhonacker *et al* 2012), these paradigms also relate to the current debate on how to control whether a housing system is compliant with official animal welfare legislation or standards. Control of compliance with welfare claims may focus on resources (box sizes etc), management (feeding regimes etc) or be based, more directly, on animal welfare status (for a sample of animals) (Lundmark *et al*



2015). Hence, in this discussion, the three welfare paradigms meet a ‘control paradigm’ offering different perspectives on what should be in focus of the control (resources, management or current welfare status of animal), which calls for mentioning a general trend regarding use of paradigms in science. When paradigms collide in science, it is often so that one gives way to the other (Kuhn 1996). As research progresses it becomes clearer what the advantages and disadvantages of the different paradigms are and, at some point, it comes to the sort of paradigm shift that Kuhn described (Okasha 2002). The ever-present scientific uncertainty lessens within one paradigm and grows within another and thus scientists in the field become more inclined to work from one than the other. This *modus vivendi* is, however, most likely when the scientific uncertainty is caused by experimental uncertainty, eg when additional data make it clearer which paradigm best accommodates the existing data.

In the discussion of which paradigm for animal welfare to choose, it seems, however, that the scientific uncertainty as to which paradigm is ‘best’ is not caused so much by lack of data or imprecise data on the welfare of animals, but more by a theoretical or foundational disagreement as to what actually constitutes the welfare of an animal — what Kuhn would call ‘the crisis stage’ where the different paradigms of the scientific discipline clash. The paradigm disagreement then relates to the very definition of the subject, which is more likely to be influenced by the values implicit in any definition. Therefore, it is subject to an ethical discussion rather than empirical uncertainty that, in principle at least, can be solved by obtaining better data. Empirical disagreements might circle around the correct way to interpret the data, but ethical disagreements relate to the background assumptions that shape the research questions (Sandøe *et al* 2004).

Above this, there is the added difficulty of dealing with animals. It is hard to come to an agreement on what animal welfare is since we cannot ask the animal directly, or at least not understand the answer without interpretation. Also, and simultaneously, there is a disagreement on how to question the issue — indeed what questions to ask at all. Within the different paradigms, the methodologies of research and the interpretation can be as objective as possible. But choosing the paradigm means choosing a set of values that cannot be justified through science but are pre-scientific in the sense that they define what methodology is chosen and how results are clustered, ie how science is done. Just as it is very difficult to objectify what ‘human quality of life’ is and hence how to measure it, it is similarly very difficult to settle once and for all what ‘animal welfare’ is (for a philosophical discussion of this, see Nordenfelt 2006).

In our understanding, these limits make it impossible for us to claim too much certainty of our judgments about the needs of mink. What can be agreed upon is the importance for a sentient being, eg a mink, to be able to fulfil/perform its behavioural needs. The disagreement we have revealed

and discussed is around what a ‘behavioural need’ actually is. Here, we would like to suggest that, when faced with theoretical or foundational uncertainties about central aspects of the welfare impact of certain housing systems etc on production animals, it would be ethically sound to use a version of the precautionary principle as discussed in Cronney and Millman (2007) where, as a rule of thumb, the burden of proof lies on the producers to show that a certain practice, housing system, etc does not harm the animal, rather than demanding that it has to be demonstrated that it does in fact harm the animal (Cronney & Millman 2007). In our understanding, this means that one should be careful to take away opportunities from the animal when:

- There is a conflict between our common sense reasons to believe something and the results of scientific studies faced with theoretical or foundational uncertainty. In this case, the common sense or straightforward assumption being that semi-aquatic animals have their welfare reduced when denied access to swimming water and some scientific results showing that swimming is not a behavioural need of these animals.
- It can be argued that by interpreting some of the basic assumptions of the scientific methodology differently one ends up with other scientific answers. We demonstrated this is the case in some welfare studies: access to swimming water is important to the welfare of mink based on a broader understanding of what a ‘behavioural need’ is than chosen by responsible scientists.

Obviously, the inherent uncertainty in all scientific research carries with it the need to use a precautionary principle carefully. If we can only act when we are certain of not doing anything wrong, our hands will be tied in all matters. This has often led to criticism of using the precautionary principle at all. There is, however, from our point of view at least, a difference between either demanding that it should be shown without doubt that denying mink access to swimming water is not detrimental to their welfare or arguing that, in the light of the theoretical uncertainty clouding the issue and the value-laden disagreements existing beneath the different welfare paradigms, there is a case for not denying the minks this opportunity.

Mink are sentient animals capable of having better or worse welfare. No one in the discussions described in this paper denies this. What is discussed is the extent to which swimming water affects that welfare. Our suggestion is that as long as the answers to that issue are so dependent on choice of welfare paradigm and on the underlying values of the researchers examining the question, it would be more in line with the Treaty of Lisbon (Lisbon Treaty [European Commission 2007]), in which article 13 Part 1, Principles, requires that full regard shall be paid to animal welfare in all decisions to grant them access to swimming water as it could be argued that it is a central behavioural need that the animals are otherwise denied the opportunity to perform/fulfil.

## Animal welfare implications and conclusion

There is a general agreement that animals have behavioural needs and should be provided the opportunity to express them. However, in the case of minks' alleged need to swim, as a consequence of their semi-aquatic nature, a number of scientists (Vinke *et al* 2006, 2008; Møller *et al* 2011) contend that swimming in mink is an incentive-induced behaviour and does not conform, therefore, with classical conception of behavioural needs. We have argued that: the classical definition of behavioural needs provides an incomplete account of motivation and that studies on the swimming behaviour of mink are inconclusive. Consumer-demand studies consistently show that mink prioritise access to a swimming bath over other enrichment (Cooper & Mason 1997, 2000, 2001; Mason *et al* 1997, 1999, 2001; Warburton & Mason 2003) resources and although some studies, comparing mink with and without swimming water, have documented the 'positive effects' of swimming on common welfare indicators, reduction in maladaptive behaviour, increased social play behaviour etc (Mononen *et al* 2008; Mohaibes *et al* 2009), the majority of similar studies have found little or no welfare benefits.

We have argued that the measurements of motivational strength, welfare indicators as well as the observations of wild and feral mink should all be included in the assessment of the significance of swimming to the welfare of mink. The differences in the evaluation of the importance of swimming water for mink seem largely to be an expression of a foundational uncertainty about what elements in an animal's life constitute 'animal welfare' and, hence, what has to be studied. There are different competing paradigms and the results of the research into both behavioural needs and swimming water are influenced by the choice of paradigm. It is scientifically impossible to give a univocal answer to the question of how swimming water (or rather the absence of it) affects the welfare of mink. It also seems reasonable to expect that a semi-aquatic predator will have its welfare reduced when denied access to swimming, even if we do not know exactly how the animal benefits from it. In this situation, it seems that it is most reasonable to use a mild version of the precautionary principle and ensure that the mink have access to swimming water until it can be demonstrated, with a higher degree of certainty than exists today, that caging without such access does not negatively impinge on their welfare. Whether this will ever be possible given that the uncertainty, as shown here, is more a theoretical or foundational uncertainty than an empirical one, remains an open question. But, as more data created within the different welfare paradigms will not provide an answer to which paradigm is the 'right one', this seems unlikely.

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