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Behavioural needs of captive marine mammals

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Abstract

Behavioural needs are defined as behaviours that are primarily motivated by internal stimuli and if an animal is prevented from performing them its welfare is compromised. It is suggested that the two major behavioural needs for captive marine mammals are the need to receive stimulation and the need to control the environment. There is evidence that animal welfare may be compromised in understimulating environments and that the addition of stimulation and/or control can improve the animal's well-being. Three manipulations which have been shown to be effective in improving an animal's welfare are environmental enrichment, behavioural engineering and training. Each of these manipulations is discussed in relation to marine mammals. It is concluded that if captive marine mammals show signs of compromised welfare then intervention by increasing the animal's stimulation and or control of its environment will improve its well-being.

Key words: marine mammals, needs, welfare, stress, enrichment, training.

Introduction

A major step forward in the study of animal welfare has been the identification of behavioural needs. Although researchers, zoos, circuses, farmers etc. have been well aware of animals' physical needs, only recently have they started discussing animals' "behavioural needs" (*e.g.* Hughes and Duncan, 1988). Behavioural needs can be operationally defined as "behaviours that are primarily motivated by internal stimuli and, if an animal is prevented from performing them for prolonged periods, the individual's welfare may be compromised." (Friend, 1989, p. 151). In other words, if an animal has a strong urge (*i.e.* a behavioural need) to perform a behaviour that circumstances prevent it from performing, then that animal will suffer until either the urge passes or it is given an opportunity to perform that behaviour. Possible examples of behavioural needs include the need to forage, the need to mate, the need to capture prey, the need to graze, the need to perform comfort behaviours (such as grooming, burying faeces) and the need to patrol. More general needs might include the need to explore and the need to control. In any case, the existence of a specific need for a species is determined using experimental manipulations such as: (a) depriving the animal of the chance to perform a specific behaviour and determining the consequences: (b) preference experiments, and (c) perceived costs where the elasticity of demand to perform a behaviour is determined (see Dawkins, 1990 and Friend, 1989, for detailed analyses of these different procedures).

Although it difficult to identify an animal's needs, it is relatively easy to determine that an animal does not have his needs taken care of—its welfare and therefore health is compromised. Broom (1990) lists some measures of poor welfare which include failure to grow, high levels of adrenal hormones, high frequencies of stereotypes, severely reduced responsiveness, misdirected behaviours and impaired immune system function. These signs of poor welfare are fairly well agreed upon by researchers in the area, if not in their exact words, at least in their content (*e.g.* Dawkins, 1990; Fraser, 1990; Kiley-Worthington, 1990).

If the cause of the above symptoms is indeed the failure to provide for an animal's needs, then the provision of the situation enabling performance of a specific behavioural need should alleviate, if not eliminate, those symptoms. A physically and psychologically healthy animal should grow normally, have normal levels of adrenal hormones; show few, if any, stereotyped behaviour patterns, normal responsiveness to environmental stimuli, and have a normal immune system response. Therefore, a practical way of determining whether an animal's welfare is compromised due to lack of opportunity to perform a specific behaviour, is to create a situation promoting that particular behaviour. If the animal takes advantage of the opportunity to perform the behaviour, and if there is a consequent improvement in the animal's welfare, then it can be inferred that the performance of that behaviour is necessary for that individual—under those specific circumstances (see also Friend, 1989). Obviously, in this type of experiment the use of appropriate control groups is essential in order to determine how specific the behavioural need is.

Some of the symptoms of poor welfare, such as reduced responsiveness and high levels of stereotyped behaviour patterns are familiar to students of marine mammal behaviour and may occur in dolphinaria and zoos (*e.g.* Greenwood, 1977; Kastelein and Wiepkema, 1988; Kastelein, Wiepkema and Slegtenhorst, 1989). The appearance of these symptoms suggests that the animal is being maintained in sub-optimum conditions, where its behavioural needs are not adequately met.

The normal physical environment of captive mammals in general, and marine mammals in specific is very different from their normal habitat of deep and shallow water, of beaches and estuaries, of rivers and currents, of grass flats and underwater canyons. Two differences which I feel are most relevant are that the captive environment may be very understimulating and that the animal has little, if any, control over it. The animal has complete knowledge of his living space and thus has nothing to explore. Furthermore, since its nutritional requirements are delivered in a form concentrated both in location and time, the animal does not need to spend time foraging, a dominant activity of most non-captive animals. Thus the captive animal has nothing to do most of the time (McFarland, 1989; Carlstead, Seidensticker and Baldwin, 1991). It has no control or influence over when, what and where it will be fed, nor can he control most of the other significant events in its life.

I suggest that in most cases this lack of stimulation and lack of control over environmental events are the major factors that could contribute to poor welfare for mammals maintained in zoos, circuses and aquaria. In this review I will attempt to show that providing the animal with novel stimulation and control is sufficient to improve his welfare.

Physical environment manipulations

It is well documented that living in an impoverished environment is stressful for many species of mammals (*e.g.* McFarland, 1989; Levine, 1960; Stolba and Wood-Gush, 1980; Stevenson, 1983; Wood-Gush *et al.*, 1983; Barnett and Hemsworth, 1990). Furthermore, much research has shown that introducing novel stimuli to the environment reduces stress related symptoms such as pacing, stereotyped behaviour patterns and inactivity (*e.g.* Ogden, Filay, and Maple, 1990; Maki and Bloomsmith, 1989; Tripp, 1985; Westergaard and Fragaszy, 1985; Izard, 1991; Reinhardt, 1991; Duncan and Poole, 1990; Tennessen, 1989). Does this also hold true for captive marine mammals?

The most sterile captive environment is often found in marine mammal pools. The pool usually consists of four walls, a floor with a drain and water jets. Food is handed directly to the marine mammals in order to prevent a buildup of organic matter, thus eliminating the need for their most common behaviour, foraging. The pool is often devoid of objects because of problems in cleaning them and because the marine mammal could either swallow or be injured by small objects. The study section of pinniped enclosures is frequently similarly sterile. It is safe to say that some captive marine mammals live in a physically understimulating environment.

Their response to this understimulation is the same as that of captive terrestrial mammals; they show abnormal behaviour. For example, Sweeney (1990) maintains that the excess sexual activity found in captive dolphins is due to extreme understimulation. Other behaviours which may be due to understimulation in marine mammals include a) exaggerated play behaviour with items which find their way into the pool—such as leaves, props, etc (*e.g.* Prescott, 1981), b) misdirected behaviour patterns, *e.g.* sexual overtures to the trainers and other species (*e.g.* Lilly, 1967; Prescott, 1981), c) play behaviour with other species in the tank including turtles, and mimicry of sea lions (*e.g.* Tayler and Saayman, 1973), d) and high levels of stereotyped behaviour patterns (Amundin, 1974; Greenwood, 1977; Kastelein and Wiepkema, 1988; Kastelein and Wiepkema, 1989).

It should come as no surprise that attempts have been made to determine the effects of environmental enrichment on marine mammals. Amundin (1974) added a variety of toys to his harbor porpoise pool in an attempt to reduce boredom and consequent stereotyped behaviour. He observed that time spent performing stereotyped behaviour decreased from 95% of the time before introducing the toys to 16% several months after the introduction of the toys. The introduction of toys to the dolphins in the Seven Seas Pavilion of Chicago seemed to have a positive effect on the behaviour of dolphins and pinnipeds (Sevenich, 1986). An additional benefit is that stimulating devices can reduce destructive behaviour in marine mammals (Sweeney, 1990). He states: "Efforts toward reducing destructive behaviour should include the design of interesting and stimulating devices for the animals' recreation. Such playtime opportunities are not limited to toys but may include devices such as water jets, air streams, rubbing devices and as many other elements as the imagination can produce" (Sweeney, 1990). The challenge of finding appropriate toys that promote play behaviour and do not habituate is well illustrated by Casson (personal communication). He found that sea otters would attempt to destroy their exhibit by playing with heavy rocks, light fixtures, buckets etc. They would use rocks as hammers to break anything breakable. Casson introduced several types of toys but he found that if the otter couldn't rip them apart or use them as tools to break something else, they quickly lost interest. Eventually he found that ice blocks were an ideal toy in that they melted before the otter got bored. Unfortunately the otters also tired of the ice and returned to exhibit destruction.

Habituation to toys is common to all the reports on the use of toys (Amundin, 1974; Markowitz, 1982; Sevenich, 1986; Sweeney, 1990). All of these reports agree that the toys must be rotated to prevent habituation. An interesting exception is found in a report by Gewalt (1989) on two captive Inia. Even though the two Inia had a supply of toys in their pool, they preferred to swallow air and make slowly rising rings of air bubbles through which they would swim (perhaps similar to the smoke rings of bored smokers). In addition they would rub a cleaning brush with trapped air on the pool bottom creating a bed of air bubbles on which they would temporarily lounge. Gewalt did not find habituation to these games.

It can be concluded that interacting with manipulable objects such as toys improves the welfare of most mammals, including marine mammals. The manipulation of the objects is intrinsically reinforcing in that it decreases boredom. To be effective, the manipulable objects must be continually changed or the animal will habituate to them. Although environmental enrichment contributes to one of the needs of the captive animal it does not satisfy the other major need of captive animals, control over the environment.

Behavioural Engineering

Behavioural Engineering is an extension of operant conditioning to the zoo environment. It was developed by Markowitz and his colleagues in order to improve both the welfare of zoo mammals and the quality of the exhibit. The goal of behavioural engineering is to provide the captive animal with reinforcement contingent on the performance of a specific, usually species-specific, behaviour, thereby both increasing the complexity of the animal's environment and providing the animal with some control over it. In addition, by making the reinforcement extrinsic, it may be possible to prevent habituation to the apparatus.

Several researchers have found that control and/or prediction over any aspect of the environment is reinforcing and beneficial to captive animals. For example, growing pigs have been trained to turn on infrared heat when they need it and laying hens made much better use of nest boxes and perches when they were given a 30 minute artificial dusk as opposed to simply turning off the lights (Tennessen, 1989). In primates, Hanson, Larson and Snowdon (1976) showed the effect of control over aversive stimuli. They presented adult rhesus macaques with loud, continuous white noise. Monkeys in group A could terminate the noise by pressing a level, Monkeys in the group B were yoked to the first group; they experienced the exact same noise, but had no control over its effect. Monkeys in group C were not exposed to the noise. Results showed that the group with the control (A) did not differ from the no noise group (C) in terms of cortisol levels and aggression. The yoked group (B) had significantly higher levels of aggression and cortisol than the other two groups. These beneficial effects of control and prediction over environmental events had been found in many different types of experiments and has been shown to be a robust phenomenon. In behavioural engineering the zoo animal is usually given control over food reinforcement. Instead of being a passive welfare case, the animal is allowed the option of working for his food.

There is abundant research showing that a wide range of animals prefer to work for at least a part of their food, for example chickens (Duncan and Hughes, 1972), rats (Neuringer, 1969; Singh, 1970), Polar bears (Markowitz and Woodworth, 1977) and chimpanzees (Menzel, 1991). This phenomenon (labeled contrafreeloading) was reviewed by Osborne (1977). While contrafreeloading might seem contrary to optimal foraging theory (*e.g.* Stevens and Krebs, 1986), it may be explained by assuming that the cost of absence of control or of not working is greater than the cost of foraging.

Even if the animal prefers free food to working, when it is forced to work for his food his well-being is improved. Primates show increased activity and reduced stereotyped behaviour when provided with the opportunity to forage for food (*e.g.* Bloomstrand *et al.*, 1986; Chamove *et al.*, 1982; Nash, 1982; Tripp, 1985; Markowitz and Woodworth, 1977; Line *et al.*, 1991). A very interesting series of experiments summarized in Line *et al.* (1991) illustrates this point nicely. They investigated the effects of control over environmental events on individually housed Rhesus monkeys. Ten monkeys were given access to three rods. Touching the first rod turned on a "top 40" radio-station. The second rod turned it off. The third rod provided food on a VR schedule. The monkeys were monitored for 12 weeks before they were given the rods and for 12 weeks while the rods were in place. The monkeys activated the food rod about 10 000 times per day, earning them about 550 pellets per day. They also turned on the radio an average of 76 times per day. Their results showed that the increased stimulation and the increased ability to control significantly improved the welfare of the monkeys as seen by: (1) a decrease in cortisol, (2) a decrease in cage manipulation behaviours, (3) a decrease in what they called "abnormal behaviour", (4) a decrease in self grooming, (5) an increase in time standing and a decrease in time sitting, and (6) an increase in the monkey's ability to cope with stressful events as measured by the monkey's heart rates during blood tests and restraint. In addition, there was no evidence of habituation to the apparatus. This same pattern of results was found in an experiment by Mineka, Gunnar, and Champoux who investigated the effects of control on a group of infant rhesus monkeys. In a thorough review of the effects of environmental conditions on the psychological well-being of primates Woolverton *et al.* (1990) conclude that "providing a naturalistic environment is not as critical as arranging dynamic events that are contingent upon behaviour (*i.e.* giving the animal some control)".

The beneficial effects of working has been found in several non-primate species, including felines (Markowitz and LaForse, 1987), bears (Carlstead, Seidensticker and Baldwin, 1991; Myers, 1977), elephants (Stevens, 1977), and most types of circus animals (Kiley-Worthington, 1990). A beneficial side-effect of having animals work for their food is that changes in behaviour are more detectable, allowing for earlier recognition of veterinary problems (Markowitz, Schmidt and Moody, 1978). In spite of some criticism (*e.g.* Hutchings, Hancocks and Calip, 1978 a, b) who argue that behavioural engineers should be much more careful in their interpretation of the effects of the manipulations, that it might not be a panacea for all species, and that the engineered response may become a stereotyped behaviour, the overwhelming consensus of opinion is that making the animals forage or work for their food is beneficial to their welfare.

There are few studies of behavioural engineering in marine mammals, and those existing studies are, for the most part, anecdotal. However, even anecdotal reports show quite conclusively that marine mammals can learn to manipulate automatic devices resulting in reinforcement, that this manipulation can be maintained at high rates, and is performed even when the animal has access to free food.

Markowitz and his co-workers (*e.g.* Markowitz, Schmidt and Moody, 1978; Markowitz, 1990) trained polar bears to "call" for their food. The bear could chose to either have the food catapulted into the pool, requiring the bear to dive and swim after it, or have the food dropped into their mouth. If the animal chose not to work, he received food ad lib. Both polar bears chose to work but while the female chose to have the food dropped to her mouth, the male often chose to have the food catapulted into the pool and then swam after it. "The exercise . . . has produced remarkable changes in the male, reducing his chronic stereotyped pacing and helping him to maintain adequate weight, which prior to the inception of this program he was unable to do" (p. 192, Markowitz, Schmidt and Moody, 1978). Markowitz (1990) also reported on a zoo exhibit where polar bears were trained to approach electronically reproduced seal sounds. Their approach would trigger a feeder to catapult a fish into a pool, requiring them to swim after the fish. He reported that the polar bears actively used their apparatus.

Behavioural engineering has also been utilized in otter exhibits. Myers (1977) trained an otter on a buzzer command to slide down a slide in order to activate a minnow-feeder. He found that the otter incorporated the sliding behaviour into a behavioural chain including sliding, swimming, diving, eating, scent-making, grooming, napping and exploration. The use of the slide became a trigger for the entire sequence of events. Myers states: "If the cues to sliding were spaced far enough apart, say 30 minutes, this entire sequence of behaviour might be repeated many times per day" (p. 146 Myers, 1977). Foster-Turley and Markowitz (Markowitz, 1990) trained river otters (*Aonyx cinerea*) to hunt for live prey in several areas. They reported that all of the river otters actively hunted for prey under these circumstances and none of them became ill. Each animal hunted hundreds of times per day. Finally, in a simple yet elegant example of creativity, Casson (1990) froze food inside different sized containers of ice. The resulting ice blocks were manipulated, broken and smashed. Boredom didn't set in and the anticipation of finding food within kept interest at a peak. (When the ice blocks were used as toys without fish frozen inside, the play behaviour otters gradually ceased.) The performance of this behaviour decreased the amount of stereotyped behaviour and destructive behaviour in their otter exhibit. Thus it can be concluded that otters and polar bears will work for food and that the response does not rapidly habituate.

Behavioural engineering has also been applied to pinnipeds. Kastelein and his colleagues (Kastelein and Wiepkema, 1989, Kastelein, Wiepkema and Siegtenhorst, 1989) have explored the use of "occupational therapy" in order to reduce stereotyped swimming in walruses. They developed a feeding trough which was placed in the bottom of one of two pools. The trough was filled with large rocks and clams and fish were dumped on top of the rocks. In order to obtain the food the walruses were forced to forage between the rocks. Through the use of before and after measures of behaviours they found good evidence that the digging trough reduced the stereotyped swimming, probably by increasing the overall activity of the animals. Kastelein *et al.* (1991) introduced a modification of the feeding trough to the walruses. The new device consists of a barrel filled with fish with a grid on the top and holes on the bottom. The walrus was required to blow air into the holes causing the fish to float up to the grid where they could be sucked out. This device caused the walruses to increase the time spent feeding from 15 minutes per day to two hours and also decreased the amount of stereotyped behaviour shown by the walruses.

The only study found using behavioural engineering in cetacea was by Mackay (1981), and the purpose of that study was communication and not welfare. Mackay trained two dolphins to whistle at a specific frequency in order to activate a food dispenser. Even though the experiment was designed only to supplement the normal fish intake, eliminating hunger as a motivator, the dolphins would sometimes continue to work the apparatus and collect fish which were not eaten. This suggests that at least one motivator of the whistling was control over the environment.

Mackay also investigated the effects of different types of reinforcers. The dolphins were successively given the opportunity to lower a plastic bottle to the pool surface, to turn on a water hose, activate an underwater pump, turn on the pool lights, or pilot a toy submarine. Whereas most of these consequences were explored, interest habituated quite rapidly. An exception was the house light, after five weeks of exposure to this consequence the light was being switched on-off approximately 40 times per night, suggesting some persistent interest.

These studies in marine mammals are in full accord with the studies on terrestrial mammals. All captive mammals, if given the opportunity, will perform operant responses that provide some control over the environment. The fact that the marine mammals will work in the presence of free food, will chose to dive for fish over fish delivered to the mouth, and will perform operants even when satiated suggest that the mere performance of the operant is reinforcing. The results of behavioural engineering experiments suggest that the performance of the operant improves the welfare of the animal, probably by giving the animal some control over the environment.

Social Complexity

The social environment is a major source of complexity and stimulation for mammals; in addition it is a major source of control for the animal. There are two major types of social interaction, with the cage or pool mates and/or with the caretaker or trainer. Given that the optimal intraspecific environment is easily derived from the social biology of the species, and given that the group composition is usually fixed, I shall discuss only he interaction between caretaker and animal. This interaction is one of the more important factors in the life of the captive animal. As Line *et al.* (1991) state in regard to the laboratory Rhesus: "Human activities are a major source of variation in the laboratory environment, and the monkeys are very attentive to people in the room. People are directly involved in events both pleasurable and aversive to the animals and thus have a significant impact on their well-being . . . Except for lighting, all major environmental changes were directly connected with animal caretakers or research personnel. The monkeys usually watched humans who were in the room and directed their gaze to the room door when they heard the outer building door open. Heart rate and activity generally changed quickly when a human entered, but also returned to baseline levels soon after the person left the room." this description of the Rhesus should be familiar to anyone who has worked with Tursiops. As soon as one approaches poolside the dolphin immediately swims over, makes eye contact and often solicits some type of interaction.

In view of the importance of the trainer-animal interaction it is surprising how little research has been done on the subject. The existing research can be divide into two categories, those emphasizing the quantity of the interaction and those emphasizing the quality of the interaction. The major factor involved in the quantity of the interaction is the number of hours per day that the handler works with the animal. While this number varies between facilities, from talks with marine mammal trainers, it is usually around 1 to 2 hours per animal. The beneficial effect of increased training time is shown in a controlled study using marine mammals. Kastelein and Wiepkema (1988) alternated weeks in which Steller Sea lions received three twenty minute sessions with weeks in which they were only free fed. They found that the Steller Sea Lions showed significantly less stereotyped behaviour during the weeks in which they were trained. Kiley-Worthington (1990) suggests that the welfare of all species of mammals in circuses and zoos would be improved by increasing both the training time per animal per day and the number and types of behaviours trained. In conversations with marine mammal trainers, the overall consensus was that training sessions are beneficial to the animal and that the animals should interact with the trainer at least several hours per day.

There is also evidence suggesting that the quality of the trainer-animal interaction is also important. Research on farm animals has shown that a positive attitude toward animals contributes to their welfare. If the dairy farmer has a positive attitude toward his cows, then they produce more milk (Seebrook, 1980). Conversely pigs once traumatized by their handler are forever more fearful of humans (Gonyou *et al.*, 1986; Mendl, 1990). Even chickens show beneficial effects of regular gentle handling by humans (Gross and Siegel, 1979). The benefits of a positive relationship with marine mammals has been emphasized by many marine mammal trainers (*e.g.* Blanchard, 1971; Desmond, 1983). In discussing the differentiating characteristics of good and bad trainers, Blanchard (1971) states: "The first thing a good trainer would do with an animal is to build a good relationship . . . rapport . . . usually by giving the animal a lot of attention . . . A good trainer has respect for his animals . . . You [the trainer] must be sincere, and really care about that animal . . ." It may be obvious, but it can be concluded that a positive relationship with the trainer is important for the welfare of the marine mammal.

The quality of the training session is itself important to the welfare of animals. In this regard many marine mammal trainers are quite advanced and sophisticated and the techniques used by marine mammal trainers are now being applied to a wide variety of zoo animals (*e.g.* Desmond and Laule, 1987; Laule, 1989). The good marine mammal trainer constantly strives for variability and unpredictability in terms of: a) the schedule of reinforcement, b) the type of reinforcement and c) the behaviour that the animal is asked to perform (*e.g.* Brill, 1981; Butcher, 1980; Van der Toorn, 1987). For example, the current training policy at Sea World, USA, is that it is very important to keep the training sessions unpredictable. The animal never knows if he will have a learning, play, exercise or social session. In addition, the animal never knows the sequence of behaviours within any session. And finally, the animal never knows when and/or what type of reinforcement he will receive. The use of variability and unpredictability in the training session serves four functions. First, it keeps the animal's attention focused on the trainer. Second, by keeping the session unpredictable the animal is less bored and therefore more motivated to perform. Third, by the extensive use of schedules of reinforcement the animal is not frustrated when performance is not followed by reward. And fourth, by the addition of non-food reinforcers, not only are longer sessions possible, but the trainer can tap into a variety of motivational systems such as social, sexual, and exploratory motivators. Not only does the use of several types of reinforcement increase the unpredictability of the session but it also broadens the motivational base for the performance of the behaviour (see also Van der Toorn, 1987). For example, a dolphin can become food satiated in the middle of a session but still perform for tactile reinforcement.

A good example of how improving the quality of the training session can improve the well-being of a marine mammal can be seen in the training of "Chuckles", a solitary Inia at the Pittsburgh Zoo (Smith *et al.*, 1990; Burrows *et al.*, 1990). According to their reports, Chuckles was originally trained and maintained with traditional food reinforcement. He showed a severe breakdown in this obedience and show performance, performing less than 50% of the requested behaviours. In addition he started playing with food and showed an increase of aggression. His trainers initiated a series of radical changes in his daily routine. First, they determined what types of non-food reinforcers were preferred by Chuckles. They then fed him before the training session. During the session Chuckles received no food reinforcement. This resulted in a dramatic improvement in Chuckle's obedience and performance (Burrows *et al.*, 1990). Another innovation they introduced was to allow the animal to select his reinforcement. This was accomplished by placing paddles at various fixed locations. Each paddle was associated with a different reinforcement. The dolphin would press the appropriate paddle to indicate the reinforcement he wanted. Chuckles showed definite preferences in his preferred reinforcer for a few days and then would shift his preference to another reinforcer (Smith *et al.*, 1990). Because all of the changes were introduced concurrently, it is impossible to determine their relative contributions to the improvement of the animal's welfare. However it can be stated that these changes in the quality of the training sessions resulted in a definite improvement in Chuckle's well-being.

Summary and Conclusions

A review of the literature shows that mammals both need to receive stimulation and to control their environment. This need was determined empirically by showing that mammals in understimulating environments show signs of stress such as exaggerated stereotyped behaviour. The provision of stimulation and/or control either by an enriched environment, behavioural engineering or increased social interactions enhances the welfare of these mammals. Although the bulk of the research focused on terrestrial mammals, the existing research on marine mammals is in complete accord with the above findings.

There are benefits and costs associated with enrichment, behavioural engineering and training. The enriched environment while relatively easy to install, must be continually changed in order to prevent habituation. In addition, the type of enrichment used must be determined empirically. Behavioural engineering, while both enriching the environment and providing the animal with control, is usually expensive to install and maintain. Increasing training time is the ideal solution in that it provides the animal with both everchanging stimulation and control over many aspects of the environment, but it is expensive in terms of manpower.

Every facility should observe their animals and record the frequency of stress related behaviours such as stereotypes, misdirected behaviours, and signs of depression. If there are indications that the animals are stressed, then steps should be taken to eliminate or reduce the stressors. In most cases this can be accomplished by environmental enrichment, behavioural engineering or increased social interaction. In all cases the efficacy of the intervention should be determined by before and after measures and the results made public.

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