**Genetics and Behavior during Handling, Restraint, and Herding**

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The primary objective of this chapter is to discuss the effects of genetics on the behavior of herding animals during handling and restraint. Compared to rodents, poultry, and fruit flies (Drosophilia) very little behavioral genetics work has been done on livestock. During our careers we have observed thousands of animals under many different conditions. In this chapter we will discuss our observations under practical conditions and research findings, which would affect behavior during handling, herding, or restraint.

Writing on the behavioral aspects of animal domestication for the Quarterly Review of Biology Price (1984) stated:

It is difficult to generalize about the effects of domestication on either genetic or phenotypic variability because of different selection pressures on different traits and species. However, it is apparent that, with respect to animal behavior, domestication has influenced the quantitative rather than the qualitative nature of the response.

To put it in simpler words, domestication changes the intensity of a behavioral response. For example, zebras are more flighty and nervous than domestic horses. Parsons (1988) further wrote that domestic animals are more stress resistant because they have been selected for a calm attitude toward man. In either event, a genetic predisposition to be fearful or calm interacts with early experience and learning in very complex ways. The term temperament will be used in this chapter to refer to nervous system reactivity, which is determined by both genetic and environmental factors. During handling, fear is a major determinant of an animal's behavior. Genetic influences on temperament interact with early experience and learning to shape adult patterns of behavior. The most convincing examples of genetic influence on behavior come from selection and strain studies of behavior in mice (DeFries et al., 1978). Selective breeding of rats for either high or low fearfulness clearly shows that genetics plays a major role in determining an animal's temperament (Broadhurst, 1960; Eysenck and Broadhurst, 1964; Huck and Price, 1975). Behaviors studied in the laboratory are clearly shown to be substantially influenced by genetic factors (Plomin, 1990). In the following sections we will discuss the interacting forces of genetics and experience. Some of the topics which will be covered are flocking behavior, herding behavior, flight zone, social behavior, attraction and reaction to novelty, inheritability of behavior, and sire effect; some general principles for handling domestic animals will also be discussed.

**PRINCIPLES OF HERD BEHAVIOR**

In domestic herd animals such as cattle and sheep, genetic factors influence herd behavior. This behavior partially evolved as a defense from predators. Interestingly, people who work with wildlife have observed that African herding animals bunch together more tightly than similar animals in North America. This may be due to more predators such as lions, hyenas, and cheetahs. Herd animals find safety in numbers. With eyes positioned on the sides of the head, herd animals have a wide visual field (Prince, 1977; Hutson, 1993; Matthews, 1993). Panoramic vision enables animals to move together as a herd and constantly scan the surroundings for predators or other dangers. When herding animals are startled, their eyes and ears will quickly orient in the direction of any novel sight or sound. Orienting responses are accompanied by an internal state of nervous system arousal (Boissy, 1995; Rogan and LeDoux, 1996; Davis, 1992). Orienting responses alert the animal to possible danger. When they become frightened, herding animals do one of three things; they may freeze and stand completely still, mill around and bunch tightly together, or flee. When they are cornered, herding animals will fight. When in flight, cattle, deer, and bison all raise their tails. Kiley-Worthington (1976) suggests that the raised tail serves as a signal of danger to the rest of the herd.

The first author has observed that wild ungulates such as the American bison have stronger herding behavior compared to domestic cattle. Separation of a single animal from the herd will cause it to make an intense effort to rejoin its herdmates (Grandin, 1993). Domestic cattle become more difficult to handle and separate when they become agitated and engage in "shelter-seeking behavior." Each animal will attempt to push itself into the middle of the group where it will be safe from predators. The strongest animals will end up in the middle of the milling herd. In their natural environments, prey species animals such as elk and deer will spread apart when grazing a hillside, but at the first sign of danger they will group closer together and flee as a herd. Domestic herding animals display similar behavior. When herding animals sense danger they tend to flock together. The smaller hoofed animals tend to be more reactive and will herd together more tightly than the larger ones. For example, sheep are more vulnerable to predators than cattle, and therefore bunch together very tightly to find safety in numbers.

**Flight Zone**

The flight zone is the distance within which a person can approach an animal before it moves away. Herd animals usually turn and face a potential threat when it is outside of their flight zone, but when it enters the flight zone the animals turn and move away. Hedigar (1968) first described the flight zone principle in wild animals. Kilgour (1971) and Grandin (1980a,b) further described flight zone principles for domestic sheep and cattle and showed how working along on the edge of the animal's flight zone, both cattle and sheep can be moved easily (Fig. 4.1). Small, flighty herd animals such as deer and antelope have larger flight zones than domestic herding animals. They also have higher stress hormone levels than large, heavy animals such as cattle or Cape buffalo (Morton et al., 1995).



Figure 4.1: Flight zone diagram showing the correct positions for the handler to move an animal.

Genetic factors influence individual flight zone sizes between animals of the same species or breed. For example, in a large group of animals with similar genetics and previous handling experiences, most members of the group will have similar flight distances, but a few individuals will have either a very small or a very large flight zone. Flight zone size is also strongly affected by experience and learning. An animal that survives a close call with danger learns to be more wary of similar dangers in the future and increases its flight zone size accordingly. Furthermore, a completely tame or trained animal has no flight zone and will allow people to approach and touch it (Price, 1984). Cattle that have people moving around them everyday will have smaller flight zones than genetically similar cattle raised on ranches in the mountains who seldom see people. Thus, interactions between genetics and experience in shaping an animals flight zone size can be complex.

**Working the Flight Zone**

Flight zone principles can be used by handlers to move a single animal or large groups of animals. To move a single animal, the handler positions himself in relation to the animal's point of balance at the shoulder (Kilgour and Dalton, 1984). To move an animal forward, the handler is positioned behind the point of balance. To move the animal backward, the handler moves in front of the point of balance. Figure 4.1 illustrates the correct handler positions for moving an animal forward. Controlling the movements of a large herd while on foot, on horseback, or in a vehicle is done by alternately entering and withdrawing from the edge of the herd's collective flight zone. An entire group of animals can be induced to move forward by the handler moving in the opposite direction (Fig. 4.2). These positions work on all herd animals.



Figure 4.2 Collective flight zone of a large flock of sheep. As the people walk through, the sheep move away and circle around them.

Dogs trained for herding use the principles of the flight zone and the same positions described above to control livestock movement. Coppinger and Coppinger (1993) propose that dogs which herd livestock in this manner are displaying a natural hunting strategy used by wolves. Fortunately for the livestock, though, domestic dogs have been bred so that they do not attack or kill.

**Social Behavior**

When a herd is moving, social rank can determine an animal's position within the herd. Animals with high social rank seldom lead (Hedigar, 1955, 1968). Being a leader is a more dangerous position, so animals with high social rank lag behind or remain in the safety of the middle of the herd. Social behavior also has an influence on learning. Boissy and Le Neindre (1990) found that in tasks where cattle had to press a plate to obtain a food reward, the presence of a companion facilitated learning. Cattle trained with companions learned quickly compared to isolated animals. This was probably due to less fear. Kilgore and de Langen (1970) further showed that presence of companions reduces fear and lowers secretion of stress hormones in sheep.

These principles are familiar to most people that handle or raise domestic cattle and horses. Horse trainers use trained horses that are calm to help ease the fear in young horses of novel experiences. For example, loading in a trailer for the first time, being ridden for the first time, or even the stress of weaning can be reduced by having a calm companion horse nearby. In Australia, tame "coacher" cattle are used to assist in gathering wild feral cattle (Roche, 1988). Fordyce (1987) also used a few tame steers to facilitate training Brahman calves to novel handling procedures. On "Old West" cattle drives, lead steers with a calm temperament were kept around and excitable leaders were destroyed (Harger, 1928). Excitable leaders caused stampedes.

**Attraction and Reaction to Novelty in Cattle and Pigs**

Both highly reactive wild herd animals discussed in Chapter 1, and highly reactive farm animals with an excitable temperament are both attracted to and fearful of novelty. Lawrence et al. (1991) found that the most reactive pigs were also the ones that were most attracted to novelty. The pigs most likely to approach a novel bucket placed in their pen also showed the most intense startle responses to a person stamping his foot. Highly reactive pigs also display behavior differences compared to nonreactive pigs in an open field test. Dantzer and Mormede (1978) found that highly reactive Pictrain pigs walk around more in a novel arena compared to placid Large White pigs. Pictrains also learn an active avoidance task quicker than Large White pigs. Willham et al. (1964) also found breed differences in learning active avoidance tasks between excitable Hampshire piglets and placid Durocs. The Hampshire piglets learn to avoid shocks quickly compared to Durocs. The breed effect was greater than the effect of individual differences between litters of the same breeds. Thus, highly reactive piglets are vigilant and intensely aware of changes in their environment, which may facilitate certain types of learning. Furthermore, Hemsworth et al. (1990) found that the trait "fear of humans" in pigs has an inheritability estimate of 0.38.

**Genetic Effects on Cattle Behavior**

Temperament in cattle is' definitely heritable. Studies on the inheritability of temperament in dairy cattle estimate inheritability as 0.40 (O'Blesness, et al., 1960), 0.53 (Dickson et al., 1970), and 0.45 (Sato, 1981). In beef cattle, the estimates are 0.40 (Shrode and Hammack, 1971) and 0.48-0.44 (Stricklin et al., 1980).

Cattle with Brahman genetics are generally considered flighty compared to breeds with British genetics such as Angus and Hereford. However, Brahman cattle are the most inquisitive and will investigate or follow a person or a dog. A common practice used in Australia to move groups of Brahmans is allowing them to follow a person. The tendency to follow a person is greater in Brahman compared to British or European Continental breeds. Nevertheless, Hohenboken (1987) found that if Brahmans are handled gently they can become extremely docile. Murphey et al. (1980, 1981) also discussed behavioral differences between several breeds in their flight zone size, and in their tendency to approach novel objects or a man lying on the ground. The breeds with the largest flight zones had the strongest tendency to approach novel objects. This is only true when the animals voluntarily approach the novel object. During forced movements where the animals are being driven toward a novel object just the opposite is true. The excitable flighty individuals will be most fearful and they will be more likely to "spook" or balk.

**Temperament Differences between Cattle Breeds**

There are many well-documented examples of differences in the temperament between different breeds of cattle. Stricklin et al. (1980) reported that Herefords were the most docile, British breed and Galloways were the most excitable. Three studies show that Angus cows are more temperamental than Herefords (Stricklin et al., 1980; Tulloh, 1961; Wagnon et al., 1966). Angus cattle dominated Hereford cattle in social rank even though they weighed less (Strickin et al., 1980; Wagnon et al., 1966). Fordyce et al. (1988) also found that Brahman cross cattle become more agitated during restraint than Short-horns. More recent research by Voisinet et al. (1997) had similar results. Braford, Simmental X Red Angus, Red Brangus, and Simmental X Brahman cattle became more excited during restraint than Angus, Simmental X Red Angus, and Tarentais X Angus.

In 1993, the first author began to receive reports from cattle feeders in the United States about certain cattle that were unable to adapt to a feedlot. Newly arrived cattle in a feedlot usually adapt to vehicles and people within a few days. However, feedlot operators began to notice that some crossbreeds with European Continental genetics were never able to adapt to the feedlot. Some of these animals had to be removed from the feedlot and returned to pasture. Further observations by the first author suggest that the behavior of highly reactive excitable European Continental crosses during handling or restraint is different from the behavior of Brahman or Brahman cross cattle. For example, when Brahman cattle become agitated they are seldom self-destructive. However, the first author has observed that European Continental crosses are more likely to injure themselves if they panic during handling in squeeze chutes or truck loading ramps. Brahman cattle are more likely to lie down and become immobile. Certain genetic lines of European Continental cattle are more excitable than British breeds (Grandin, 1994; Stricklin et al., 1980). The second author has made similar observations in both calm and high-strung breeds of horses. The more reactive high-strung breeds such as Arabians or Thoroughbreds are more likely to panic compared to the more placid and less fearful breeds such as draft horses.

**Sire Effect**

Genetic influences on behavior can be clearly shown in studies of sire effect. Differences in behavior of the offspring of different sires cannot be attributed to learning behavior patterns from the mother. Dickson et al. (1970) found that sire had a significant affect on behavior and temperament of cows in the milking parlor. Arave et al. (1974) showed that Holstein heifers from certain sires had higher activity levels and greater learning ability Both ranchers and dairymen have learned from practical experience that calves from certain sires will be more nervous and excitable. Torres-Hernandez and Hohenboken (1979) found a similar relationship in sheep. Ewes by Romney sires were more agitated when placed in a stressful test situation compared to ewes sired by Suffolk or Columbia ewes.

**INDIVIDUAL DIFFERENCES**

In "Behavior and Evolution," Mayr (1958) wrote,

The time has come to stress the existence of genetic differences in behavior, in view of the enormous amount of material the students of various forms of learning have accumulated on non-genetic variation in behavior. Striking individual differences have been described for predator-prey relationships, for the reactions of birds to mimicking or to warning colorations, for childcare among primates, and for maternal behavior in rats. It is generally agreed by observers that much of this individual difference is not affected by experience but remains essentially constant throughout the entire lifetime of the individual.

Individual differences in animal behavior have been widely discussed by Hirsh (1963), Scott and Fuller (1965), Fuller and Thompson (1978), and Plomin (1990). Livestock animals show individual differences in behaviors similar to those found in laboratory animals and dogs. Kerr and Wood-Gush (1985) investigated a relationship between individual behavioral differences and production measures in dairy cows. They propose that the behavior of dairy heifers in one context can be used to predict behavior in other situations. Furthermore, Kerr and Wood-Gush (1987) found that an individual dairy heifer's reaction to being touched by a human observer showed a consistent individual pattern, which remained consistent for a 2-year period.

In his experience training horses, the second author has observed similar individual differences in the temperament of horses. High-strung fearful horses often take several years to habituate and stop fearing a novel situation such as a new riding arena, transport vehicle, or a strange person. Calmer, more placid animals will habituate more easily to a novel stimulus than high-strung, flighty animals.

An open field test or flight zone test can also be used to assess temperament. Kilgore (1975) used the open field test as an assessment of temperament in dairy cows; Le Neindre et al. (1995) documented individual differences in the docility of Limousin cattle. In this study individual cattle were separated from their herdmates by a person working their flight zone. Individuals were considered aggressive if they lowered their heads or charged, the handler. A passive flight zone test can also be used. In this test a person stands or sits quietly and waits for animals to voluntarily approach. Animals with a calm temperament and low fear of humans will approach more closely and fearful animals will have a larger flight zone. Murphey et al. (1980) found that he could approach the dairy breeds more closely than the beef breeds.

**Temperament Rating of Cattle during Restraint**

"Chute Scores" are numerical rating scales used to measure the reaction of cattle to restraint during veterinary procedures. The scales designate calm through highly agitated (fearful) animals. Fordyce et al. (1988) used a seven-digit numerical scale. Grandin (19,94) used a five-point scale for rating temperament in a manually operated squeeze chute: (1) calm, stands still, no movement; (2) slightly restless; (3) restless, shaking the restraint device; (4) vigorously shaking the restraint device and attempting to escape; and (5) a berserk frenzy However, Grandin (1992) used a four-point scale for cattle restrained in a hydraulic squeeze chute because it holds an animal's body more tightly and greatly limits movement compared to a simple head stanchion.

Grandin (1992) assessed the temperament of bulls, which were restrained in a squeeze chute four times at 30-day intervals. She concluded from this study that to obtain accurate temperament evaluations on individual animals they should be scored more than once. Temperament scores were stable over time for the calmest and the most excitable animals. Temperament scores taken in a squeeze chute may more accurately show the animals true physiological reactivity compared to passive flight zone tests.

The first author has observed that confronting an animal with a sudden novel or aversive experience is more likely to make it show its true reactivity Flight zone is possibly more affected by learning than reaction to a sudden aversive event. For example, Herefords, which are a calm, placid breed, may have large flight zones if they are raised where they seldom see people, but even a very wild, extensively raised Hereford will seldom become highly agitated and struggle violently in a squeeze chute. On the other hand, a tame halter broke individual of the U.S. genetic lines of Saler or Limousin is much more likely to panic when suddenly confronted with novelty compared to an extensively raised Hereford.

**Hybrid and Crossbred Pig Temperament**

Across several different handling tests, Lawrence et al. (1991) compared two separate groups of modern hybrid Cotswald Landrace X Large White pigs. Both groups were reared under the same conditions, but group A and group B of the hybrids differed in their behavior. The first author has also observed differences in the behavior of hybrid pigs bred on different farms. Pigs from one farm were calmer than pigs from another farm. The first author speculates that the differences may be due to differences in how the managers of each farm selected breeding stock and differences in handling.

The handling tests used by Lawrence et al. (1991) were: (1) willingness to leave the home pens, (2) movement ease through a hallway, (3) response to a suddenly approaching human, (4) restraint-resistance using a snout snare, and (5) vocalization during restraint. With the exception of vocalization, all the tests had a strong tendency to correlate. The single best predictor of temperament in the pigs was the suddenly approaching human who stamped his foot. The response was scored on a five-point scale: (1) no response, (2) mild flinch, (3) animal backed away from the person, (4) animal backed away and squealed, and (5) animal attempted to escape. Lawrence et al. (1991) concluded that the temperament differences between individuals were stable over time.

The first author has observed that very lean hybrid pigs are much more excitable during handling than fatter breeds of pigs. Ultra-lean hybrid pigs with very little back fat became popular in the United States during the mid 1990s. From her experience, she speculates that this effect cannot be attributed entirely to early rearing environments. Striking differences in pig behavior occur in lean hybrids, which were raised in the same building operated by the same people. Many pork producers have commented that lean hybrids are more excitable than older crossbred pigs with large amounts of back fat. The differences in behavior were first noticed when producers changed breeding stocks. Lean hybrids are more reactive and more likely to squeal when touched. Pigs with a very excitable temperament are much more difficult to handle (Grandin, 1994). The first author has observed that they can be moved easily if the handler moves slowly and avoids sudden movements. Sudden movements cause excitable pigs to bunch together and pile up.

At the slaughter plant lean hybrids cause serious handling, problems in plants which process 1000 pigs per hour on a single line. The highly reactive pigs balk more, and are more difficult to drive. Several large slaughter plants have had to install a second complete handling and stunning system in order to handle the lean hybrids at a rate of 500 pigs per hour in each system.

**Physiological Measures during Handling**

Genetic factors influence physiological measures of handling stress. Zavy et al. (1992) showed breed differences in cortisol (stress hormone) levels between Bos taurus and Bos indicus cattle. Furthermore, Zavy et al. (1992) found that Brahman cross calves have higher cortisol levels than crosses of Angus and Hereford. Stricklin et al. (1980) reported that Angus cattle have higher cortisol levels than Herefords. Angus also had higher heart rates than Herefords (Stricklin et al., 1980). Syme and Elphick (1982) used a commercial heart-rate monitor to study heart rate and handling stress in merino sheep. The sheep were all neutered males raised on the same farm. Temperament classifications were:(1) quiet, no response to being separated from the group; (2) jumpers, which attempted to jump out of the pen after being separated; and (3) vocalizers. Quiet sheep had lower heart rates compared to jumpers and vocalizers. Furthermore, Syme and Elphick (1982) found vocal and jumper sheep were seldom the first animals to move through a handling facility Grandin (1980b) has made similar observations in cattle. The wildest and most difficult to handle cattle tend to move through a handling race at the end of the group. This was recently demonstrated by Orihuela and Solano (1994) with cattle in slaughter plants. Animals at the end of the group took longer to move through the race. McCann et al. (1988a,b) found a similar correlation between emotionality scores and heart rate in horses. Response to being herded, isolation, and being approached by people were used as tests of emotionality Horses with strong reactions to isolation and being approached by people had higher heart rates.

**Temperament Problems in Crossbred Cattle**

Temperament problems with crossbreds have been observed by cattle breeders. Bonsma (1975a,b) stated that B. indicus Brahman crossbreds have more temperament problems than purebred Brahman. The first author has also made similar observations in crossbreeds of Brahman and Hereford cattle. Compared to their purebred parents, the crossbred calves were more difficult to halter break. In the United States, there have been increasing problems with very excitable beef cattle that are likely to become extremely agitated and fearful when they are suddenly confronted with the novel surroundings of an auction market or slaughter plant (Grandin, 1994). Problems with highly reactive animals tend to be most evident in cattle breeds imported from Europe and in crosses of these breeds. Observations by the first author in feedlots and slaughter plants indicate that crossbred animals are more likely to become agitated compared to purebred European Continental cattle. These cattle were introduced to extensive ranching operations in the United States during the late 1960s and early 1970s, and came into favor when the, drive for lean beef motivated producers to select for lean, rapidly growing cattle. Cattle producers are aware of this problem. In response, two U.S. breed associations have added temperament scoring to their selection criteria.

An example of genetic selection for leanness which caused handling problems in a slaughter plant was observed by both authors. Three hundred highly excitable fine-boned heifers of European Continental and British genetics, which had been selected for rapid growth and lean meat were observed. These heifers were impossible to handle calmly, and they sometimes engaged in self-destructive behavior. One heifer tore off her front leg and two others had ripped off pieces of a hoof. This occurred when they stepped in a crack between the loading ramp and the truck, which caused them to panic. Cattle with a calmer temperament will stop and withdraw their foot from the crack. We observed another heifer, which fell down and became so panicked that she thrashed around on the floor and was unable to make coordinated movements to get up. Another heifer pounded her head against the side of the chute after she fell down. The heifers constantly bellowed and if they were touched they kicked with both back feet. When a plant employee leaned over the side of the race to encourage a heifer to move, she responded by kicking with both back feet to a height of about 7 feet, which narrowly missed his head. One hind foot caught the brim of his hard hat with such force that it flew high in the air. These agitated behaviors have a strong genetic basis. Cattle with a calmer temperament do not display such frenzied, agitated behavior, even when they originate from a remote ranch and have had minimal previous contact with people. This type of behavior is similar to that of a high-strung horse. Horses are more likely to injure themselves when they panic compared to cattle. The first author has observed thousands of cattle move through this particular facility. In several years, she had never observed such berserk behavior.

The authors speculate that the increased problems with highly reactive and excitable cattle and pigs are the result of over selection for leanness and rapid growth. Over the last 20 years, the first author has observed a vast improvement in handling methods and equipment design for livestock in both the United States and Canada. This should theoretically lower the frequency of over reactive responses of livestock animals in novel situations. Unfortunately, this is not always the case. Indiscriminant selection for rapid growth and leanness may be related to increased handling problems.

**ANIMAL SIZE, SHAPE, COAT COLOR, AND TEMPERAMENT**

The mechanisms which translate gene potentials into adult forms are very complicated because all physical characteristics are affected by numerous genes (Keeler, 1965). Many of these genes interact with each other (Wright, 1978). Russian geneticists have observed that body shape in animals is related to temperament. Krushinski (1960) reported that slender, narrow-bodied dogs had increased excitability compared to "athletic wide-bodied" dogs. In foxes and guinea pigs, coat color is associated with differences in physiology, morphology, and behavior (Keeler, 1968; Wright, 1978). In many cases, coat color can be used as a genetic marker for such traits (Keeler, 1975).

Both authors hypothesize that there appears to be a relationship between body shape, bone structure, hair patterns, hair color, and temperament in cattle, pigs, and horses. During her career, the first author has handled and observed thousands of cattle and pigs in over 100 slaughter plants throughout the United States, Canada, and Europe. The second author has ridden, trained, and shod numerous horses. Both authors have observed that animals with a highly reactive temperament often have a lean, slender body and a fine-boned skeleton. The first author has observed that selecting pigs and cattle for lean meat and thin back fat has resulted in animals, which are more reactive to sudden novelty. Both authors have observed that it is the slender, smooth-bodied animals, which are most reactive. If animals are selected for leanness and bulging muscles they tend to be less reactive than the lean, smooth-bodied slender animals. However, both types of lean animals are probably more reactive than animals with more body fat. In Angus cattle, double-muscled animals had more excitable temperaments scores than normal animals (Holmes et al., 1972). The first author has observed that Charolais cattle bred in Quebec, Canada, with heavy bones and muscular bodies, are very calm at a noisy livestock auction compared to slender, lean Charolais cattle which are raised by some U.S. breeders. When we looked at the different body shapes and sizes of different breeds of pigs, cattle, and horses, the physique-temperament relationship became obvious. Arabian horses are lean, reactive, fine-boned, and spirited. Draft horses are muscular and heavy boned with mostly calm temperaments. When the draft horse breeds were developed it was likely that any horse which spooked and turned over the beer wagon was quickly eliminated. Early breeders probably selected for strong calm animals with heavy bones. Another example of the physique-temperament relationship is highly prolific Chinese pigs that have an abundance of fat and bear many offspring. These animals are very placid and nonreactive, whereas pigs, which carry the porcine stress gene slender, have low amounts of fat, and are more reactive. Pictrain pigs and the Chinese breeds are extreme examples of the relationship between temperament and body morphology. Temperament differences became obvious to both authors after observing hundreds of animals under different conditions.

Both authors further hypothesize that the size and shape of wild herd animals is also related to temperament. Highly reactive, delicate, lightweight antelope and deer survive in the wild by fleeing quickly from predators, and heavy animals like cattle and bison survive by either attacking or fleeing. However, the heaviest herding animal, the Cape buffalo, survives by attacking because it is too heavy to flee. The small, delicate, fine-boned, defenseless animals such as antelope have the most excitable temperaments, especially if they live in an environment with many predators. These animals are hyper vigilant and equipped with huge ears, which enable them to orient and localize faint sounds of danger. Any change in their environment will result in instant orientation and possible flight. The larger, heavier animals are more placid but they can be dangerous to handle in a confined space. If the handlers enter the animal's flight zone they are more likely to attack. The American bison is one of the most dangerous animals when it is cornered. The first author has observed bison butt a fence with their heads up to 20 times. They have also been known to eviscerate a horse with their upward curving horns. Bison appear to be intermediate in the survival strategy. They are very excitable and survive by fleeing, but since they are fairly heavy animals they often attack when they are unable to flee. Measurements of the stress hormone cortisol in a variety of hoofed animals has indicated that the large, heavy Cape buffalo is less stressed by capture and restraint than a flighty animal such as the nyala. When 18 different species of African animals were captured, the Cape buffalo was the only species in which cortisol levels did not rise (Morton et al., 1995).

**Coat Color**

In artificial selection studies conducted for the U.S. Department of Agriculture on over 34,000 guinea pigs, Wright (1978) showed that selecting for different hair colors changed many other characteristics. This early research revealed many patterns of associated changes in body shape, relative size of certain internal organs, and changes in temperament.

Both authors have heard reports from dairymen that white holsteins are flighty and often more dangerous to handle than more pigmented cows. These casual observations made by dairymen may be explained partially by findings from studies on coat color-temperament relationships in other animals. Genetic selection for body traits has an effect on behavioral traits, and selection for behavioral traits leads to changes in body traits (Belyaev, 1979).

This phenomenon has clearly been demonstrated in rats and foxes (Keeler, 1942; Keeler et al., 1968). Breeding for the black non-agouti coat color in rats resulted in tamer, easier to handle rats (Keeler, 1942). In foxes, graded differences in temperament were found between foxes selected for different coat colors (Keeler, 1968, 1975). Foxes that were all raised in the same wooded compound had flight zone differences that ranged from silvers (200 yards), to platinums (100 to 200 yards), to ambers (100 to 3. yards). It is interesting to note that the foxes became progressively tamer as more and more mutant coat color genes were added. Tameness was also highly correlated with adrenal gland weights. The size of the adrenal decreases and the body weight increases as the foxes became tamer. The animals with the most mutant coat color genes were the tamest. Therefore, variations in coat color and hair patterns are related to behavior.

**Hair Whorls**

Both authors have observed that morphological traits are related to temperament. The second author in his work as a horse trainer observed that the hair whorl on a horse's forehead was related to temperament. Horses with hair whorls high on the forehead or two spiral hair whorls were more reactive and "high strung." The observation that hair whorl patterns were related to temperament was first observed hundreds of years ago in Arabian horses. More recently horse trainers and veterinarians have casually observed that hair whorl patterns are related to temperament (Tellington-Jones and Bruns, 1985; Barker, 1990; Friedly, 1990). Many body traits form very early in development when the brain is forming. This may explain relationships between body traits and temperament. In humans, children with developmental disorders, such as Down's syndrome and Prader-Willi syndrome have a high incidence of abnormal scalp hair whorl patterns (Smith and Gong, 1973, 1974). In schizophrenics there is a higher prevalence of counter-clockwise scalp whorls (Alexander et al., 1992). It is now well known that hair whorl patterns form in the fetus at the same time the brain is forming (Smith and Gong, 1974).

Many scientists believed that these observations were rubbish and that the trainers were wrong. Cattle have similar hair whorl patterns on their foreheads (Fig. 4.3). We decided to study hair whorls and temperament in cattle because the behavior of cattle is not confounded by the experience of being trained for riding. A total of 1500 cattle were temperament-ranked (with the rating scale that was described previously) while they were restrained in a hydraulic squeeze chute for vaccinations. The survey was conducted at a commercial feedlot in Colorado. Seventy-two percent of the cattle were European X British crosses and the rest were zebu crosses from Mexico. The animals originated from many different ranches. To help prevent bias the person determining the temperament rankings was positioned so that he could not see the hair whorl. A second observer noted hair whorl location.



Figure 4.3: The position of the round hair whorl on the animal's forehead is linked to temperament. Cattle with round hair whorls above the top of the eyes were more likely to become fearful and agitated when they were restrained.

The results of our study clearly showed that cattle with hair whorls above the eyes became significantly more agitated during restraint than cattle with hair whorls below the eyes (Grandin et aL, 1995). Further study of feedlot cattle, which had come from the same ranch, also indicated that animals with hair whorls above the eyes had larger flight zones and were more likely to entirely avoid a person who approached them.

**Bone Structure**

The beef cattle in our first study had a higher percentage of hair whorls above the eyes compared to Holstein cows at a large commercial dairy (Tanner et al., 1994; Grandin et al., 1995). Holsteins are much less reactive to novelty and aversive stimuli than beef cattle. During handling at commercial feedlots Holsteins are much less likely to become excited compared to beef cattle. Voisinet et al. (1996) has also found that a calm temperament is related to weight gain. Cattle with the calmest temperament, standing calmly when restrained in a squeeze chute, had the highest weight gains.

The authors speculate that there may be a relationship between hair whorl position on the forehead and bone structure. Hair whorl height may possibly be related to increased vigilance, more acute senses, and a stronger orienting response. A low hair whorl may be related to reduced vigilance and a reduced orienting response. Bone structure may be related to overall nervous system reactivity and fearfulness. We speculate that these two aspects of temperament may have different neurotransmitter mechanisms. Possibly, the temperament of an animal is determined by more than one biological mechanism, which is influenced by different sets of genetic factors. In other words, orienting responses and a full-blown fear response may be influenced by different genetic mechanisms.

In most cattle and horses, the fine-boned, slender-bodied animals that resemble deer have a nervous temperament and a high hair whorl. The heavy-boned, muscular animals are more likely to have a calm temperament and a low hair whorl. The Holstein dairy cow lacks heavy muscling but fits the above criteria because she is heavy boned. We started to speculate about the possibility of two separate genetic mechanisms influencing temperament after the first author visited the Lasater Beefmaster herd. This herd has been closed to new genetics for 60 years and the cattle have been subjected to a unique set of selection pressures. Lasater (1972) selected his cattle using the natural principle of survival of the fittest. Heifers that were unable to give birth unassisted and protect their calf from the coyotes were culled. However, Lasater required cattle that were commercially useful so he also selected for temperament and carcass traits. The Beefmaster's breed is half Brahman, quarter Hereford, and quarter Shorthorn. Lasater's selection criteria resulted in cows, which are very protective of their calves but are extremely tame and seek contact with people. It is unusual to observe range cows that will come up and lick people and will stand still while being scratched and petted. The appearance of these reddish brown animals is striking. They are muscular and heavy boned and have either high hair whorls on the forehead or no hair whorls.

Dale Lasater, Tom Lasater's son, explained to these authors how they selected for temperament. Instead of using sudden aversive novelty (such as restraint) as a temperament test, they tested the temperament of hungry, newly weaned calves by sitting in the pen with them. Hungry calves, which failed to eat from a person's hand after 2 days, were culled. When the herd was first started about a quarter of the calves were culled; today, only 1% is culled for temperament (Dale Lassater, personal communication, 1996).

Faure and Mills (Chapter 8) demonstrated that the traits of fearfulness and social reinstatement are genetically separate. Social reinstatement is the tendency of an isolated bird to rejoin flockmates. In a wild population it is likely that both high fear and high social reinstatement naturally would appear together in the same animal because this would improve survival. In domestic cattle the high-strung, nervous animals will bunch together more tightly when they become excited. The tight bunching behavior is probably motivated by high fear. Social reinstatement is a trait that makes animals bond and that is probably not motivated by fear. Faure and Mills' social reinstatement trait is not the same as fear because they were able to select and breed both low-fear high-social reinstatement birds and vice versa. Another speculation is that Lasater duplicated the Faure and Mills' experiment in their cattle. The Beefmaster cattle have high bonding and good maternal traits but still have enough nervous system reactivity to be alert and protect their calves from predators. These high hair whorl, heavy-boned cattle are good mothers and there is a striking contrast between them and heavy-boned, low hair whorl Holstein dairy cows which are poor mothers. We further speculate that the high-fear may be more related to fine bone structure and the hair whorl position may be related to Faure and Mills' social reinstatement trait. As stated in earlier chapters, different traits within an animal are linked in ways that are not fully understood.

**EFFECTS OF EARLY EXPERIENCE AND HANDLING**

Research on the effects of early experience upon later behavior in animals clearly shows that frightening early experiences, gentle handing, barren environments, or opportunities to explore novel environments will affect young animals more dramatically than older ones. The effects of early experiences are considered to be less readily reversible than those of later experience (Levine, 1968; Scott and Fuller, 1965). S. Levine et al. (1967), L. Levine et al. (1979), Denenberg and Whimbey (1968), and Denenberg et al. (1967) studied many treatments and subsequent effects on both infant and adult rats. Fuller and Thompson (1978) summarize these studies by saying, "An adult rat shocked for eating out of a white dish learns to avoid white dishes but is otherwise much the same as before. The younger rat shocked in roughly the same manner shows excessive emotionality in many situations thereafter." Early rearing methods were also shown by Denenberg (1961) to change nervous system reactivity in a rodent's response to open field testing. Melzak (1954) and Melzak and Burns (1965) found that raising dogs in barren and restricted environments makes them more fearful and reactive to novel stimuli. Early rearing effects have also been studied in cattle by Dellmeier et al. (1985). The calves in this study were reared in individual stalls which restricted movement. When they were later tested in an open field pen, the stall-raised calves were more energetic, had a greater level of activity, and ran around excessively compared to calves reared in group pens. Fordyce (1987) also showed that adult cattle which are handled quietly as calves are quieter during handling compared to nonhandled controls. Calves reared in an intensive system can also be sorted quickly compared to calves reared in a more extensive system (Boivin et al 1992). Near weaning time, Boissy and Bouissou (1988) found that handling and contact with people improves the ease of handling in cattle. Early experiences will affect how animals react in the future to handling, restraint, or novel situations (Gonyou, 1993; Hemsworth et al., 1986).

Lyons (1987) found that goats hand-reared by people react less strongly to changes in the environment compared to goats raised on their dams. Differ ences in early rearing methods resulted in long-term, stable differences in temperament. Several studies have shown that previous experience has a significant effect on an animal's flight zone size and its physiological responses to handling and restraint (Ewbank, 1993; Gonyou, 1993; Boissy and Bouissou, 1988; Ried and Mills, 1962; Hastings et al., 1992). For example, both hand-reared cattle and hand-reared deer show lower cortisol levels during restraint compared to animals with less early contact with people (Hastings et al., 1992; Boandle a al., 1989). Hastings et al. (1992) also found that "tame" hand-reared deer had much lower cortisol stress hormone levels when restrained compared to deer raised by their mothers. Interestingly, both groups actively resisted restraint and vocalized. In summary, Grandin (1984, 1987) suggests that compared to cattle having previous experience with rough handling, animals with previous experience with gentle handling will be calmer and easier to handle in the future.

**Effects of Environment and Experience**

Early environment effects on the behavior of pigs reared indoors have also been studied by Grandin et al. (1987) and Grandin (1989). Environmental enrichment made the pigs calmer and less reactive. They startled less when a person suddenly jerked open the gate to their pens. Pigs reared with assorted objects to play with, straw bedding, and daily petting were more willing to approach a novel object or novel person compared to pigs reared in barren pens. Environmental enrichment also makes pigs more willing to walk through a single file chute (Pederson, 1992; Grandin, 1989). It was shown that less prodding was r~qu1red for the pigs from the "enriched" environment. However, Grandin (1987) emphasized caution in providing pigs with overindulgence. The pigs reared with frequent petting learned to be indifferent to people; they became trained to follow people and driving them through a chute became more difficult.

**Memory of Aversive Experiences**

Cattle, sheep, and other herd animals have excellent memories. They remember aversive handling experiences (Hutson, 1980, 1993; Pascoe, 1986; Grandin et al., 1986). For example, sheep subjected to aversive procedures were reluctant to reenter the test facility 6 months to a year later (Hutson, 1980). Pascoe (1986) also found that dairy cows which had received shocks remembered the shocks and showed higher heart rates when they were returned to the facility Previous rough handling also makes dairy cows reluctant to enter a milking parlor (Seabrook, 1987). Cows previously handled in a gentle manner had smaller flight zones and entered a milking parlor more quickly than cows handled in an aversive manner. It is extremely important that an animal's initial experience with a new handling facility be as positive as possible. If the animal's initial experience is aversive it may become difficult to induce the animal to reenter the facility (Grandin, 1993). Both authors have also observed that cattle or horses especially remember previous experiences that involved pain. The second author had an experience with a horse that hit its head the first time that it backed out of a horse trailer. This one incident caused pain and fright and was remembered by the horse. He soon learned to enter the trailer quietly, but during unloading he would rush out of the trailer quickly. It was almost impossible to train the horse not to back out of the trailer suddenly.

**Training and Handling Highly Reactive Animals**

Both authors have observed that the most reactive animals of a group will appear more sensitive to changes in the environment and are usually the first animals to orient toward novel sights or sounds. Highly reactive herd animals will have behaviors such as constantly rotating ear positions, raising the head quickly from the ground when grazing, excessive tail flicking even when no flies are present, flinching when touched, or moving away when approached by people. These behaviors are all signs of a highly reactive temperament. Both research studies and anecdotal observations suggest that responses to being suddenly placed in a novel environment or the reaction to sudden novel stimulus are two of the most accurate behavioral tests of nervous system reactivity (Lawrence et al., 1991). Cattle arriving at a novel auction yard and suddenly being chased up an alley by people is analogous to placing a rat in an open field test or suddenly stamping your foot in a group of pigs. Animals with genetically higher levels of nervous system reactivity are more likely to have intense reactions to sudden novelty (Grandin, 1997). Highly reactive animals can be conditioned to cooperate during veterinary procedures such as injections (Grandin et al., 1995). To summarize the results of this study (discussed in detail in Chapter 1), adult antelope at the Denver Zoo were trained to accept routine blood tests and their cortisol remained at baseline levels. This showed that the antelope were not fearful (Grandin et al., 1996). The training was done in small, incremental steps over a period of weeks, and great care was taken to avoid triggering a massive flight reaction. For instance, when the antelope oriented and froze during any small change in the procedure, the procedure was stopped. Each day new procedures were gradually introduced until the antelope habituated and no longer oriented. However, it is very important to not confuse taming effects on adult animals with the change that takes place in the nervous system of young animals after handling. When the trained nyala were suddenly confronted with something not encountered during their training, their true nervous system reactivity was displayed and they reacted with explosive panic. Bongo antelope that were trained at the Denver Zoo had low (almost baseline) levels of cortisol when they voluntarily stood in a box and had their blood drawn (Grandin et al., 1996).

In contrast to the highly reactive nyala or other reactive herd species, training placid animals such as Hereford cattle or Suffolk sheep to accept novel procedures can be done quickly and habituation to nonpainful procedures can occur even when the animals are pushed beyond the orienting response. However, if a highly reactive animal is trained too quickly and panics during the training, it may be very slow to habituate afterward. Highly reactive animals may become more fearful with each forced handling trial, whereas an animal with a more placid temperament may habituate and become less fearful. Grandin et al. (1994) found this in Angus X Hereford X Charlais X Simmental crossbred cattle, which became increasingly agitated when they were repeatedly run through a squeeze chute on the same day. Animals need time to calm down between training trials and practical experience has shown that training trials should be spaced at least 24 hours apart.

During handling and driving in alleys, lean hybrid pigs have been observed to startle frequently and are more easily excited compared to fat crossbred pigs (Grandin, 1994). The hybrids are highly reactive when a whip is cracked and raise their ears instantaneously in response to novel sounds. Lanier et al. (1995) conducted experiments on genetically similar crossbred pigs with identical rearing experiences and found individual differences in their adaptability to a forced novel swimming task. Some of the pigs readily adapted to a series of swimming tasks and others remained highly stressed. Some of the pigs had baseline epinephrine (adrenalin) levels after swimming, and others still had high levels. In essence, the stressed pigs never adapted. To summarize, animals with a placid, calm temperament will habituate more easily to forced, nonpainful procedures than animals with a flighty, excitable temperament.

**Habituating Animals to Handling**

The genetic makeup of the pigs determines the amount of human contact required to make them calm and easy to drive through races and truck loading ramps. Genetically nervous pigs may require frequent contact with people and more environmental enrichment compared to genetically placid pigs. Grandin (1987) found that providing an excitable line of Hampshire pigs environmental enrichment which consisted of weekly walks in the aisle, rubber hoses to chew on, or people walking in their pens once a week produced less excitable pigs. Pigs from this same excitable genetic line were more willing to walk through a novel race when they were raised in an enriched environment. However, Beatie et al. (1995) found that in a placid maternal line of Landrace X Large White gilts, they became more difficult to drive when they were raised in an enriched environment. A tentative conclusion made by the first author is that environmental stimulation and enrichment are more important for facilitating handling of animals with a more highly reactive nervous system. An optimum level of contact with people is necessary to produce pigs that do not panic at the slaughter house, but with too much contact pigs become indifferent to people and difficult to drive.

To facilitate handling and adaptability to commercial conditions, the first author has experience training market-weight pigs with excitable genetics to drive quietly at the slaughter plant. The training is done on the farm during the entire finishing time (fattening period). She found that walking through the pens in a random pattern each day and training the pigs to move away in an orderly manner, only 10 to 15 seconds per pen was needed each day. The pigs learned to get up and flow around her as she walked through the pen. In this manner, they are taught to be driven quietly by people instead of learning to follow them. However, Grandin suggests that care must be taken by the person walking the pens not to frighten the pigs. The idea is to teach the pigs to become accustomed to people and to get up and move when people enter the pen, but not to get so upset that they panic. Walking the pens is especially beneficial for lean hybrids with nervous temperaments. Cattle-handling specialist Bud Williams from Canada and Burt Smith from Hawaii (T. Grandin, personal communication) have used similar training methods with wild and domestic ruminants on pastures. These experiences suggest that herding animals can be taught to either follow people or allow themselves to be driven. In some farming systems, following is more efficient, while in others driving is preferable.

**Facilitating Animal Movement**

An experienced dairy cow will walk over a drain grate in the milking parlor but young heifers often balk (Lynch and Alexander, 1973; Grandin, 1980a,b, 1996; Kilgour, 1971). Dairy cows can learn that drain grates and other things are harmless; however, animals being handled in an unfamiliar facility will balk and refuse to walk over puddles or drain grates. Shining reflections, shadows, and changes in flooring type will cause livestock to balk and refuse to move through a handling facility This is especially problematic in places such as auction yards or slaughter plants where the animals have no opportunity for learning. If leader animals are given a few minutes to investigate a shadow or puddle, they will usually step around or over it and the other animals will follow (Hutson, 1980) Unfortunately, in a high-speed slaughter plant there is not enough time to allow the leaders to investigate novel objects or areas of high contrast.

Emotionally reactive animals are often in a high state of nervous system arousal due to the novelty of the situation, which makes them more vigilant and likely to balk at small distractions in alleys and races that draw their attention. A jiggling chain, people up ahead, a sparkling reflection on a piece of metal, or air drafts and hissing exhausts blowing in their faces can all cause the animals to stop (Grandin, 1993). More placid animals will usually hesitate and look at small distractions, but they are more likely to keep moving. However, an area of high contrast or something that looks out of place is more likely to cause balking in nervous animals. In five different slaughter plants, the removal of distractions such as sparkling reflections, air drafts, and the presence of people up ahead made it possible to greatly reduce the use of electric prods (Grandin, 1996).

**Innate Nervous System Reactivity versus Taming**

A common question asked by cattle breeders in the United States is why cattle with European Continental genetics may be difficult to handle here though they are easy to handle in France. French calves are raised in close association with people and become tame. On western ranches in the United States, cattle are normally handled only two or three times a year. Early intensive handling of calves in France produces calm, easy to handle adult animals. It is well documented that early handling will make cattle and horses easy to handle (Mal and McCall, 1996; Boivin et al., 1992; Fordyce et al., 1985). The highly reactive nature of some genetic lines of European Continental cattle may be masked when they are handled in a quiet manner in close contact with people. In familiar surroundings they may appear calm, but when suddenly confronted with novelty they are more likely to panic. Boissy et al. (1996) reports similar findings in sheep. Romanov ewes, which were originally bred for intensive conditions, are stressed under extensive conditions due to a tendency to avoid humans.

The managers of bull test stations have reported two accounts of bulls that went berserk when brought to the station. The bulls charged fences and attacked the handlers, but afterward, the owner was able to walk them quietly into a trailer. They calmed down when they heard the owner's familiar voice. In horses, both authors observed that the true temperament can be masked by learning. Some horses "blow up" when they are taken to a new place or exposed to a strange stimulus. For example, owners often teach their young horses to allow their feet to be handled by a horseshoer. The horse may learn to stand and accept this handling by the owner but when the farrier arrives for the first time the horse may panic. Some horses become fearful every time they are handled by a farrier. Owners often comment that this is "out of character" for the horse. When highly reactive animals are in familiar surroundings they may be calm and their true temperament can be masked. They learn that that certain sights and sounds are harmless. Recently, the owner of a high-strung horse commented, "He's 12 years old. You'd think he learn to get over the little things by now." Taming and training adult animals may reduce their reactions to specific handling procedures but it does not change their level of innate emotional reactivity The level of emotional reactivity in an animal is like the level of water in a drinking glass. The level of water in the glass is influenced by both genetics and the environment during early life. Environmental factors can either raise or lower the initial level of water in the glass. Handling and contact with people early in life can reduce emotionality in an adult animal but it is almost impossible to manipulate the environment to such an extent that a highly reactive animal can become as calm as an animal which has calm genetics. For example, no amount of early handling can turn a high-strung Arab stallion into an "old plug" riding stable horse. You might make him calmer, but he will never be as calm as horse that is genetically calm.

**Handling Facility Design**

Solid barriers and fences are important to prevent extensively reared animals, which are not accustomed to handling, from seeing people or other things that frighten them. Mustangers who gathered wild horses in the American west used canvas corrals (Wyman, 1946; Amaral, 1977). Opaque plastic corrals are also used to successfully gather wild ungulates (Fowler, 1978). Feral horses, reindeer, and several species in Africa are held in holding corrals made of fabric. Herd animals have an instinct to flee from danger they can see. If they cannot see a potential danger they are less likely to flee. Barrier fences work because they exploit this behavioral characteristic of the animals.

Herd animals respect a barrier that appears visually substantial (Grandin, 1993). Practical experience shows that the use of solid barriers is most important for highly fearful or reactive animals. People handling cattle, deer, sheep, and wild horses have independently discovered these principles (Grandin, 1980a; Kilgour, 1971; Fowler, 1978). Herding animals seek safety behind barriers. Maybe it is like seeking safety from predators in the middle of the herd. Whittington and Chamove in New Zealand (1995) found that installing solid barriers on a deer pasture reduced vigilance. Solid barriers also reduced the tendency of deer to react by running away from a moving novel stimulus. The novel stimulus used in this study was a person draped with a sheet.

Tulloh (1961) showed that Brahman cattle are more difficult to block with gates compared to British breeds. When Brahman cattle are running in an alleyway they do not see the fence. Adding a 30-cm metal strip or tying ribbons to a fence can prevent the animals from hitting it. When either wild or domestic herd animals panic, they are likely to crash into fences constructed of thin rods or chain link which are difficult to see.

Grandin (1993) found that extensively raised cattle remain quieter and become less agitated (fearful) when the sides of restraint devices are covered with solid material such as metal, plywood, or cardboard. Solid barriers on the side of a squeeze chute prevent the animal from seeing the chute operator who stands deqi in the animal's flight zone (Fig. 4.4). Squeeze chute operators have to stand next to the machine with their arms held high over their heads to put their hands on the controls. Seeing people in this position often makes cattle lunge and jump in attempt to escape (Fig. 4.5). Installing cardboard on the outside of the squeeze chute can substantially reduce agitated behavior and less pressure will be required to hold the animal. All species will stand more quietly in a restraint device if pressure is applied with a slow steady motion. Sudden jerky motions of a restraint device cause excitement. There is also an optimal pressure. The restraint device must apply sufficient pressure to provide the feeling of restraint, but excessive pressure which would cause pain should be avoided.



Figure 4.4 Rubber louvers on the side of the squeeze chute prevent the cattle from seeing people deep in their flight zone. The sides are designed so that the handler can access the animal for vaccinations, but its vision is blocked.

**The Influence of Darkness or Light on Handling**

Environmental effects of darkness or light are also important. There is a paradoxical aspect of darkness. It is both calming and fear-provoking. Animals are reluctant to enter a dark enclosure, but calm down when they are in one. Van Putten and Elshof (1978) discussed the reluctance of pigs to enter dark places. Calming effects of darkness are also well known in cattle and chickens. Placing herd animals in dark enclosures stops attempts to escape. Some evidence suggests that darkness reduces physiological responses to stress (Douglass et al., 1984). Cattle restrained in a dark box had lower cortisol levels than cattle restrained in a squeeze chute (Hale et al., 1978). However, if the box is not familiar it may increase stress (Lay et al., 1992). Furthermore, when moving through a race, cattle, sheep, and pigs all have a tendency to move from a darker area to a more brightly illuminated area. Lights can be used to attract many species into races and restraint devices (Grandin, 1980a; Van Putten and Elshof, 1978). Light must be used to illuminate the area up ahead, but must not shine in an approaching animal's eyes.

Parsons and Helphinstine (1969) used a dark box for handling cattle, and Pollard and Littlejohn (1994) and Pollard et al. (1992) used a dark room for deer. Deer in a dark room lose their flight zone and can be touched by people. When a handler was present in the dark room, the deer bunched together less tightly and investigated more compared to deer in a lighted room. The first author has observed dramatic effects of darkness on bleshock antelope. Placing the antelope in a completely dark crate stopped it from kicking. If it saw a small amount of light coming through the air holes, it kicked violently In order to calm frightened horses, the second author has had success with covering their eyes with a soft blanket. This has to be approached slowly, but when the horse accepts having its eyes covered, the calming effect is obvious.

Cattle and other hoofed animals will often refuse to enter a race or restraint device if it looks like a dead end. Cattle entering a restraint device must see a lighted place to put their heads, but if they see an avenue of escape they are more likely to become agitated. The first author has observed that extensively raised cattle will remain quieter in a restraint device if there is also a solid barrier around the animal's head. This is especially important with flighty animals which are not accustomed to close contact with people.

**Genetic Effects on Handling Facility Design**

For thousands of years, domestic cattle, sheep, horses, and pigs have been selected for both behavioral and physical traits. For example, British and European Continental breeds of cattle are physiologically adapted to cold climates and they are therefore raised primarily in the midwestern and northern United States. In contrast, Brahman cattle are adapted to warmer climates and they are thus raised in the southern United States. The first author has observed that the temperamental differences between these breeds; has had a substantial influence on the design of cattle handling facilities in the United States. These differences in design evolved over many years because ranchers used what worked. For example, in the northern United States, when cattle are being sorted into groups by gender or weight, the mostly placid British cattle are sorted in 3.5- to 5-meter-wide alleys by people moving among them either on foot or on horseback. This method works because animals with a calm temperament can be easily separated from the group. Cattle with Brahman genetics are more excitable and have to be sorted in a 70-cm-wide, single-file race, which has gates at the end leading to separate pens. When Brahman cattle get excited, they engage in shelter-seeking behavior and herd tightly, which makes it difficult to sort out a single animal in a wide alley. Removing a single animal from the group is more difficult. It is much easier to sort cattle which have an excitable temperament through a single-file chute. Hohenboken (1987) also commented that Brahmans behave differently in corrals and working facilities compared to B. taurus cattle. Tulloh (1961) reported that Brahman cattle flock more tightly than the British breeds such as Hereford or Angus and they were more difficult to block at gates. Compared to cattle, all breeds of sheep flock more tightly together. Therefore almost all sheep are sorted through single-file chutes. Whateley et al., (1974) and Schupe (1978) also showed breed differences in flocking behavior of sheep. Rambouillet flock tightly and Chevoits act more independently.

**CONCLUSION**

Both genetic factors and the animal's rearing environment will determine how an animal will behave during handling. Animals with a highly reactive, excitable temperament will become more fearful and agitated when confronted by sudden novelty compared to animals with a calm, placid temperament. Animals with a calm temperament will habituate more easily to new handling procedures. Stress levels will remain low in flighty excitable animals if new procedures are introduced very slowly An understanding of the influence of genetics on behavior will facilitate animal handling and training.

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