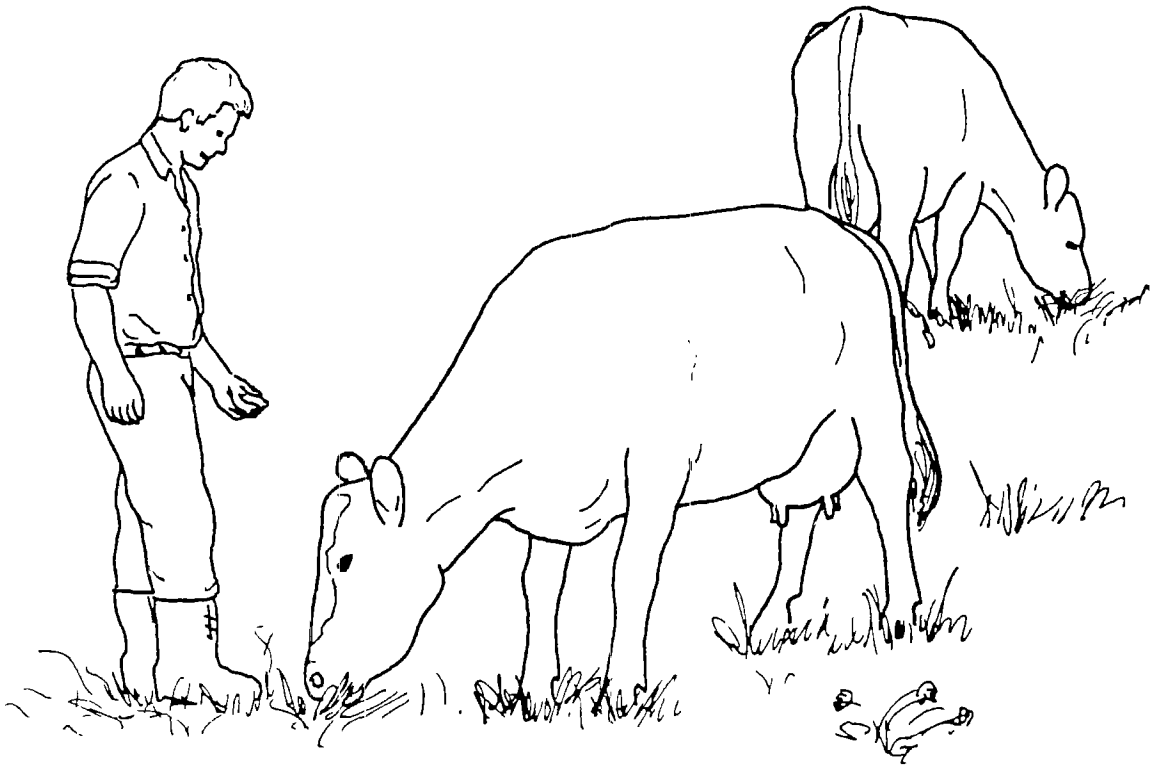
Social behaviour of cattle and the human/animal relationship

Xavier Boivin



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Foreword

This booklet is based on the manuscripts of four lectures that Dr. Xavier Boivin gave during his 9-month stay as a guest scientist at Department of Animal Science in 1992. His stay was financed by a postdoctorate fellowship (project no. 565022) from Norwegian Agricultural Research Council (NLVF).

In 1991, Xavier Boivin received his doctorate as an ethologist at University of Rennes, France, with a thesis titled "Human/animal Relationship in Cattle (Bos taurus)" (in French). At our department he has conducted the research project "Influence of handling at different ages of weaning on the human/goat relationship". We gratefully appreciate Dr. Boivin's contribution to increasing our knowledge about the behaviour of cattle and goats, and about the human/animal relationship in general. The purpose of this booklet is to share some of this knowledge with students and other persons who might be interested.

We thank Aina Solli for her work with the lay-out of the manuscript and Grethe Tuven for her drawing of the front page.

Bjarne O. Braastad

Contents

1. Introduction

Cattle species is domesticated since at least 6200 BC and several millions of cows are used today for different productions around the world. This common human/cattle history gives the impression that their behaviour is very well known. However many problems of handling them still exist. The purpose of this booklet is to provide a better understanding of two aspects of cattle behaviour which are essential for the farm management: I) The social behaviour of cattle; II) The human/cattle relationship.

1.1. The social behaviour of cattle

One of the main characteristics of cattle is their social behaviour. It is almost impossible to find a cow alone and the separation of an animal from the group constitutes a great perturbation for it. This characteristic is not specific for cattle but is observed in almost all domestic species. Living in an organized group facilitates the process of domestication (Hale, 1969).
Human use of domestic species involves actually taking into account their social behaviour. In a cattle flock, for example, interactions between individuals are not randomly distributed but follow strict rules. An advanced system of communication has been developed in cattle species and it is important for the rearing of the animals to understand their "language". In addition, social life is certainly an adaptation of the species to environmental conditions. Therefore, the artificial conditions of husbandry (or experimentation) must be well-adapted to their social organisation.

1.2. The human/cattle relationship

Cattle are large and strong animals and are potentially dangerous for humans. Several accidents during handling clearly demonstrate the importance of a good human/animal relationship. Caretakers build and manage the cattle environment. The human behaviour determine the level and the quality of the relationship with the animals. If traditionally Europeen farmers were very close to their animals and spent a lot of time with them, the development of the modern husbandry leads to an increase in the number of animals per farmer and, then, of a decrease in the number of human contacts given to the animals.

Under these conditions, animals are less and less habituated to the human presence and more and more reacting to handling. The production of the animals and the welfare and the security of both animals and caretaker are dependant on the human/animal relationship. Therefore, it seems essential to better understand the relevant factors of the human/animal relationship in order to improve it.

The social behaviour and human/animal relationship are indeed linked. The human/animal relationship implicated the establishment of a communication system between two different species and a "socialization" of the animals towards humans. As it has been shown by the studies on human/dog relationship (Scott, 1970), this socialization could employ the same mechanism as used for the intra-specific socialization. Thus, the knowledge of social behaviour and intra-specific socialization seems also important in order to understand better how the animals react towards human presence or human handling.

After a short presentation of the systematic position of cattle and of their sensory world (essential to understand how the animal perceived their environment), this booklet is divided into four chapters: Social organisation and communication in cattle; Socialization in cattle; Human/animal relationship in farm animal; Investigations about the human/cattle relationship. Informations and scientific works presented in this booklet are mainly reported from the studies of two laboratories of the French institute on agronomical research (I.N.R.A.): Nouzilly (M.F. Bouissou, A. Boissy) and Theix (P. Le Neindre, I. Veissier).

1.1. Systematic position of domestic cattle

The domestic cattle belong to the Bovidae family. The general characteristics of this family are long limbs with two main fingers and two lateral and rudimentary fingers. They can move quickly and the large species like cattle are well adapted to large open spaces. They have no incisor or canine in the superior maxillar. Thus they can not bite the other animals. Males and females can have non-deciduous horns. It can be an advantage in the defense of the individuals and for the establishment of the social hierarchy.

Fourteen subfamilies are forming the Bovidae family. Among them, Ovinae, Caprinae and Bovinae include domestic species. The Bovinae include seven genera: Bison bonabus (European bison), Bison (American bison), Bubalus (Buffalo), Poephagus (Asian yak), Ovibos (Circumpolar musk ox), Bos indicus (Zebu) and Bos taurus (our cows). The two last species are domesticated. Their wild ancestors have completely disappeared.

1.2. Sensory world of domestic cattle

There is few scientific studies about cattle perception, surely because it is more easy to work on this subject with smaller animals. However, it is important to recall briefly

different visual, auditory and olfactory aspects of their perception to better understand their reactions to the environment.

1.2.1. The visual perception of cattle

It is important to remember that wild cattle were living in large open spaces. Thus the visual sense was important in detecting the presence of peers or predators.
The field of vision could be drawn as in Figure 1. Animals could look backwards without moving their head but in these directions they only perceive form and movement without further perception. They need to turn their head to have a binocular vision and discriminate between objects. In their visual area, the line defined by the shoulders is of great importance for the stockman to handle the animals. When the handler stays in front of this line, the animal stopps or walks backwards. When he is behind this line, the animal walks forwards.
Animals are able to see colours and to recognize other individuals. But they are very disturbed by contrasts. A white line drawn on the floor can stop the animals and some of them jump over it when they want to pass through. When they pass from a dark pen to a clear area, cattle are very disturbed by the difference in brightness and could react very briskly to this new situation.
To summarize this section, visual sense is very important for cattle and as we will see below, a visual communication has been developed in their social organisation.

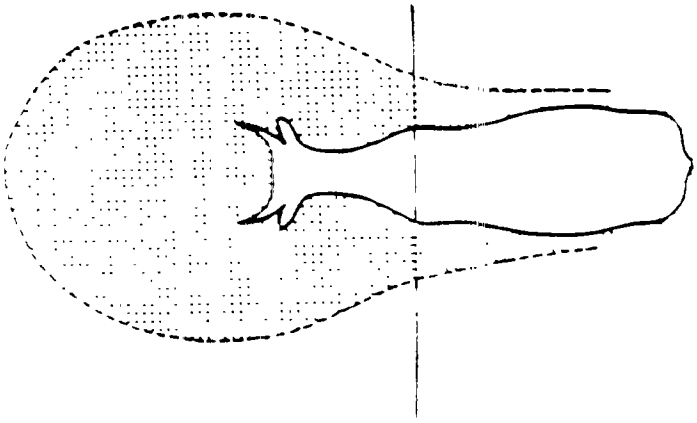


Figure 1: Field of vision of a cow

1.2.2. The auditory perception of cattle

Cattle emit cries in different situations (between bulls, dam/young relationships, aggression, separation from the peers,...). Vocalisations in Artyodactyls do not seem to be specific to the situation in which the animals are, but to their degree of excitement and to their interest in a stimulus (Kiley, 1972). But one of the main functions of a calling cry is locating the others animals. It is often noticed that animals feel the need to answer to a calling cry or to cry when other animals are passing before them. Cattle are able to recognize specific sounds. For example, Murphy and Mura Duarte (1983/84) showed that calves are able to learn their identification number when spoken by humans. It is possible that cattle are able to recognize the voice of the other individuals.
Caretakers use their voice a lot when they want to handle the animal. It is interesting to notice that the same types of cry are used around the world. Long and soft whistles are used to reduce the fear of the animals. Short and loud words are used to move the animal. Long, high-pitched and loud whistles or cries stop them. It is recommended to say something to the animals before a handling to notice them about your presence and to avoid briskly surprising reactions from them.

1.2.3. The olfactory perception of cattle

The presence of several smelling glands has been detected on many places in the cattle body but no specialized functions have been found for them. Cattle are able to recognize another animal just by its smell. They are also able to perceive the physiological state of an animal (ex: oestrus state). A strange behaviour called flehmen is often observed after an animal has perceived a strong smell (urine, faeces, blood,...). The sniffing animal retracts his nostrils as it will perceive more strongly the smell. This behaviour is observed without any relationship with age or physiological state.

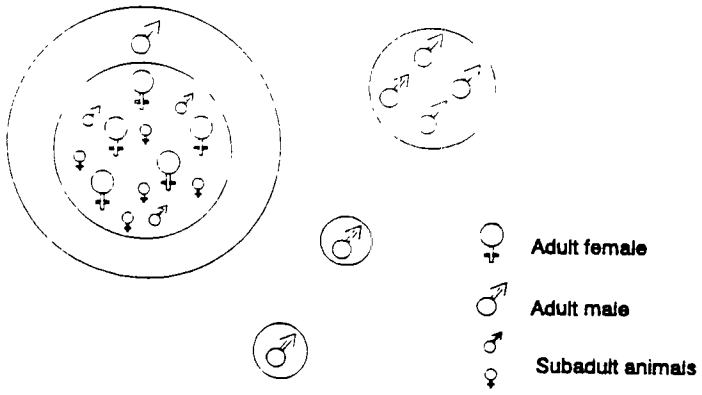


Figure 2:
Social structure of wild Bovinae
(From BOUISSOU, 1985)

Part I: The social behaviour of cattle

2.1. Social organisation and communication in cattle

2.1.1. Meaning of "social animals" and interest in the social life

Several individuals can be seen together in the same place and at the same time. These animals are forming an aggregation if their gathering is due to a particular and favourable place of the environment (e.g. taxies due to a physical or chemical agent).

The animals are forming a social group if they are gathering by a mutual attraction outside sexual or parental periods (gregariousness) (Bouissou, 1985).

Cattle could be classified in this last category. The main explaination of the social life of cattle is that is an anti-predator strategy. Several animals together have more chances of detecting the presence of a predator than a single animal. Thus, it is well-known that a predator who is detected does not try to hunt the group. In addition, it is more difficult for a predator to concentrate on a particular prey if it is watching a group than if it is looking at a single animal . Thus, a predator that tries to run in the middle of a group without choosing a prey, has very few chances of getting one (e.g. anti-predator strategy of a fish shoal). Lastly, cattle have an active anti-predator strategy. They charge the predator. It is more efficient to charge together than to charge alone.

2.1.2. Social structure of wild Bovinae

Bouissou (1985) has reviewed the social structure of
Bovinae. All its genera are gregarious and not territorial. They are characterized by precocial young, an active defense of the group, a social grooming and low inter-individual distances. The social structure of wild and feral Bovinae are described in the Figure 2. Feral animals are domestic animals that have returned to wild conditions. The social groups are formed by females and sub-adult males. There is often an adult male in the periphery of the group, but he interacts very little with the females outside the reproduction period and is not integrated in the organisation of the group. The other males can be solitary or in group and approach the group of females only during the reproduction period.

2.1.3. Description of social interactions in domestic cattle

In contrast to horses or monkeys, the face of cattle takes no part in the intra-specific communication. Only the posture of the body of the animal and more precisely the position of the neck and the forehead have social significance (Schloeth, 1958; Fig.3).

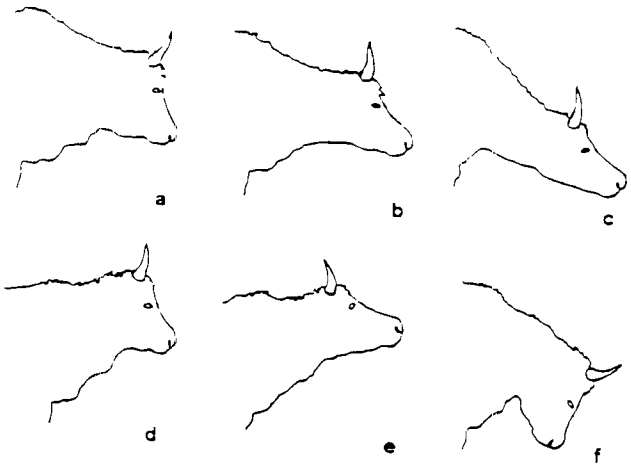


Figure 3:
Visual communication in cattle

The position of the neck and the forehead are essential
a: neutral posture; b: approaching posture; c:submissive posture; d: avoidance posture; e:alert posture; f: threat posture

(From SCHLOETH, 1958)

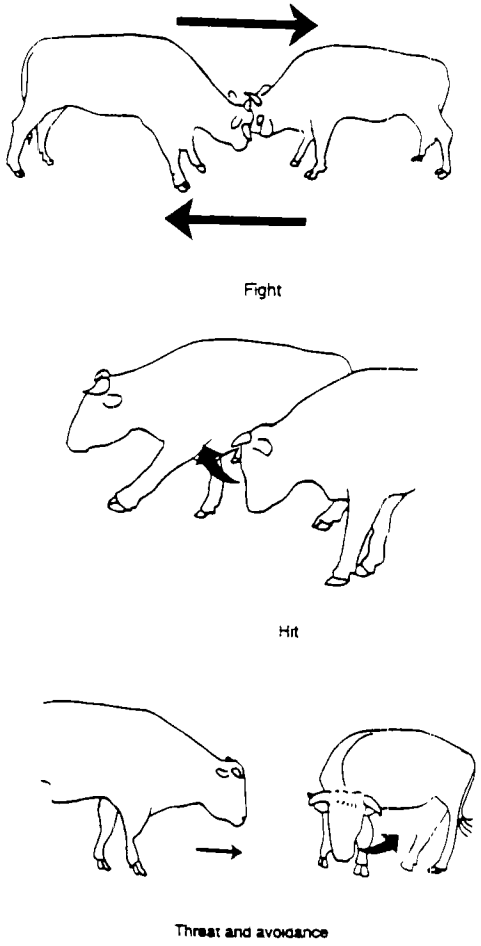


Figure 4:
Agonistic behaviour

2.1.3.1. Agonistic interactions

Agonistic interactions in cattle can be classified into four categories: fight, hit, threat and avoidance (Bouissou, 1985). They are drawn in Figure 4.

a) Fight
This is usually the most violent interactions between two animals. They are most often head-against-head and they push together until one animal goes away (the looser) and usually receives a hit by the winner.

b) Hit
Often, a hit follows an unsufficiently effective threat. There is often not only one, but many successive hits and the animal pursues the other.

c) Threat

Four attitudes or actions can be designed by this word. a) the animal moves quickly its head to one side in the direction of the other animal. b) without moving, the animal is orienting towards the other animal. His neck is orienting down and the forehead is perpendicular to the ground. c) The animal takes the same position but his body slowly turns and becomes parallel to the other animal (especially with fighting bulls). d) The animal begins to charge the other animal that flies away before the contact.

d) Avoidance

This behaviour is the most frequent after the formerly described behaviours, but it could be done without any action from the animal that is withdrawing. It varies from just a movement of the head in the opposite direction to a quick fly. Some time, their is no avoidance but the animal takes a submissive position. The neck, as in the threat, is orienting down but the forehead is orienting to the direction of the other animal.

2.1.3.2. Non-agonistic interactions

Non-agonistic interactions could be classified in four categories: sniffing, licking, rubbing and sexual interactions.

a) Sniffing

Cattle sniffthe the whole body of other animals but a great majority of sniffing concern the ano-genital area. As I have described above, the sniffing serves to recognize others individuals and their physiological state.

b) Licking

Licking is always following sniffing. They often lick the back part of the body (croup, hips or tail) but not the ano-genital region (bulls practise this behaviour with the heat cows during their sexual behaviour). The shoulder and the neck are often licked after a licking solicitation. The animal that will be licked approaches the other animal with an

avoidance attitude (the neck is orienting down and the forehead towards the other animal). It can often give little head hits under the head or the neck of the other animal.

c) Rubbing

The animal rubs an other animal with his forehead, cheeks or neck.

d) Sexual behaviour

The following behaviours are often practised during the sexual period but could be seen outside this period. The animal puts its head on the croup or on the back of the other animal (Fig.5). This behaviour is preceding the mounting behaviour (Fig.5). The mounted cow goes away if she is not in oestrus.
Another behaviour called "Head game" could be classified in this category. Two animals are head-against-head as in the fight (low position of the heads) and are pushing or rubbing slowly. The frequency of this behaviour is increasing during the sexual period.

The frequency of agonistic and non-agonistic periods varies between individuals. Individuals can live closely with a low frequency of interactions. The frequency of the interactions also varies according to the seasons (Schloeth, 1961; Fig.6). This Figure shows the evolution of social interactions in a semi-wild cattle flock during one year. The frequency of agonistic interactions is increasing during the reproduction period and lickings are decreasing in the same time.

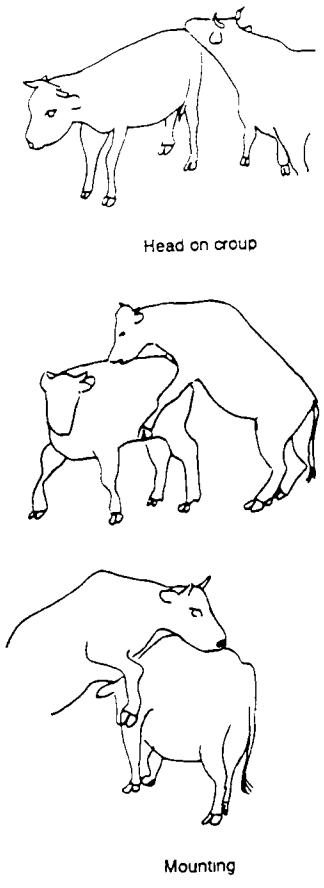


Figure 5:
Sexual behaviour

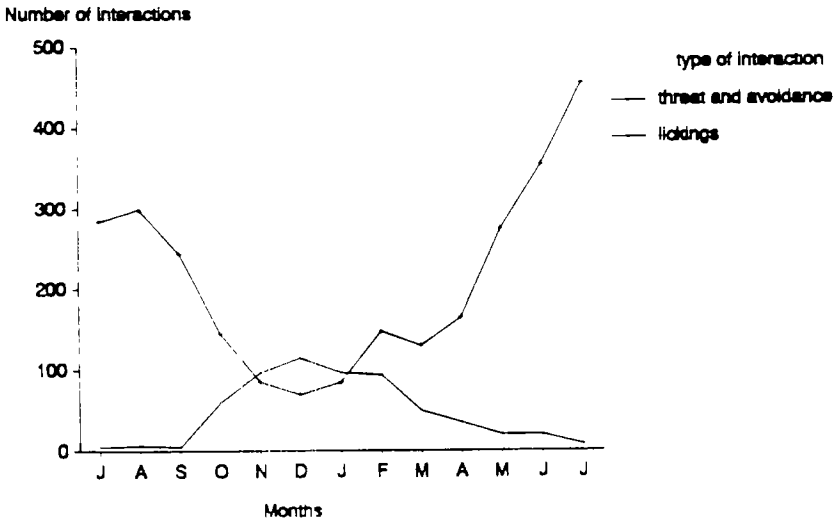


Figure 6:
The frequency of social interactions
in a semi-wild cattle flock over one year
(From Schloeth, 1961)

2.1.4. Hierarchy, Affinities and Leadership in a domestic cattle

2.1.4.1. Hierarchy

A social hierarchy exists when animals are positioning in different ranks consecutively to agonistic interactions (Fig.7). The outcom of the fight between two animals is then predictable.
A dominant animal attacks more frequently a subordinate than the subordinate attacks it. When all the agonistic interactions between two animals are going in the same direction, the dominance is called "absolute". The dominance is "relative" if one of the two animals gives statistically more hits than the other (Fig.7). The dominance in cattle is absolute (Bouissou, 1985).

Two methods are used to determine the hierarchy in a cattle flock. The first consists of observation of the spontaneous social behaviour of the animals. Observations in a large open space as a pasture require several hours for the observer. The frequency of interactions is very low. If observations in natural conditions are not necessary for the study, it is quicker to observe the animals in a free-stall (confined place) where dominant and subordinates are closer and thus interact more often.
The second way to find the rank of the different animal in a group is to place them in a competition test for example with a single source of food (Fig.8). When two animals are placed in this situation, the time spent eating by each animal clearly demonstrates the dominant and the subordinate. Bouissou (1985) found with 3 years old dairy heifers that the subordinate never ate in a 3 minute test.

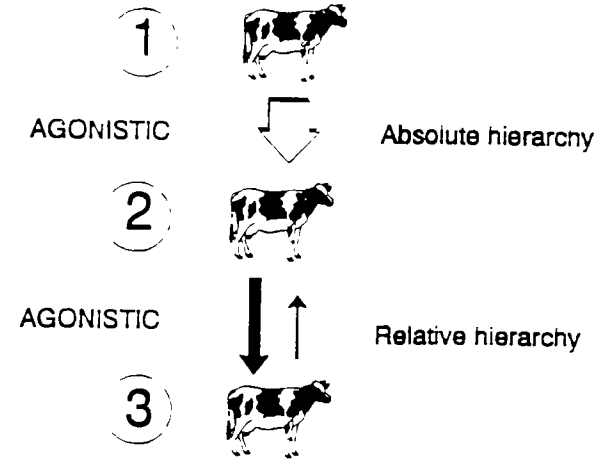


Figure 7:
Definition of social hierarchy

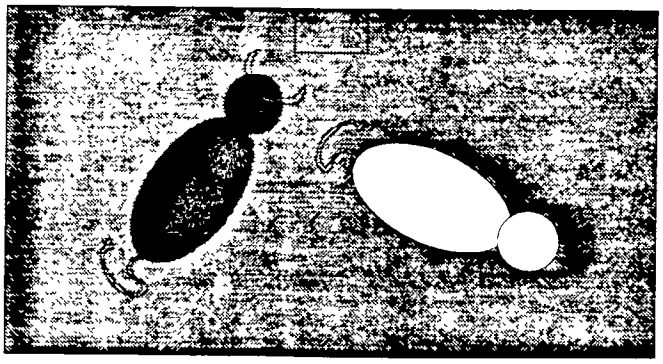


Figure 8:
Food competition test

Different types of hierarchy exist in cattle groups (Fig.9: Bouissou,1985). If an animal A dominates an animal B, B dominates C and A dominates C, the relationships is said to be transitive. If C dominates A, the relationships is intransitive. As in the first case, if no intransitive relationships are found in a group, the hierarchy is strictly linear (type a, Fig.9). It is often the case in small group of cattle. If three animals from intransitive relationships as in type b-d (Fig.9), are put together in a food competition test, no one eat because they spend their time being hit by their dominant and hitting their subordinate.

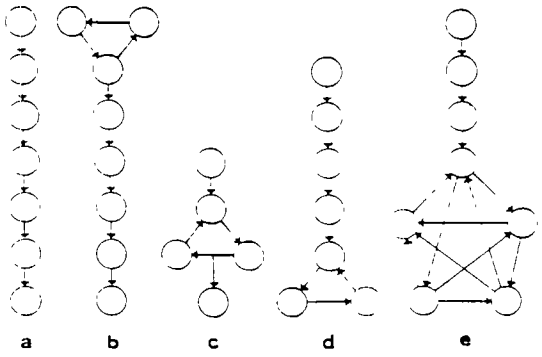


Figure 9:

Hierarchical forms observed in cattle groups

a) strictly linear hierarchy; b, c and d): linear hierarchy with an intransitive relationship; e) complex hierarchy

(From Bouissou, 1985)

2.1.4.2. Affinities (or attachment)

If agonistic interactions are well-known, less studies are available about affinities. Opposite to gregariousness (need of contact with animals from the same species), affinity or attachment concerns particular individuals. Wikler (1976) defined attachment as the preference or the exclusivity with which specific behaviour are executed in the presence of particular individuals or directed towards them. Four methods can be used to demonstrate and quantify attachment.

a) Preferential interactions

A low frequency of agonistic interactions and a high frequency of non-agonistic interactions between two individuals, relatively to the mean distributions of interactions between all the animals, are a good indicator of the existence of affinities. The observed distribution of non-agonistic interactions in a group of 24 months old heifers is significantly different (Fig.10) from the theoretical distribution if these interactions would be randomly given (Boivin, unpublished data). In the same way, Figure 11 a from Reinhard (1980) shows the distribution of frequency of lickings between the members of a 29 female zebus (Bos indicus) group. The cow called Daisy (Da) received the greater quantity of contacts from the other cows.

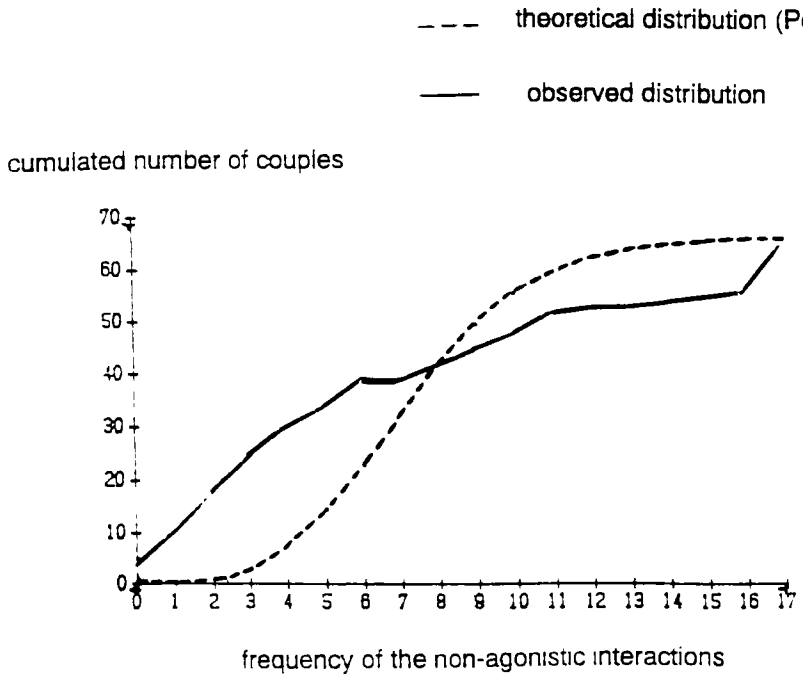


Figure 10:
Comparison between the random distribution and the observed distribution of non-agonistic interactions in a 18 months old range heifers group

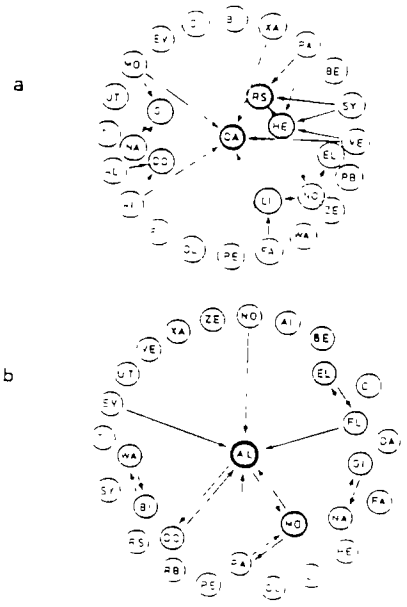


Figure 11:
Association between animals in a 29 female zebus flock
a) for licking
b) during grazing
(From Reinhard, 1980)

b) Proximity and synchronisation

Proximity of particular individuals and activity synchronisation (grazing,lying,...) between these animals can indicate an affinity between them. Thus, in the same flock described above, Reinhard (1980) observed that particular individuals are more often seen together during grazing than with the other individuals (Fig.11 b).

c) Test of social preference

It could be useful to compare the intensity of a link between two individuals to perform an experimental procedure as in Figure 12 (from Veissier, 1987). The animal has the choice between the supposedly preferred animal and another animal. The time spent by the tested animal in front of the two alternatives can be measured (ex between the mother and her weaning calf: Fig.12).

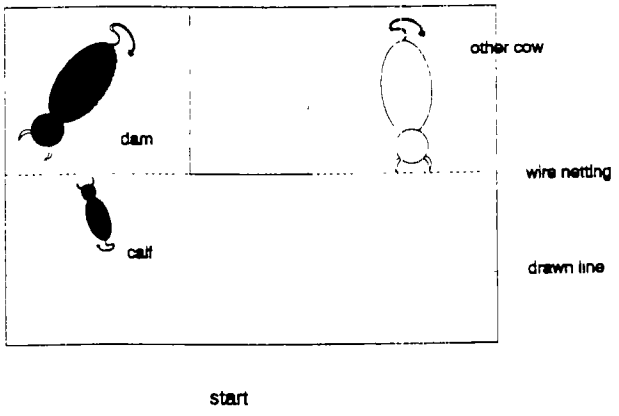


Figure 12:
Test of social preference
(e.g. mother/calf relationship)
(From Veissier, 1987)

d) Observation of the behaviour during separation or gathering of the tested and the supposedly preferred animal.

The separation of an animal from its preferred animal can constitute a great perturbation if the link between them is very strong. The behaviour and the internal state (hormonal concentration and heart rate for example) can be good indicators to assess the intensity of the link.

All these methods are able to demonstrate the existence of an attachment between individuals. But it is important to emphasize that the absence of response in one of these methods shall not be considered as an absence of a link. Many factors are implicated for each method. The different methods have to be used complementary.

2.1.4.3. Existence of a leadership.

If the concept of leadership has often been used, it is not easy to demonstrate a real fonction of leader for an animal in a group of cattle. Indeed, the definition of a leadership could take different meaning according to the situations (Bouissou, 1985):
(i) The leaders can be the animals that instigate the movement of the group or the beginning of an activity (e.g.: grazing). No relationship has been found between this type of leadership and the hierarchical rank of the "leader" animals. This role of leader is maybe not volontary. These animals could have the best perception of the stimuli and

could perceive them earlier than other animals. The other animals could perceive later the same information and follow the "leader".
(ii) The leader could also be the animal that controls the aggressiveness within the group or protects the group. These categories have never been demonstrated in cattle.
(iii) Lastly the "leader" animals can be in the first position when they are forced to move by the human or a dog or lead to be milked. In the case of a forced movement, the dominant animals would be the first to avoid the fearful stimulus (dog or human). In the milking procedure, this situation can be assimilated to a competitive test (to obtain food for example).

2.1.5. Conclusion

An advanced system of communication exists in cattle and leads to a strict organisation of the social group. The social hierarchy is absolute in cattle and determines a great part of their behaviour, especially in situation of competition. But the presence of clear affinities between particular individuals allows to think that the cohesion and the organisation of the social group is a balance between agonistic and non-agonistic interactions (Deputte, 1979).

2.2. Socialization in cattle

The previous chapters have briefly described the sensory world of cattle and their social behaviour (communication between animals, structure and organisation of the social group). The aim of this chapter is to show how the young animal is integrated in the social group from birth (mother/young relationship) to adult state, how it takes its place in the social hierarchy and how it can establish affinities with particular individuals.

2.2.1. Development of the social behaviour in calves from birth to adult state in semi-natural conditions.

This process has been well described by Le Neindre (1984) with cattle flocks which are scarcely disturbed by human: calving occured in pasture conditions during Summer time. Mothers and calves were put together in a free-stable during winter time.
Figure 13 shows the development of the social relationships between the members of a group of cattle, before, during and after parturition:

a- the days before the parturition, the mother interacts normally with the other cows.

b- just before parturition, the cow is usually seen alone (more then 10 meters from the others cows) in a sheltered area. Craig (1981) thought that this isolation may be passive. Just after parturition, the other cows come and sniff the young (Le Neindre, 1984). In contrast, Donaldson (1970) observed a defense of the area by the mother against the other cows. This behaviour might depend on the environmental conditions (more or less artificial) or on the breed.

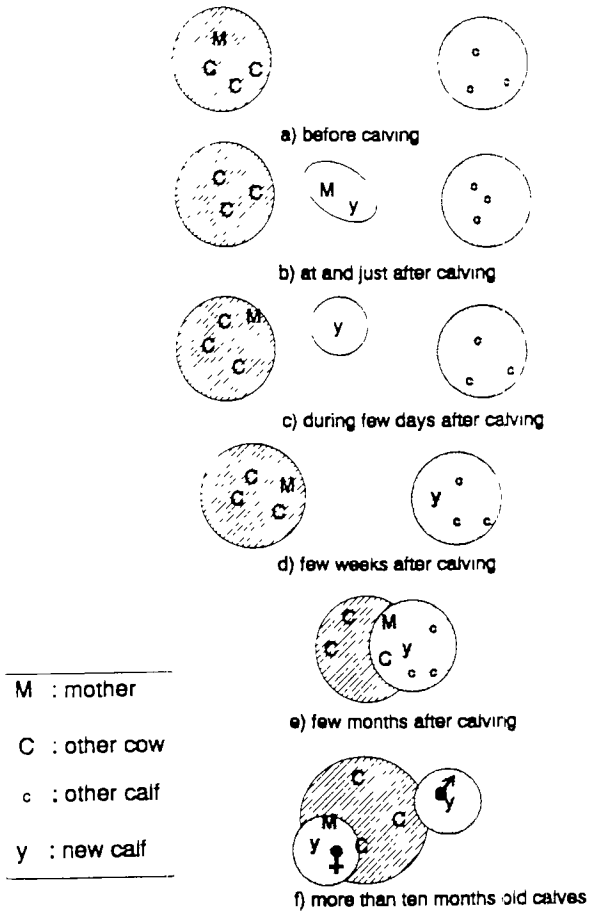


Figure 13: Socialization of the new calf
(from Le Neindre, 1984)

c- during the following days, the calf is generally seen alone and the mother spends the great majority of her time in the group of cows. The mother comes only to suckle the young with a maximum of eight sucklings per day especially during the first days. This anti-predator strategy is call "hider" in contrast to the "follower" strategy in which the young follows the mother in the social group like in sheep. This strategy protects the young from the predator, from the presence or the aggressiveness of the other cows and then facilitates the creation of a durable young/dam relationship.

d- after several days, the young is observed with the other calves ("nursery") outside the group of cows. He interacts little with them during the first weeks. After this period, different plays are observed between calves but very few agonistic interactions are noticed.

e- after several months, the activities of calves and cows are more synchronized and the two groups are mixed.

f- after 10 months, the female calves are more integrated in the cow group and the male calves are more often seen together and outside the group of females.

During this process, the young animal is progressively integrated in the organisation of the social group. By the play with other calves and the interactions with adults, it learns progressively the "social rules", takes place in the hierarchy and creates affinities. The social group of cattle is matriarchal. The comparison between male and female calves after 10 months shows clearly that young males are more emancipated and interact more with the other animals than female calves that continue to be closer to their dams (Le Neindre, 1984; Fig.14). The percentage of agonistic interactions among female calves is also very low compared with male calves. Then, Veissier et al. (1991) showed that calves continue to be close to the mother after the birth of a new brother or sister one year later. Reinhard (1980) observed with Bos indicus that sisters and dams could continue to be attached several years after birth.

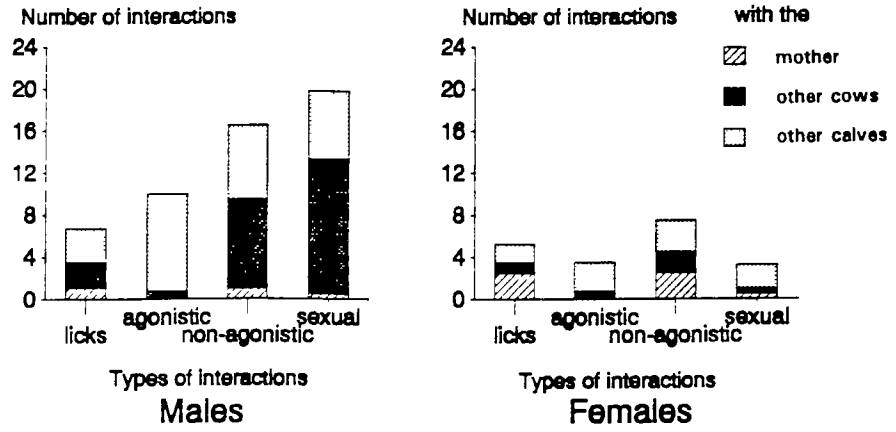


Figure 14:
Social interactions of 10 months old male and female calves (from Le Neindre, 1984)

2.2.2. Ontogenesis of the social relationships under practical farm conditions

The situation described above is unusual under practical conditions on farms. The calves are often separated from the mothers at birth (artificial feeding), one day after birth (traditional rearing condition where the calf is led twice a day to suck its mother) or around 9 months (range or free-stall conditions). After the separation, they can be reared together or separate from the other calves. Another common practice on farms is the change of the composition of the social group by the introduction of one or several non-familiar animals. The studies about the establishment of social behaviour, hierarchy and affinities in these types of animals have allowed us to better understand the relevant parameters of the social behaviour of cattle.

2.2.2.1. Establishment of the hierarchy in a group of unfamiliar dairy heifers.

a) Speed of the establishment of dominant/subordinate relationships.

The first interaction between unfamiliar animals is usually agonistic: fight (35%), hit (19%), threat (17%), or avoidance (13%) (Bouissou, 1985). For 50% of the animals, the first interaction reveals a dominant/subordinate relationship. The initial number of interactions is high at the beginning and reach a balance within an hour (Bouissou, 1985; Fig.15). After 15 minutes, almost 75% of the dominance/subordinate relationships are established and 94% after an hour (Fig.15). One of the main parameters for the speed of the hierarchy establishment is the social experience of the animals. Animals that have lived in isolation from the other calves are slower to establish their dominant/subordinate relationships than animals that have lived in group before the constitution of the new group. Animals that have experienced encounters with non-familiar animals are also more quicker to establish their hierarchy (Fig.15).

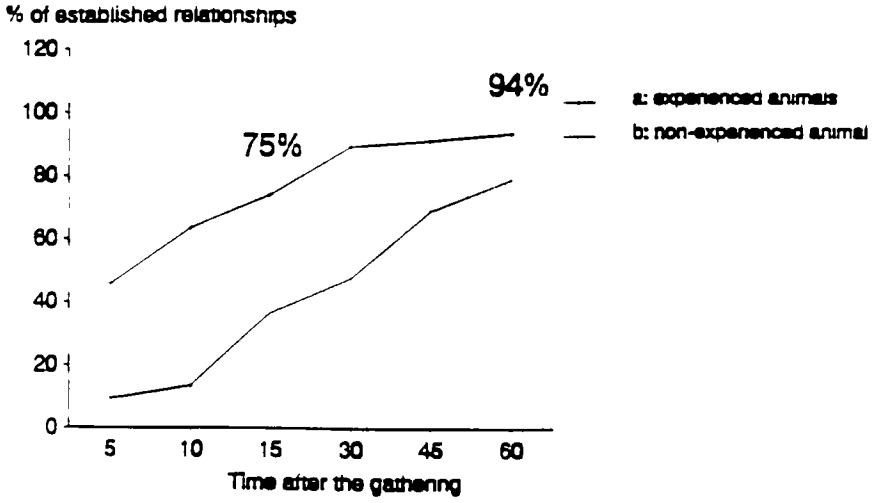


Figure 15:

Establishment of dominant/subordinate relationships

a: non-experienced : live only with the same animals since birth

b: experienced : have earlier met unfamiliar animals

b) Relevant factors for the determination of the social rank of an animal.

Several studies have demonstrated the influence of different factors on the rank of an animal: its size and its weight are positively correlated to the social rank; its age and its experience, the presence of horns and the breed (genetic factors) and the social rank of its mother (especially in range or free-stall breeding) influence its social rank. But one of the main factors seems to be its way to react during the social interactions. Bouissou (1985) observed a good correlation between the quantity of agonistic interactions given by a calf and its social rank several months later. Fights between calves are often without success during the 10 first weeks, but the future dominant calf induced the fight more often than the future subordinate. Eighty-five per cent of the future dominant calves never fled during the ontogenesis of the dominant/subordinate relationships. Bouissou (1985) also observed that dominant/subordinate relationships could be established without aggressive interaction by the dominant animal. She made the hypothesis that the emotivity of the calves (constant way to react to a stimulus) also could be responsible for its social rank.

To confirm this hypothesis, Boissy (1990) increased the blood concentration of testosterone in dairy heifers and tested the effect of this treatment on their emotivity, their social behaviour and their social rank. Figure 16 shows the design of his experiment. The hierarchy in a cattle flock was determined and the group was divided in two. One subgroup (the more subordinate animals) was treated with testosterone during three months. The level of testosterone was equivalent to the male level. The other subgroup was a control. At the end of the treatment, observations on social behaviour and stress reactivity of the animals in a cage were made for each animal. Then animals were gathered. Social interactions were recorded and dominant/subordinate relationships were estimated. Two weeks after the end of the treatment, heifers had a normal level of testosterone. Then the two subgroups were separated another time and gathered after three months.

The results show that treated animals were significantly less stressed by the presentation of a stimulus (human, umbrella) when they were in a cage than control animals at the end of the treatment (Fig.17). They were less aggressive toward other heifers and they flew away less during social interactions (Fig.18). The latter difference persisted 3 months after the end of the treatment (Fig.18) All these changes in the behaviour of the subordinate animals modified completely the hierarchy between the animals from the two subgroups (Fig.19). The new hierarchy was not changed 3 months after the end of the treatment (Fig.19). This experiment shows clearly the influence of the emotivity and the reactions of the animals during social interactions on the establishment of hierarchy and allow us to understand how calves could establish a hierarchy between them with a very low level of agonistic interactions.

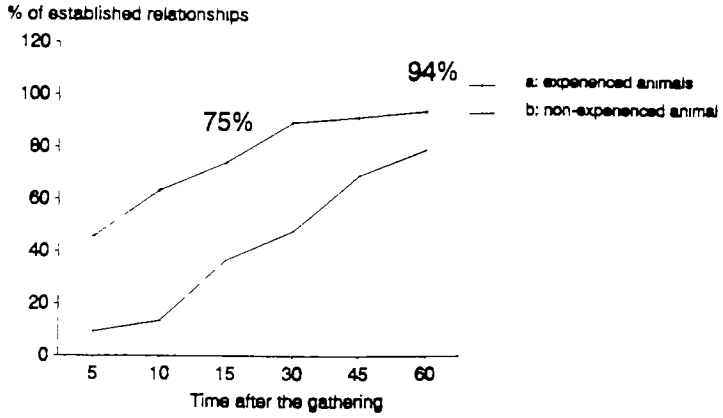


Figure 16:

Establishment of dominant/subordinate relationships

a: non-experienced : live only with the same animals since birth

b: experienced : have earlier met unfamiliar animals

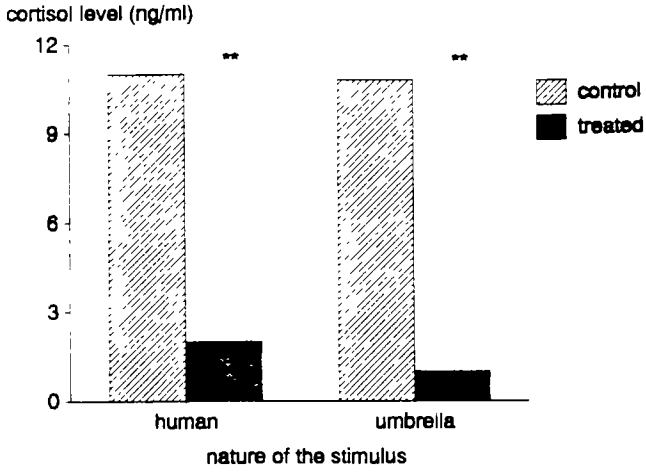


Figure 17:

Measure of the cortisol release after the presentation of a stimulus to a heifer in a cage

(Boissy, 1990)

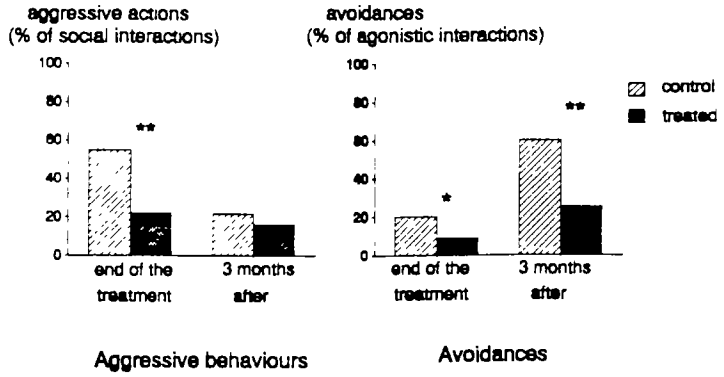


Figure 18:

Social behaviour during the gathering of the control group and the treated group

(Boissy, 1990)

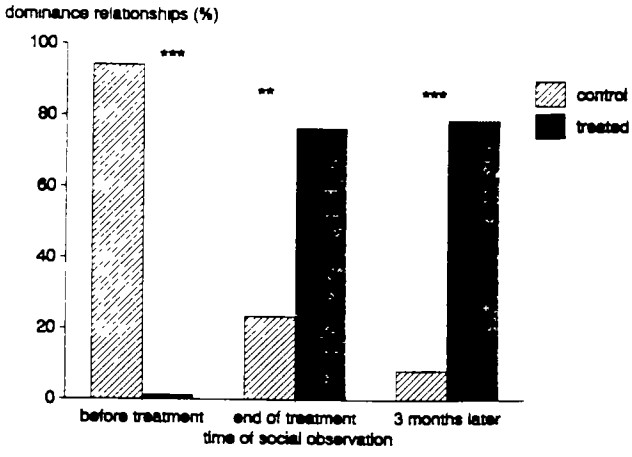


Figure 19:

Dominant/subordinate relationships between treated and control animals

(Boissy, 1990)

2.2.2.2. Establishment of affinities in a group of dairy heifers

If the dominant/subordinate relationships have been studied well, affinities have received less attention. However, affinities between particular animals seem to be the consequences of the life together during the first months after birth. Two calves that have been reared together after birth during the first 9 months, are observed more together in pasture than with the other animals when all the calves are in the same group (Ewbank, 1967). Bouissou and Hovels (1976) have also shown that animals reared together during the two first years are more tolerant (they ate more together) in a situation of food competition than when they are placed with animals only gathered with them two months before the test (Fig.20). This difference persists one year after the gathering (Fig.20). Lastly, Bouissou and Andrieu (1978) compared calves gathered just after birth, at 6 months or at 12 months. The earlier they were gathered, the more tolerance and affinities (proximity, higher frequency of non agonistic interactions and lower frequency of agonistic interactions) they showed between themselves. All these results allow the supposition that there exists a sensitive period to establish affinities between cattle.

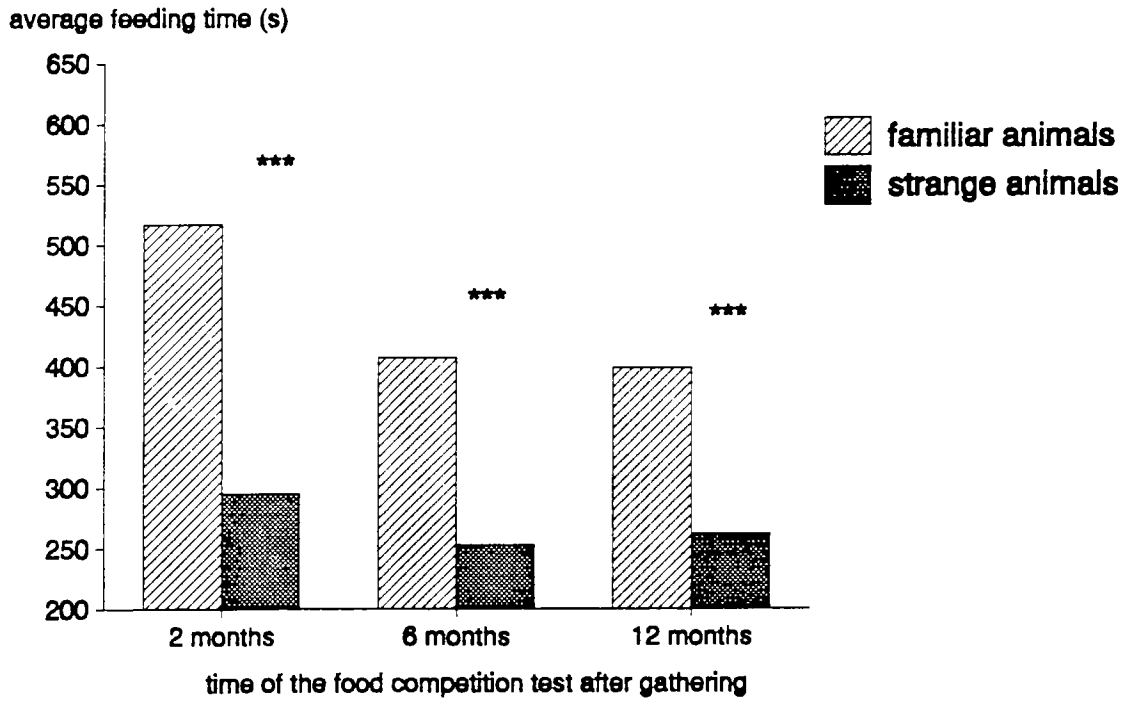


Figure 20:
Duration of the feeding in a food competition test with 2 year old familiar or strange heifers
(Bouissou and Hovels, 1976)

2.3. Conclusion: Importance of the social characteristics of cattle for human rearing practices.

Hale (1969) considered the existence of large social groups and of a social hierarchy between animals as main characteristics for the domestication of a species. We have seen previously that young animals are progressively integrated in the social group and a sensitive period could be supposed for the establishment of affinities. Humans can use this characteristics to more easily habituate the animals to human presence. In addition, animals are prone to follow a hierarchy with few changes after its establishment. If the humans can take the place of the dominants in the herd, animals can easily respect them, be less dangerous and easier to handle. The fact that animals are social and want to stay together facilitate the leading of the flock.

But these favourable characteristics also have disadvantages. A cattle is a social animal and one of the main difficulties of the farm practices is to isolate an individual for ,for example, medical treatment or prophylaxis. The two experiments described below show how important it is to avoid isolating cattle from the other animals:
Boissy (1990) showed clearly that an isolated animal is stressed. A one year old heifer was put in cage with non-tested animals in the front of the cage (Fig.21). After three seances of 21 minutes for habituation to the testing situation and to the movement of a human at seven minutes, a test session was performed as in Figure 22. The non-tested animals were removed from the pen at seven minutes. The behaviour of the tested animal and its heart rate were recorded during the test. Its blood cortisol (stress hormone) level at the beginning and at the end of the session were also recorded. The results showed no variation during the human entrance in the different parameters recorded during the last habituation session (Fig.23). In contrast, when the non tested animals were removed during the test session, the tested animal moved a lot during 41.4 % of the time when it was alone and its heart rate increased significantly (Fig.23). The cortisol level increased significantly between the beginning and the end of the session (Fig.23).

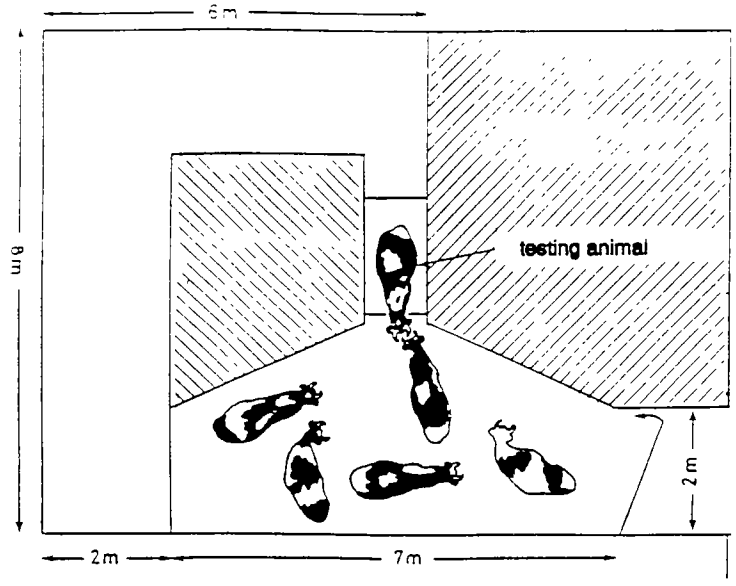


Figure 21:
Reactivity of heifers to isolation
(experimental design; Boissy, 1990)

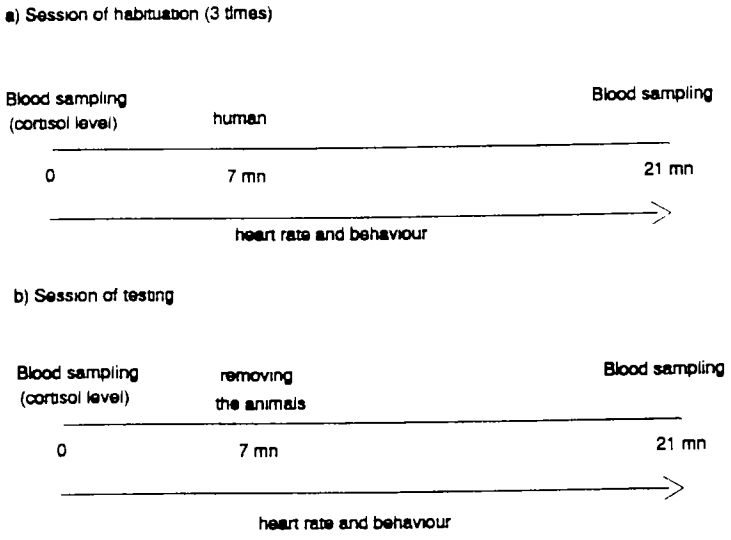


Figure 22:
Reactivity of heifers to isolation
(experimental process)
(From Bouissou, 1990)

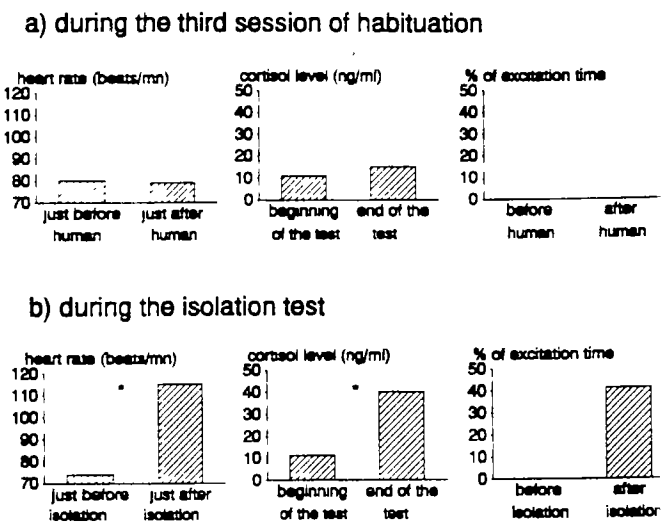


Figure 23:
Reactivity of heifers to isolation
(results; from Boissy, 1990)

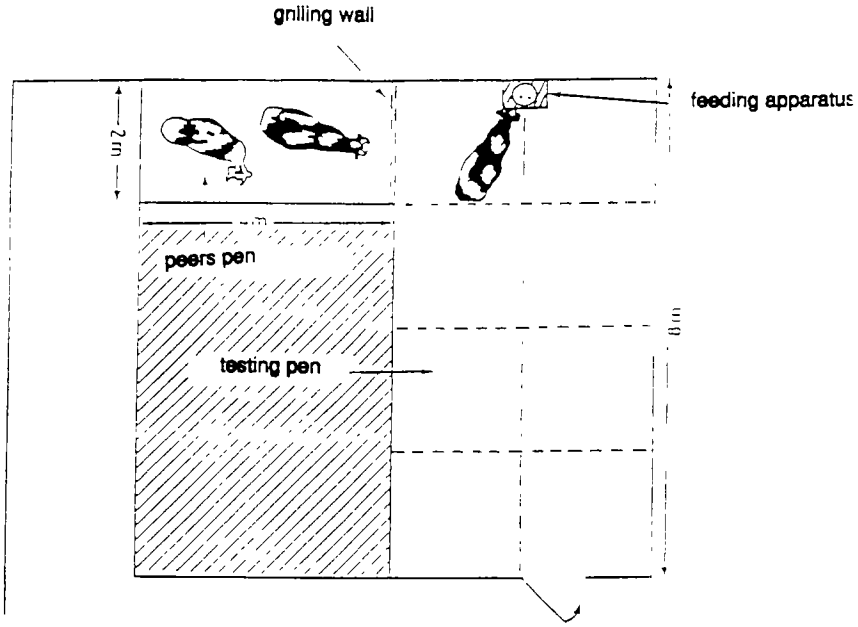
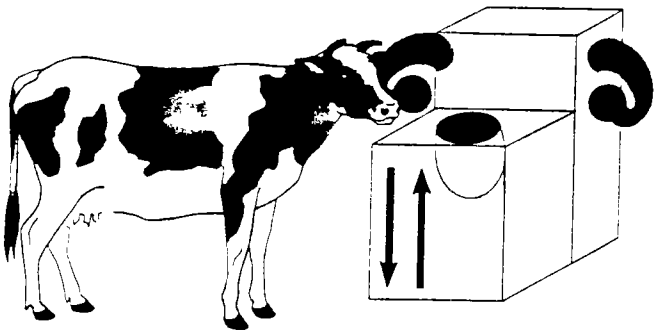


Figure 24:
Adaptation of isolate heifers
(experimental design)
(Boissy and Le Neindre, 1990)



+ 15 mn per session

+ Duration of reward: 30 secondes

+ End when the animal has eaten
2 mn 30

Figure 25:
Adaptation of isolate heifers
(experimental design)
(Boissy and Le Neindre, 1990)

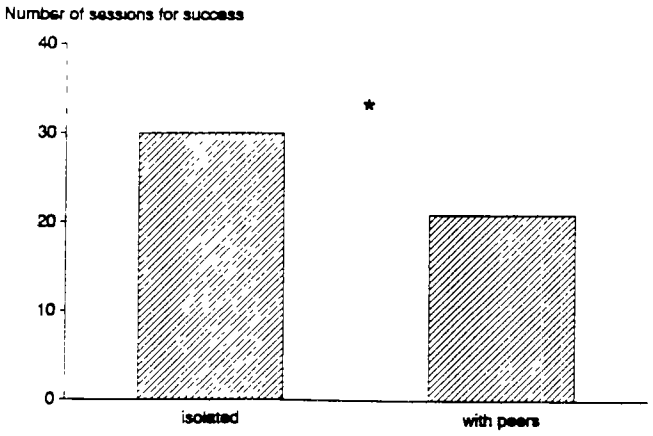


Figure 26:
Adaptation of isolated heifers
(results; Boissy and Le Neindre, 1990)

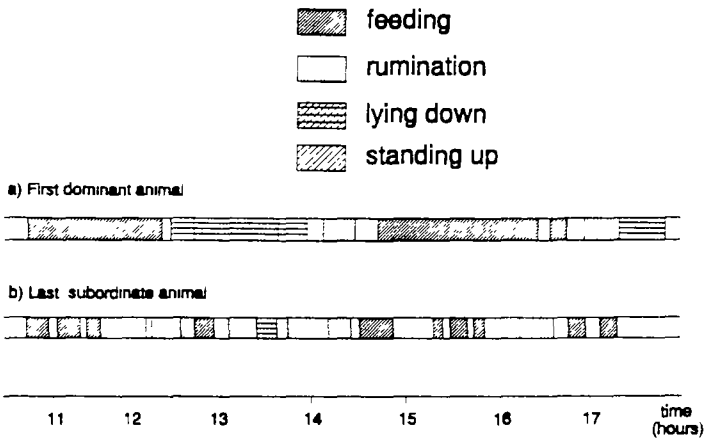


Figure 27:
Influence of the hierarchical rank
on activity rate of free-stalling heifers
(Bouissou, 1964)

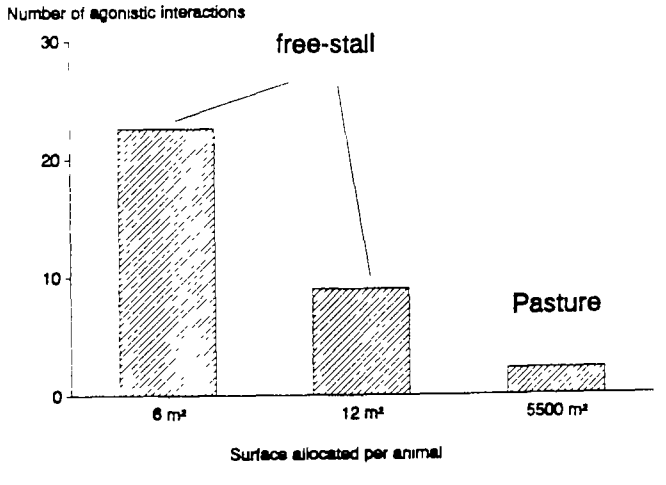


Figure 28:
Frequency of agonistic interactions
with varying space allocated to the animals
(from Signoret and Bouissou, 1971)

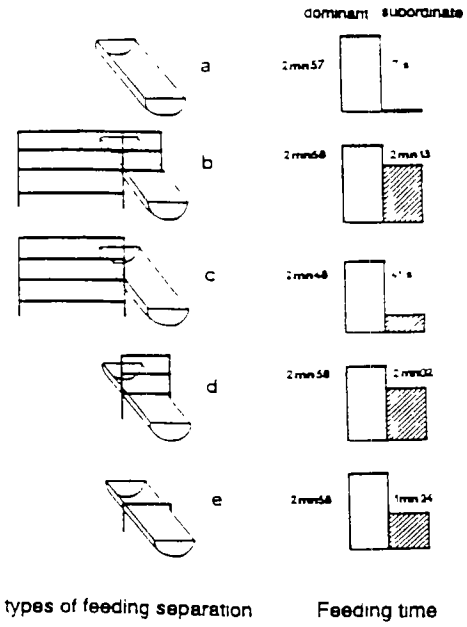


Figure 29:
Effect of the type of separation on
the feeding time in a competition test
(Signoret and Bouissou, 1971)

The isolation could also decrease the ability of adaptation to a new situation (as can be the case when farming practices are changing). Boissy and Le Neindre (1990) has shown that range animals are less able to learn a new task when they are isolated from the other animals. The design of the experiment is shown in Figure 24. An animal was put alone in a room and could or could not see an animal in a juxtaposed pen separated by a grilling wall. An apparatus with two buttons and a bucket of pellets that could go up and down was put in the testing room (Fig.25). A human that could not be seen by the animal regulated the movement of the bucket. If the bucket was in the low position, the animal could not eat.
The human tried to teach the animal to press one of the two buttons to obtain the food reward. The process of learning was first to habituate the animals to eat in the motionless bucket. Then, the human led progressively the animal to push the button with a reward (bucket in high position and 30 seconds of feeding) for each movement toward the direction of the button. The duration of the learning session was 15 minutes but could be stopped if the animal ate during two minutes in the bucket. This session was repeated once a day. Half of the animals were tested with animals in the juxtaposed pen. The other half were tested alone.
The results showed that animals alone have more slowly learned the task ($p < 0.05$) than animals toogether with non-tested animals (Fig.26). The main explanation is that isolated animal are more stressed by the situation and the movement of the bucket. So, they are less able to be adapted to this new situation.

The hierarchy, if it is an advantage as we have explained, also constitutes a great problem. It is usual that artificial conditions provide competition situations for, e.g., food or lying place. As shown by Figure 27, the daily cycles of activities are completely different in dominant and subordinate animals (Bouissou, 1964). The number of agonistic

interactions is dependant on the density of animals (Fig.28). The smoller the place available for the animals, the more hits were received by the subordinates from the dominants. The quantity of food eaten by the animal depend on the design of the place where the food is put (Fig.29). A protection for the head (e.g.: Fig.29 b and d) is essential to increase the feeding time for the subordinate animals.

All these examples showed that the welfare and economical performances of the animals can be greatly influenced by the social behaviour of the animals. These factors are well-known by the farmers and different ways have been found to solve these problems (e.g.: automatic distribution of concentrate). But many problems subsist or are created by the development of the modern husbandry, as for example the transport of the animals and the design of slaughter places (several millions of Francs of dark meet are lost each year in France).

3. Part II: The human/cattle relationship

3.1. The human/animal relationship in farm animals (general review)

Animals have always taken a great part in the human environment (Fig.30). They provide to the human society food, clothes, protection and pets. They are used for work and for transport, in fights between them or with humans (corrida), in sport competitions and shows (circus) or showed in zoos for the human pleasure. They also were taken and are taking a great place in the religions (sacrifices, sacred animals in India and Egypt, animal gods and metempsychosis). Lastly, new researches in psychology and sociology have showed the importance of the animals in the human social life or for helping the education of handicapped children.

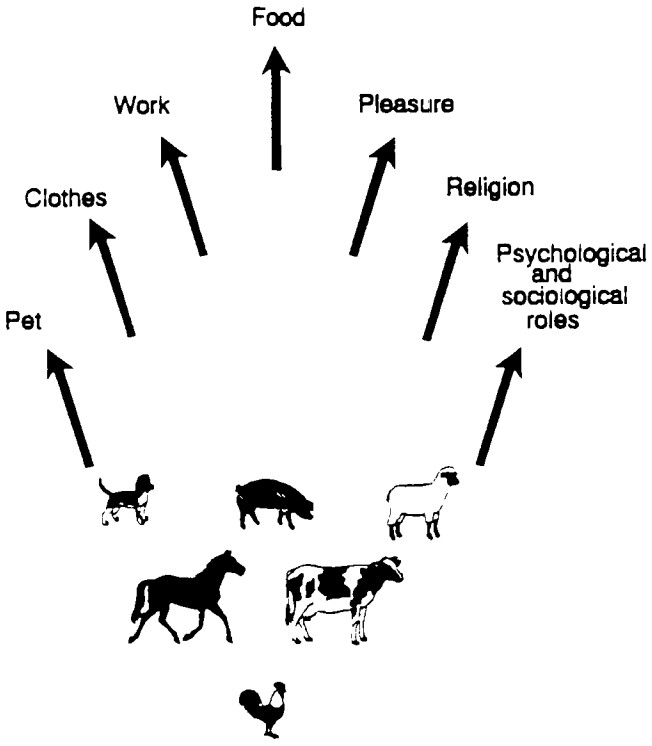


Figure 30:
Use of the animal in the human society

Three concepts are used to classify the animals according to their relationships with human: wild, tame, domestic.

1- A wild animal is an animal that flies away from the human presence. This concept is usually linked to a natural habitat for the animal (Clutton-Brock, 1987).

2- A tame animal is an animal that is not wild. It never flies from the human presence (Hediger, 1964). Price (1984) defines the process of taming as an experiential process (habituation, associative conditioning, or imitative learning) during the life of the animal. Clutton-Brock (1987) thinks that taming is obtained by a dependance of the animal to obtain something from the humans.

3- A domestic animal is an animal which as gone through "the process by which a population of animals becomes adapted to man and to captive environment by some combination of genetic changes occurring over generations and environmentally induced developmental events reoccurring during each generation" (Price, 1984).

It is sometimes difficult to classify the animals according to these categories. Because taming and domestication are processes, a continuum exists between these three concepts and some species can be found in intermediate states.

The "symbiosis" between animals and humans involved in the domestication, is recent compared to the history of mankind. The first association was found between humans and dogs for pet and hunting 14.000-12.000 years BC.

The animals used for farm production were mainly birds and mammals. Table 1 shows the archaeologic time for the rearing of the main European farm species. The oldest farm animals are the sheep 11.000 years BC. Then pigs and goats are reared since 7.000-6.000 BC. They were probably attracted by the human activities (agriculture and refuses).
The large ungulates were used in different ways by the human populations. The American indians followed the bisons in order to hunt them. Lap communities control the movements and the breeding of reindeer flocks. Our cattle, as the sheep, were probably attracted by the cereal agriculture and it is usually written that Bos primigenous (ancestral cattle) started to be reared since 6.200 BC. But in recent archaeologic studies, Wendorf et al (1990) found 9.000 years old bones from domestic cattle in Egypt, before the cereal agriculture!
The horse is the last large species to be used by humans (3.500 BC). The usefulness of the horse is essentially transport and work. For these two reasons, the development of this species in human societies was particularly fast.
Lastly, the earliest period for the farm use of hens is estimated between 3.000 and 2.000 BC. It is usually agreed that this species was at first used for cocks fights.

All these data show that we have spent several thousands of years in close contacts with the farm animals. Thus, a great empirical knowledge exists among farmers about the human-animal relationships. However several applied reasons make it necessary for us to understand better the reaction of the animals towards human:

- Sheep:	11.000 BC	
- Pig:	7.000 - 6.000 BC	
- Goat:	7.000 - 6.000 BC	
- Cattle:	6.200 BC	(9.000 BC?)
- Horse:	3.500 BC	
- Hen:	3.000 - 2.000 BC	

Table1:
Archaeological dates for the beginning of the rearing of the main European farm species

1- The empirical knowledge is not available to all people and it is hard to record. The number of farmers is decreasing quickly in Europe and their practical knowledge could easily be lost.

2- This knowledge is also hardly adaptable to the new situations. During several centuries the ways of rearing had changed very little. But the modern husbandry brought many different environmental conditions into use. The number and the quality of contacts between humans and animals are today greatly changed. All these changes lead to an alteration of the human/animal relationships and the empirical knowledge can not always help to solve the new problems which arise.

3- The human factor has always about been considered as negligible for the husbandry or impossible to learn by the farmers. For the first point, recent studies have demonstrated that the human factor could have great consequences for the production of the farm animals (see chapter I). For the second, many farmers believed that they were born with or without the skill for rearing the animals. Seabrook (1972, see Chapter II 3b) has in fact found an effect of the psychological profile of the stockman on the dairy production. But recent scientific studies allow us to understand better how the behaviour of the human and the rearing conditions influence the reactions of the animals (for example, see Chapter II 2 and 3). So, it seems possible to learn better ways to behave during contact with the animals and when rearing them.

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4- The welfare and the security of both caretakers and animals are today important aspects of the husbandry. The human/animal relationship is sometimes considered as the main factor of bad welfare for the animals. Indeed, the caretaker has a particular role in the farm. The animal could perceive him as a feeder, a social partner (positive association), but also as a predator (negative association). In this last case, the animals are obligated to accept the close presence of a predator without escape. A chronic stress in the animal can be induced by this relationship between humans and animals (see Chapter II 3a). Fear and aggressive reactions can also be induced by this situation, and the risk of accident to both humans and animals is increased considerably. The caretakers are probably also stressed by this situation.

5- The studies of human/animal relationships could allow us to better understand the processes of domestication. If it is interesting to know how the common farm species have been domesticated, this knowledge could also be useful to domesticate new species well adapted to their regions or to create alternative productions (ex: roe deer).

The aim of this presentation is to demonstrate the importance of studies on the human/animal relationship, especially in cattle husbandry. The first part of this presentation is a quick bibliographic review that presents the pertinent factors involved in the human/animal relationship and some consequences for the management. The second part presents our experiments on cattle/human relationships, performed at the I.N.R.A. of Theix (France).

3.1.1. Example of influence of the human/animal relationships on different management parameters

3.1.1.1. Influence on the food efficiency, growth rate and reproductive performance of domestic pigs

Hemsworth et al. (1987) showed that the quality of the interaction influences significantly the growth rate and the feed conversion efficiency of young pigs. The animals were allocated in two groups and were handled positively (stroking) or negatively (hit or short electric shocks) when they tried to approach the human. The handling was performed individually for three minutes, three times per week, from seven to 13 weeks of age (Fig.31). Figure 32 shows that growth rate and feed conversion efficiency are higher for the animals handled pleasantly than for animals from the other group.
In another experiment with the same handling procedure, five minutes, three times per week, since 11 weeks of age, Hemsworth et al. (1986) assessed the influence of the type of handling on male and female reproduction (Fig.33). They controlled the pregnancy rate of female pigs, 40-60 days post mating and the sexual behaviour of the males and the size of their testicles. Figure 34 shows that male pigs handled pleasantly had a complete sexual behaviour earlier ($P < 0.01$) and their testicle were larger at 23 weeks than animals from the other group. The percentage of pregnant female pigs was significantly higher for the group handled pleasantly ($P < 0.05$) than for the other group.

3.1.1.2. Influence on the milk production of dairy goat

Lyons (1989) investigated the influence of the rearing conditions after birth on milk production in dairy goats. Female kids were allocated in two groups (Fig.35). Animals from the first group were reared artificially with a multi-nipple bucket of milk. The animals from the other group were suckled individually by the mother, with few contacts with humans. All kids received the same rearing conditions after 14 weeks. At 23 months of age, parturition occurred and goats were milked mechanically and handmilked for the remaining milk. Every third day and during the 20 days after the second day after the parturition, each goat received an injection of oxytocin to measure the residual milk non-extracted by the normal procedure. Figure 36 shows that the percentage of non-extracted milk was higher at the beginning of the milking state for the dam-reared animals ($P < 0.001$) than for the artificially reared animals.

3.1.1.3. Influence on the milk production of dairy cattle

Seabrook (1972) reported different observations allowing to suppose that the caretaker could have a great influence on the milk quantity produced by his cows. He observed the production per cow on 12 farms with a single high-qualified caretaker. The same mamagement characteristics were found in each farm (same system of production): about 70 cows/herd; same food, spaces, houses, equipment, type of pasture and genetic potential. Eight farms were studying for 6 years without change. The caretaker was

changed once or twice during the same period in the four other farms. Table 2 shows that great variations in the milk production were observed after the change of the caretaker (once more than 1000 kg of milk/cow/year) . These variations were mostly higher than the highest variation observed among the eight unchanged farms.

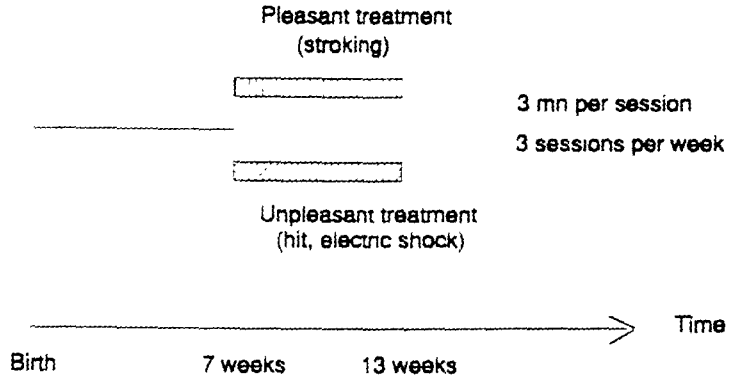


Figure 31:
Influence of the behaviour of the stockman on the growth of young pigs
(experimental process)

(Hemsworth et al., 1987)

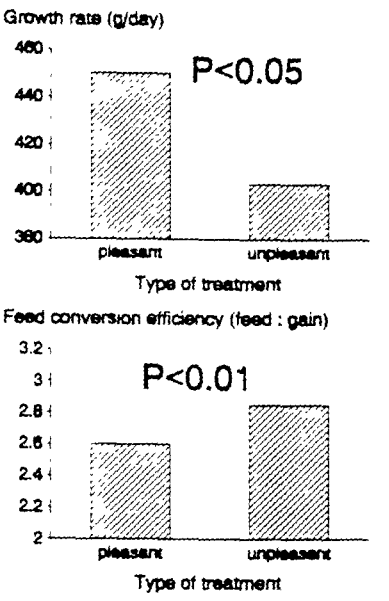


Figure32:
Growth of pigs in relation to the quality of the human/animal relationship

(Hemsworth et al., 1987)

3.1.1.4. Influence on the food efficiency and immune responses of chickens

Gross and Siegel (1982) investigated the influence of gentling (catching, stroking, food reward) with chickens during one week (90s-120s) per day at five weeks of age on food efficiency and immune response (Fig.37). Figure 38 shows that gentled animals had a higher food efficiency and a higher immune response to Mycoplasma Gallisepticum and to an artificial antigen than control animals. A high resistance to diseases is of course very important to obtain high zootechnical performances.

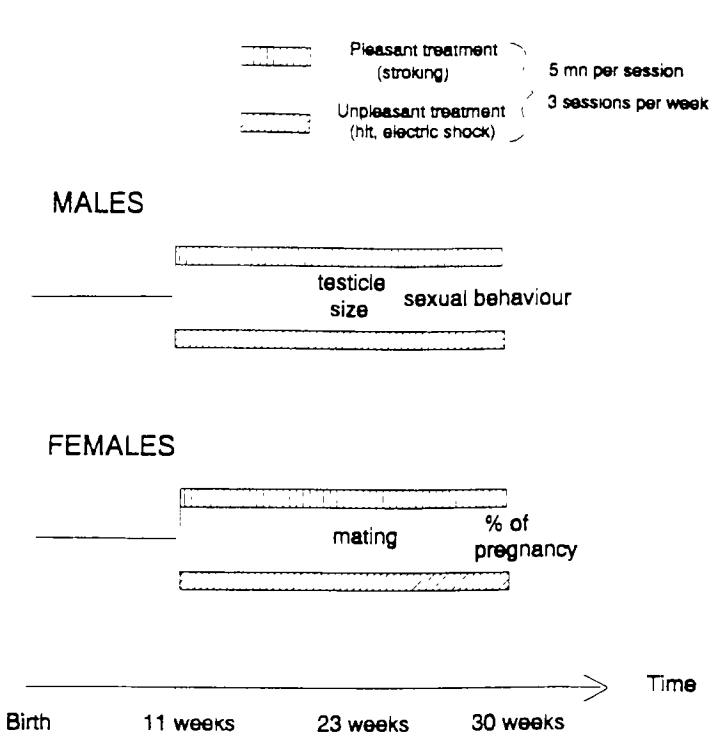


Figure 33:
Influence of the behaviour of the stockman on the reproduction of young pigs (experimental process)

(Hemsworth et al., 1986)

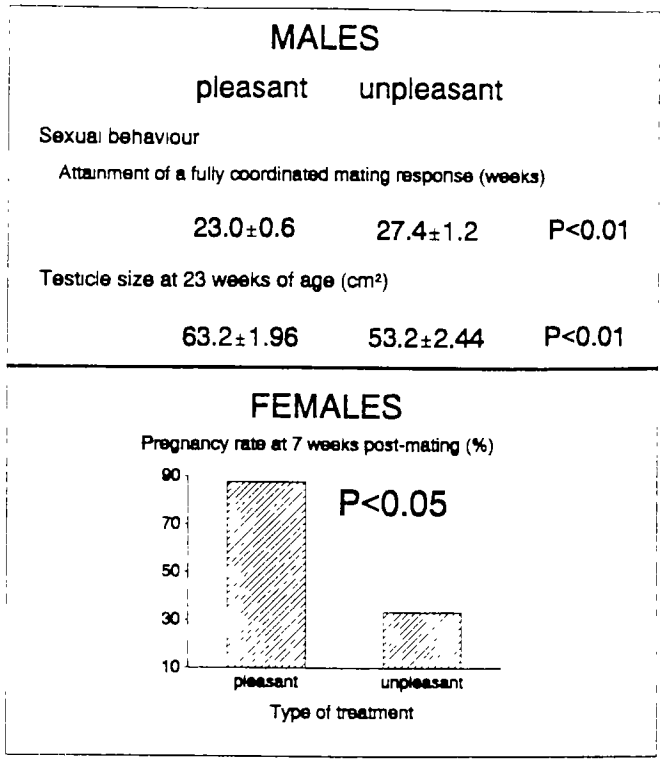


Figure 34:
Reproduction of male and female pigs in relation to the quality of the human/animal relationship
(Hemsworth et al., 1986)

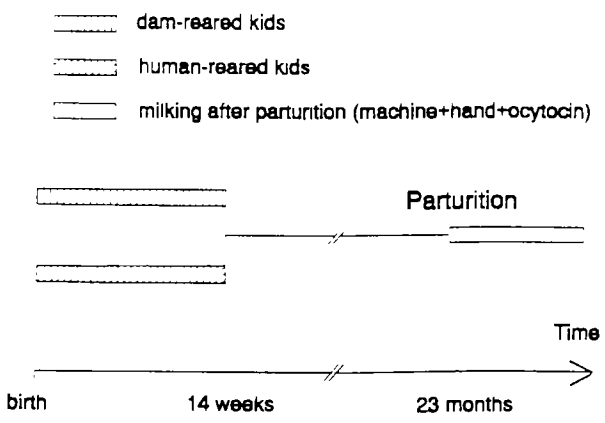


Figure 35:
Influence of rearing conditions in early age on milk production of goats (experimental process)
(Lyons, 1989)

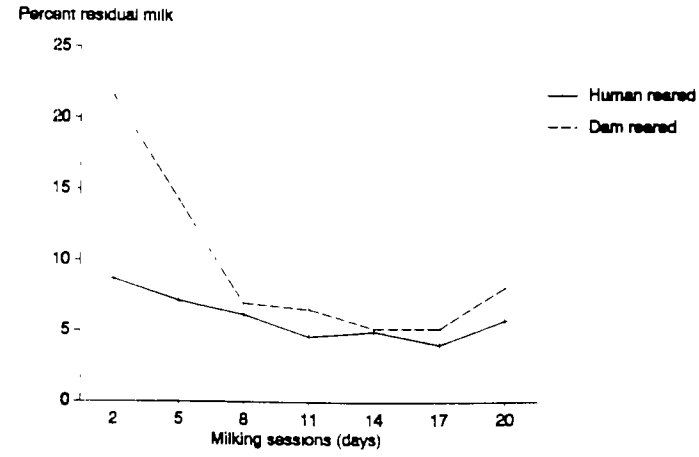


Figure 36:
Mean residual milk scores of dairy goats in relation to their rearing conditions
(Lyons, 1989)

3.1.1.5. Influence on other economic parameters

All these experiments concern zootechnical performances of the animals. But several other economic losses are related directly to the human/animal relationship: animals (especially horses and cattle) must often be slaughtered for their poor reactions toward humans or by their weak production; other animals can be lost by accident during handling; dark beef is likely to be induced by strong reactions to transport or to handling. This represents a great loss for the meat production; the time necessary to handle strongly reacting animals and the risk of accidents are also important economical factors when, today, the modern farmer has not much time to spend with his animals.

3.1.2. Relevant factors of the animal reactions towards man

3.1.2.1. Existence of genetic factors

As it has been defined previously, domestication is a process that select animals for particular characteristics related to the human use. One of the main characteristics is of course the reactivity towards humans. Different experiments have showed the presence of genetic factors in this reaction. Murphy and Duncan (1977,1978) compared two stocks of hens reared under the same conditions. Hens of one stock approached the humans, while hens of the other flew away. In the same way, Bos indicus (zebu) reacts more strongly to a cage situation than Bos taurus (our cattle) (Hearnshaw et al., 1979). Murphey et al. (1980) showed that the flight distance (distance from an approaching human when an animal flies) is greater in beef than in dairy cattle when they are reared in the same conditions.
Heritability coefficients have been estimated for the reactivity of animal towards humans. For example, this coefficient is 0.38 with pigs for the time of first interaction with humans in an encounter test (Hemsworth et al., 1990). Dickson et al. (1972) found a heritability of 0.47 for the reaction of dairy cattle during the milking process. These values are changing with the type of test, but they are sufficient to make it possible to increase the frequency of this characteristic in the population.
Lastly, Belyaev et al have selected foxes (Vulpes fulvus) for 25 years for their reactions to humans. Figure 39 from Trut (1981) shows the changes in the frequencies of aggressive behaviour and tameness in the selected populations.

12 "One man farms" observed during 6 years

- 70 cows per farm
- same genetic potential
- same technical characteristics (space, machines, ..)

8 farms without change of the cowman

average milk production:	2907.6±246.0 kg/cow/year
average variation between two years:	139.2±105.9 kg/cow/year
maximal variation between two years:	395 kg/cow/year

4 farms with a change of the cowman

	average milk production before the change (kg/cow/year)	year of the change	change in the milk production (kg/cow/year)
1)	2398.0±22.3	4	+568
2)	3075.0±147.9	5	-1096
3)	2777.0±255.4	4	+427
4)	3127.0±64.3	2	-341
	2834.0±3.5	4	-464

Table 2:
Influence of change of cowman
on the milk production
(from Seabrook, 1972)

3.1.2.2. Existence of experiential factors

a) Habituation to the human presence or to the human handling

Several studies have demonstrated that the habituation to human presence and repetition of handling can decrease the reactivity of the animals towards man (Fordyce et al., 1985; Boissy and Bouissou, 1988...). For example, Hargreaves and Hutson (1990) studied the flight distance and the heart rate of sheep before and after the repetition of imitated sham shearing, once a week during five weeks. They demonstrated in other studies that this handling is stressful for the animals. For the observations, the animal was placed in a cage at the end of a 1.5 m wide race as drawn in Figure 40. They measured the flight distance and the heart rate at this flight distance and at 1 meter from the animal. Figure 41 shows that after the sham-shearing process, animals have a lower flight distance and a lower heart rate than before the handling. Thus, the habituation to handling seems to decrease the animal's fear of humans.

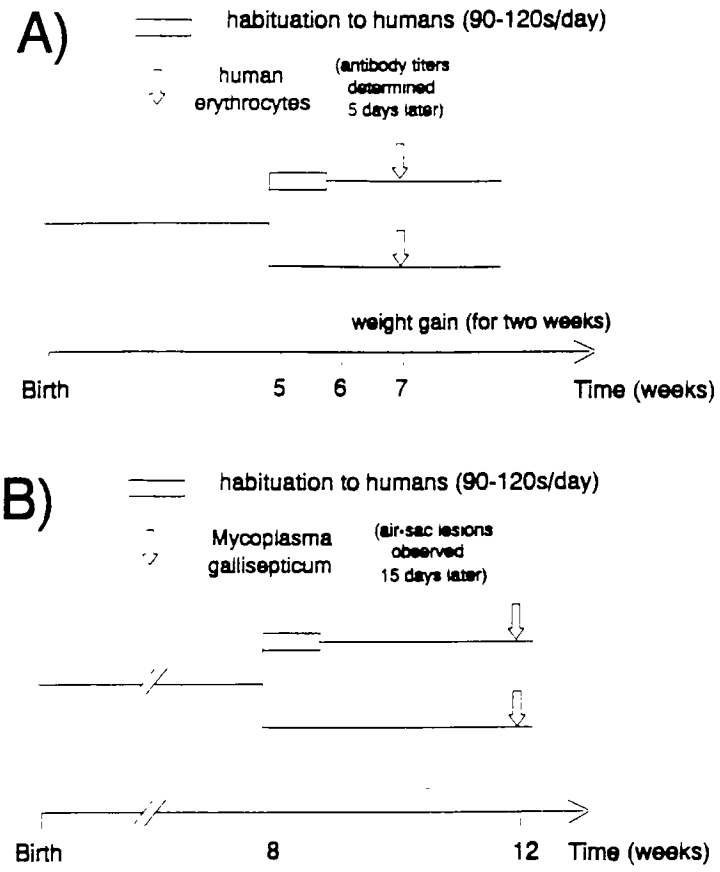


Figure 37:
Influence of habituation to humans on the physiology of chickens
(Gross and Siegel, 1979)

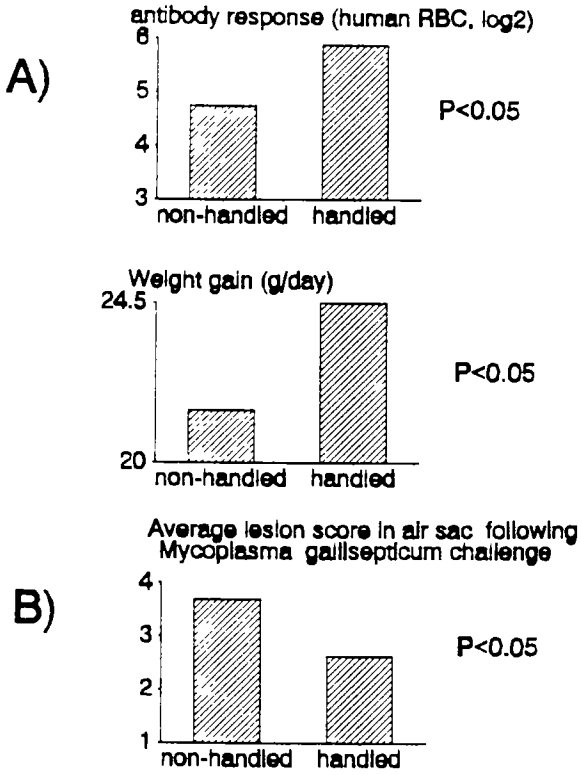


Figure 38:
Physiological reactions in chickens following a habituation period to human contacts
(Gross and Siegel, 1979)

b) Influence of early handling

The influence of events during the early age on ontogenesis is well known in many fields of Biology and especially in behavioural studies. Different experiments with different species have demonstrated that early handling by humans could have a strong effect on the human/animal relationship. For example, famous experiments by Konrad Lorenz (1935) have demonstrated that goose followed the human being as they follow the mother if he was present at hatching time. In the same way, Csermely et al. (1983/84) has demonstrated that the sight of a human by red partridges (Alectoris rufa) during the first 48 hours after hatching, decreases the later fear of the birds towards humans.
With mammals, the clearest evidences of such critical periods have been found in dogs (Freedman et al., 1961) and in foxes (Belyaev et al., 1984/85). Freedman et al. (1961), for example, reared dogs after birth in a pen with very little contact with humans. Some animals were removed from this pen at 2, 3, 4, 5, 7 or 9 weeks and handled gently with

food three times per day during one week (Fig.42). After the handling week, animals were put with the other dogs again and not handled for some time. Animal reactions were assess at 14 weeks with a leash control test during which the animal also received food. Figure 43 described the average number of balks when animals were led with a leash and the eating time during this test.
The animals non-handled during the 14 first weeks (control group) behaved as wild animals (threatening and biting attempts). The animals handled before 14 weeks were more quiet but the animals handled between 5 and 9 weeks were the most easy to lead with the leash. Those handled between 6 and 7 weeks had eaten most during this test. Later taming of animals from the control group required the same process as used for wild animals.

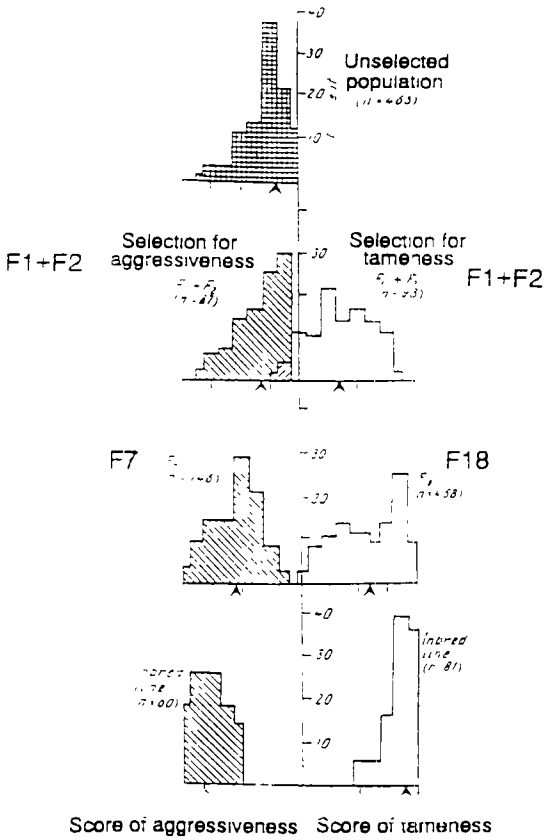


Figure 39:
Selection of silver foxes with respect to their behaviour towards humans (friendly or aggressive foxes)
(Trut, 1981)

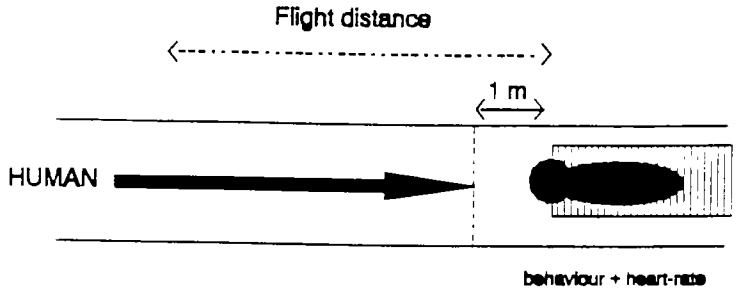


Figure 40:
Procedure to measure the flight distance and the heart-rate in sheep before and after a period of simulated sham-shearing
(from Hargreaves and Hutson, 1990)

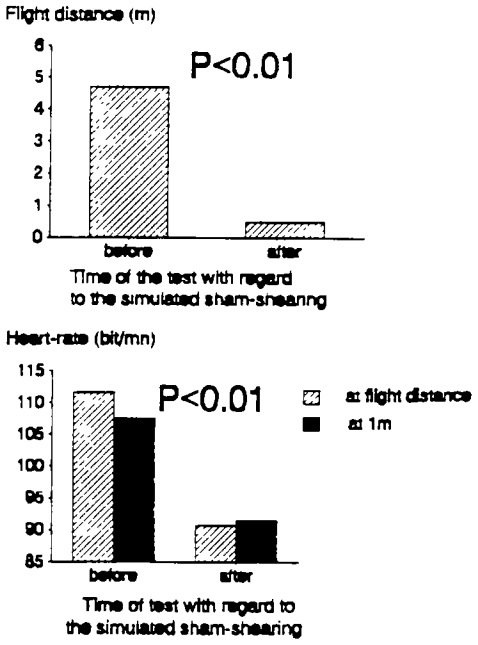


Figure 41:
Flight distance and heart-rate of sheep before and after a period of simulated sham-shearing
(Hargreaves and Hutson, 1990)

c) Behaviour and psychological characteristics of the caretaker

α) Influence of the quality of the interactions between humans and animals

Clear evidences show that the behaviour of the caretaker can modify the human/animal relationship and induce a chronic stress in farm animals. Hemsworth et al. (1986) allocated 7-weeks old pigs in four treatment groups during seven weeks and handled the animals as followed: 1- no handling session; minimal contacts between human and animal. 2- three-minute session: pleasant contacts (stroking and talking) when a pig approached the human. 3- three-minutes session: unpleasant contacts (electrical shock) when the pig approached. 4- inconsistent treatment: pleasant and unpleasant sessions randomly imposed at a ratio of 5:1. Handling sessions were repeated three times per week (Fig.44). The animals were tested during three minutes by an unfamiliar human at the end of the handling treatment in a new pen. Figure 45 shows that the pleasantly handled animals interacted more and more quickly with the human ($p < 0.01$) than the animals

from the other treatments. The animals handled unpleasantly or inconsistently were not significantly different but interacted slowly and less than the animals from the two other treatments. Figure 46 shows that the secretion of cortisol (stress hormone) was significantly highest for animals from the unpleasant treatment. The secretion of cortisol was also higher for the animals with inconsistent treatment than for the animals from the two other treatments. The average basal level of free cortisol outside the test situation (chronic stress) was also significantly higher in the animals from unpleasant and inconsistent treatments ($P < 0.01$) than for those from the two other treatments.

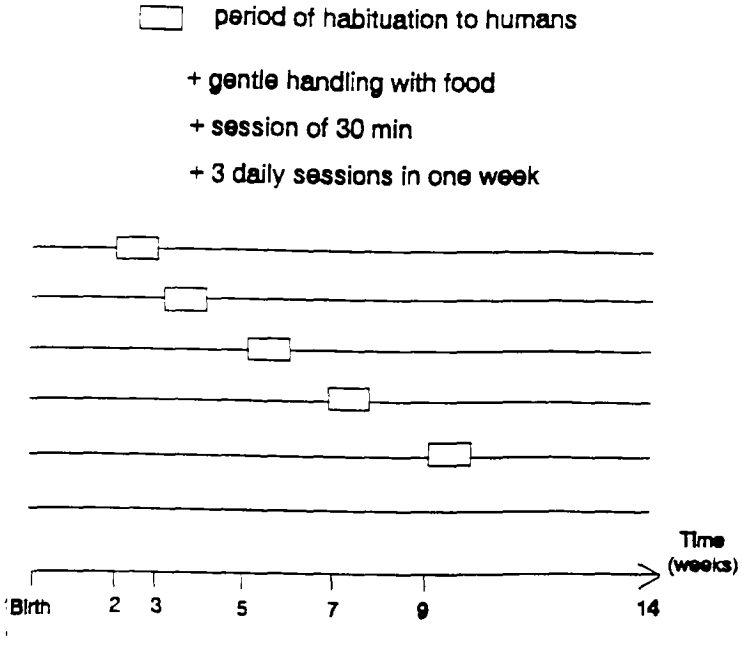


Figure 42:
Investigation of a sensitive period in dogs for their socialization to humans (Freedman et al., 1961)

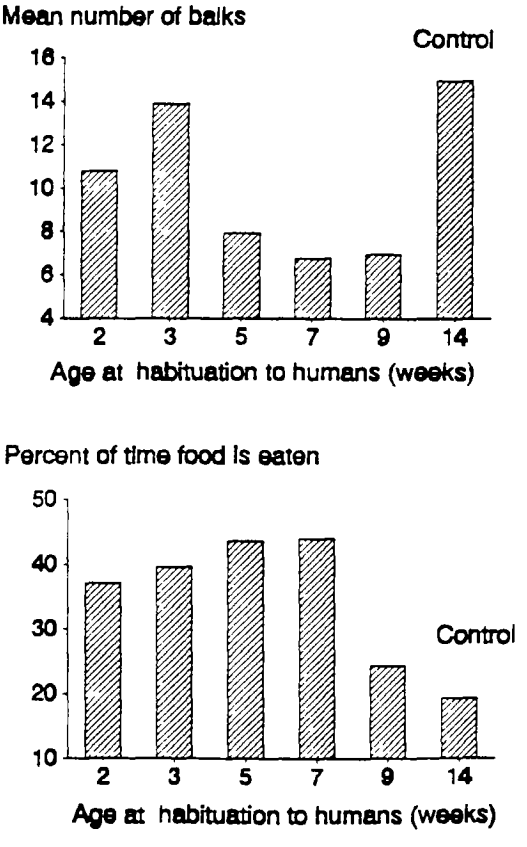


Figure 43:
Behaviour of dogs at 14 weeks of age according to their age at habituation to humans (Freedman et al., 1961)

- 3 min per session

- 3 sessions per week

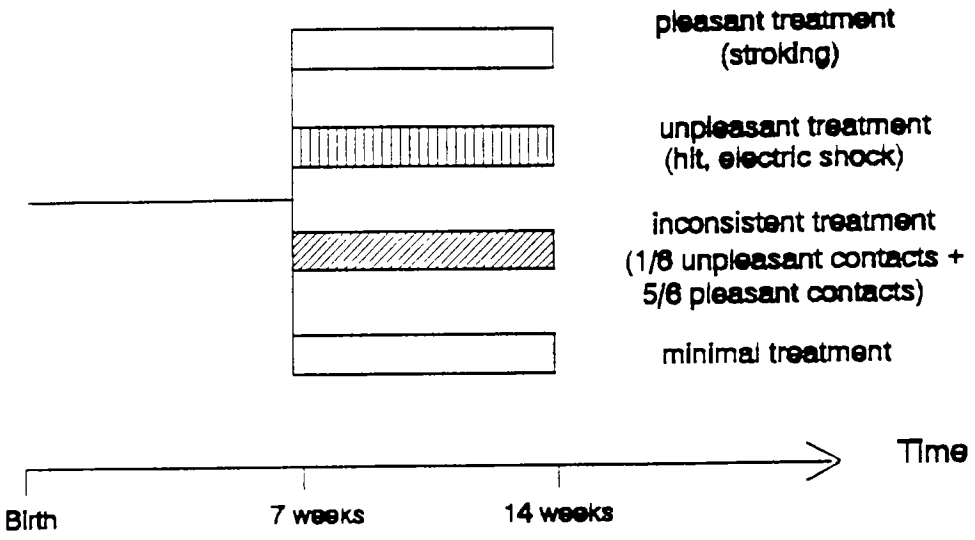


Figure 44:
Influence of the behaviour of the stockman on the pig reactivity to humans (experimental procedure)
(Hemsworth et al., 1986)

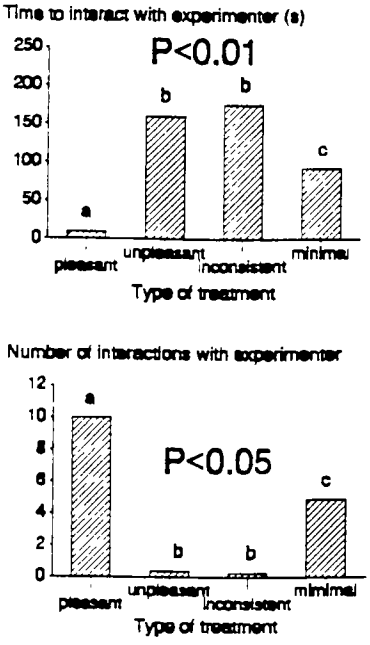


Figure 45:
Behavioural response of pigs in relation to the quality of the human/ animal relationship
(Hemsworth et al., 1986)

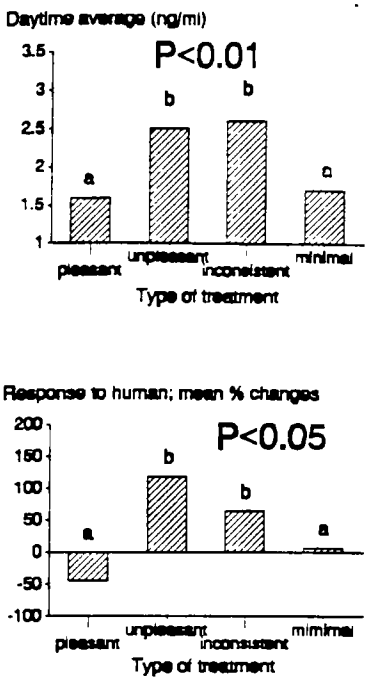


Figure 46:
Cortisol response of pigs in relation to the quality of the human/animal relationship
(Hemsworth et al., 1986)

ß- Influence of the psychological profile of the caretaker on the human/animal relationship.

Different studies have found a relationship between the behaviour or the level of production and the psychological profile of the caretaker. Renger (1975) studied the reaction of bulls in insemination centres towards their caretakers (Fig.47). Self confident and calm behaviour of the caretaker prevented aggressive behaviour and led to good human/animal relationship. In contrast, unsure or violent behaviours increased greatly the number of strong reactions from bulls. In the same way, Seabrook (1977) observed that the psychological profile of the stockman affected the quantity of milk produced by the cows (Fig.48). A good cowman is a self-confident, quiet and introvert person. Seabrook (1977) found no evidence that showed that the psychological characteristics of the caretakers influenced his technical skilfullness. But it is likely that the human/animal relationship and the behaviour of the caretaker towards the animals are greatly influenced by these psychologic factors.

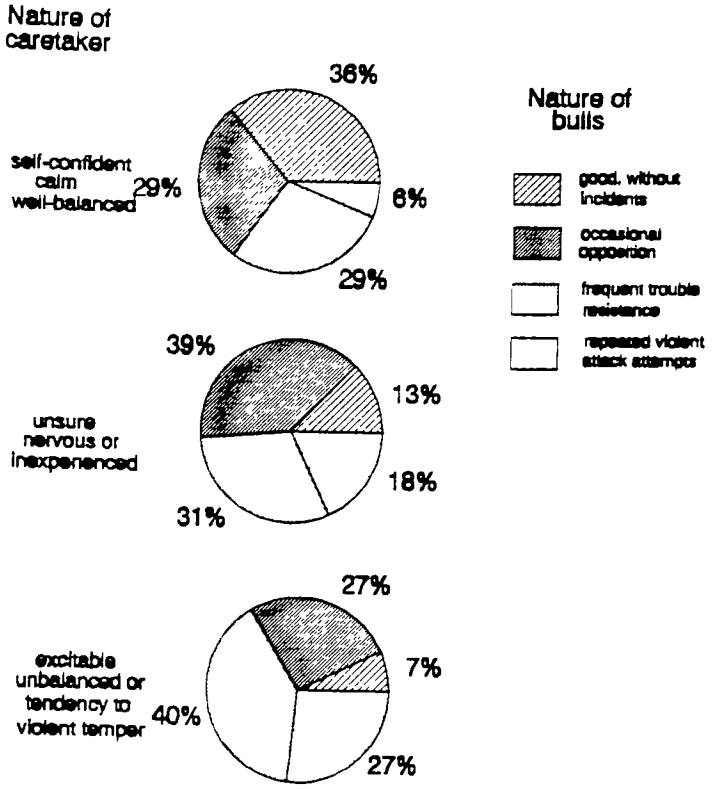


Figure 47:
Behaviour of bulls according to the psychological profile of the caretaker (Renger, 1975)

3.1.3. Conclusion

Experiments described above have clearly illustrated the existence of genetic and experiential factors in the reactivity of animals towards humans. However, even if a great empirical knowledge exists on this subject, few scientific studies are available. In addition, they are performed on several species
and thus little is known for each one. However many applied consequences are dependant on the human/animal relationships and the modern animal husbandry needs today a better understanding of this aspect of animal behaviour. Then and as we will see with cattle in the second part of this presentation, further research is required.

3.2. Investigation about the human/cattle relationship (X. Boivin, P. Le Neindre, J.M. Chupin, J.P. Garel)

The first part of this presentation attempted to show the great interest of studies about the human/animal relationship. Unfortunately, and especially with cattle, little scientific information could be found. However, there are several reasons to study the relationship

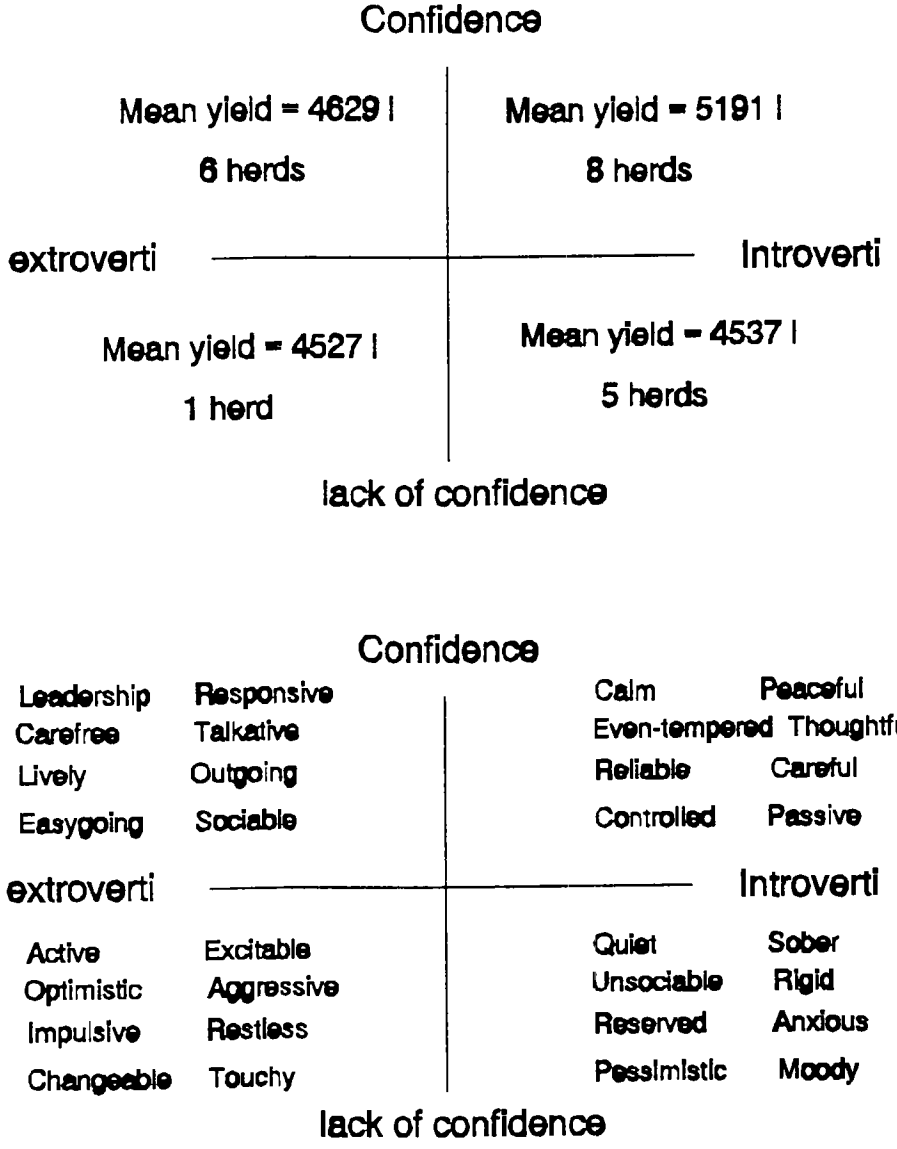


Figure 48:
Influence of the psychological profile of the cowman on the milk production (Seabrook, 1977)

between these large and forceful animals and their caretakers:

1- the practical interest of such studies is evident when it is known, for example, that 80% of the French farmers have handling problems with their cattle. Because of their weight and their strength, they need to be tamed and low reacting to avoid accidents and to reduce the time necessary for handling. As it has been discussed earlier, management parameters can also be dependant on the quality of the human/animal relationships.

2- There is a great genetic and environmental diversity in cattle breeding:

a) Several different breeds have been more or less selected for different types of productions (milk, meat, work,...).

b) Rearing conditions for young cattle could be classified into four general categories:

- the range conditions: animals are living all the time outside, almost without artificial conditions. The animals receive very few contacts with humans, especially during the first nine months after birth when the food is brought only by the mother (suckling) or available freely from pasture.

- the free-stall conditions: same number of contacts with humans as in the range conditions, but the animals are living in a stable (habituation to artificial environment). The caretakers are also closer than in the range conditions.

- the "traditional" conditions: the calves are separated from the mother one day after birth. The mother is tied and the calves are gathered in a small pen. Twice a day, the caretakers lead the calves to the mothers for suckling. The number of interactions between caretakers and the animals is high.

- the artificial suckling: the animals are separated just after birth from their mothers. The caretaker feeds the animals. A large number of contacts are given by the caretakers to the animals.

These different types of husbandry give different qualities and quantities of human contact to the animals during their early age.

This diversity in cattle husbandry gives the researcher a good opportunity to study the ontogenesis of human/animal relationships. It allows us study several genetic types of cattle under various conditions and to analyze the effects of the different factors and their interactions on the animal reactivity towards humans. It is actually important to understand this ontogenesis: the structures of the farm and the behaviour of the stockman must be well adapted to the new conditions imposed by the continuous development of the modern cattle husbandry.

To better understand the cattle/human relationship, different questions have been asked in our experiments:

- Can rearing conditions that provide little contact with humans induce strong reactions of

the animals during handling? In this case, how can we improve the human/animal relationship?

To answer this second question, we also need to ask:

- Are the quality, the quantity and the period of contacts essential in the ontogenesis of the human/animal relationship?

- Is there a genetic variability in the cattle reactivity towards humans that could allow us to select animals with these new criteria?

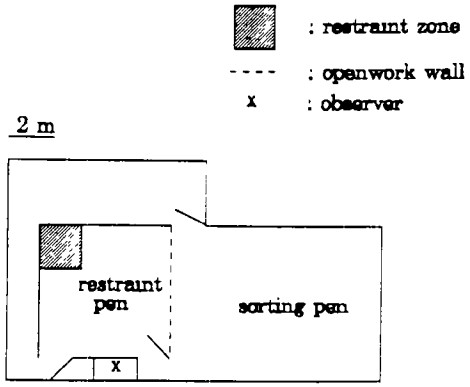
Tests to measure the reactivity of cattle to human presence and handling were imagined to answer these questions,. Then, our experimental work was divided into four parts: I) Elaboration of the handling test: influence of the human factor; II) Influence of the rearing conditions on the cattle reactions towards humans and handling; III) Genetic variability of the cattle reactions towards humans and handling; The same animals were used in the parts II) and III), but the study of these two factors is reported separately in order to better understand the results; IV) Research on sensitive periods of contacts to effectively adapt the cattle to humans.

3.2.1. Tests to measure the reactivity of cattle to human presence and handling (description)

The experimental procedures used to test the reactions of the animals were taken from practical situations: cattle are social and, thus, stressed when they are alone. They can be hard and sometimes dangerous to handle. Unfortunately, usual handling involves the separation of an animal from its social group with a close contact with the caretaker during handling. Thus, it appears essential to perform tests allowing to measure the animal reaction in these conditions and to try to improve their behaviour towards humans.

3.2.1.1. Restraint test

A group of about ten animals is placed in a 100 m^2 (Fig.49). Each animal is led to a pen with an area of 55m^2 contiguous to the sorting pen. An openwork wall allows the tested animals to remain in sight of the social group. The animal being tested remains alone for 30 s. The handler then comes into the pen and stand still for a period of 30 s. After this period, he tries to lead the animal into a corner opposite to the social group and attempts to force it to remain in this 4 m^2 zone for 30 consecutive seconds. The maximal duration of the test is 2.5 minutes. The test is stopped if the animal is restrainted 30 s or charges the handler. The test is always repeated at least twice non consecutively. The percentages of restraint by animal is calculated and the times necessary to restrain the animal for 10, 20 and 30 s in the corner are recorded. The number of aggressive animals and the number of tests in which the animals are aggressive are also recorded. In addition, the general activity of the animals (number of crossed squares, time spent motionless) is recorded during the test. It is important from the practical point of view that the animals reacted quietly (few movements) to all the situations in which the caretaker put them.



3 parts

1) animal alone during 30 s

2) animal with a passive human during 30 s

3) maximum of 2.5 min to lead the animal into the corner and keep it inside during 30 consecutive seconds

===> End of the test if the animal charges the handler

Figure 49:
Enclosure used for the restraint test

3.2.1.2. Test in a cage

As in the previous test, a group of about ten animals are placed in a 100 m2 enclosure. Then each animal is led to a cage (Fig.50). The experimental process: after the entrance into the cage, the tested animal stays alone for five minutes. Then a human comes and stopps 1 meter in front of the cage. After 30 s, he strokes the head of the animal during 30 s. Then he leaves the sight of the animal. After one minute, the same process is repeated. The heart rate is measured during the whole test. The cortisol response (stress hormone) is assessed by the difference of concentration between blood samples taken at the beginning of the test and 10 minutes after the test.

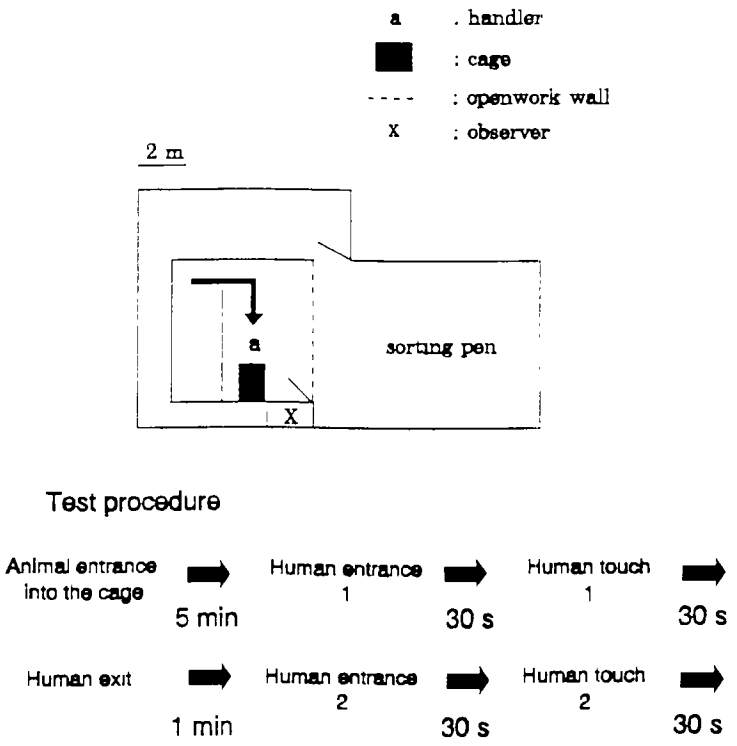


Figure 50:
Enclosure used for the cage test

3.2.2. Experimentation

3.2.2.1. Elaboration of the restraint test: influence of the human factor

a) Factors of variation in the reaction of cattle reaction during the restraint test.

This experiment was performed to assess the parts of the variation which was due to the animal and to the human parameters. Fifteen male calves from the French mountain breed Salers were used. Seven were reared traditionally and eight in free-stall conditions. Ten caretakers, with different accents and different ages, were used. They were coming from different regions in France. All were very experienced with animal handling and were at the end of period of handling training. All were also unfamiliar to the animals. An incomplete balanced block schedule was used: all tests (4 per animal and 6 per caretakers) were performed on a single day. This procedure reduced the number of tests from 150 to 60 in comparison to a complete balanced schedule. The time necessary to restraint the animal was analyzed. Animals showed a pronounced individual variation ($P < 0.01$) but no significant effect of the caretaker was found.

b) Influence of handlers familiar to the animals during the restraint test

Three groups of 14 Salers or Salers X Charolais calves were used. The calves were

between four and five months old and were reared in three I.N.R.A. farms. Two groups were reared traditionally and one group was reared in range conditions.
Three groups of two caretakers from each farm who reared the animals and two unfamiliar caretakers handled the animals during the restraint test. An incomplete balanced schedule was used (four tests per animal, seven tests per caretaker).
No difference was found between the familiar and the unfamiliar caretakers in animal performances during the test. (Fig.51).

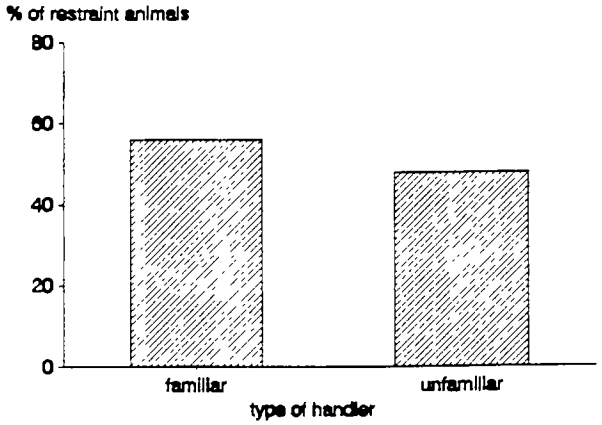


Figure 51:
Influence of familiar or unfamiliar handler
on the percentage of restraint animals

To conclude this chapter, the use of several experienced and familiar or unfamiliar handlers seems to be an unimportant factor of variation in the animal's reactions to the restraint test. For the following experiments, three different experienced caretakers were always used. No difference has been found between them in the number of animals that they have restrained.

3.2.2.2. Influence of the rearing conditions on the cattle reaction towards humans and handling

Two questions are asked in this chapter: Are the contacts in the first three months after birth important for the establishment of the human/animal relationship? Does the rearing conditions after this period influence the reactions of cattle towards humans and handling?

The experimental procedure drawn in Figure 52 was developed to answer these two questions. Eighty-three calves born in January or February were used. Forty-one calves were reared traditionally and 42 were reared in range conditions during the first three months. After this period, all the animals were put together with their mothers on pasture. Pasture conditions gave very few contacts between humans and animals. The animals were weaned at nine months.
Because the farmers said that tying the animals during winter decreases their reactivity,

this hypothesis was tested. The half part of the animals were tied during the second winter and the other part were put in range conditions during the same time. In the latter case, the quality and the quantity of the contacts between humans and animals were different from those given in the first three months after birth: The animals were fed once a day by human with hay and concentrate. At 15 months, they were gathered and put to the pasture for their second summer.
The animals were tested at 4, 8, 16 and 20 months with restraint tests. The cage tests were performed only at 20 months after the restraint tests.
Figure 53 gives the average percentage of success per animal in the restraint test and the number of aggressive animals for all the experimentation. Animals from the traditional keeping system were significantly easier to handle than range animals. Fifteen range animals were aggressive towards the handler but none from the traditional system.
Figure 54 gives the heart-rate of the animals in the cage at 20 months. This test was performed with 18 traditional animals and 17 range animals. The heart-rate is significantly higher in range animals ($P < 0.01$) than in traditional animals after the first human touch. These two results show that contacts in the first three months have a marked influence on the later behaviour of the animals even 20 months after birth.
Figures 55 and 56 show the influence of the later rearing conditions on the reactivity towards humans. If tying the animals seems to have no effect on the easiness by which animals could be restrainted (Fig.55), the increase in contacts, even under range conditions, improved the easiness of the animals reared in range conditions during the first three months (Fig.56). This effect was not shown with traditionally kept animals. However, the range animals are again hard to handle after the second period of pasture.

All these results clearly demonstrate the existence of a particular period during the first three months in which a durable effect of human/animal relationship could be established. A later increase of the contact improved the reaction of the animals towards humans but this result was lost after some months spent in the pasture.

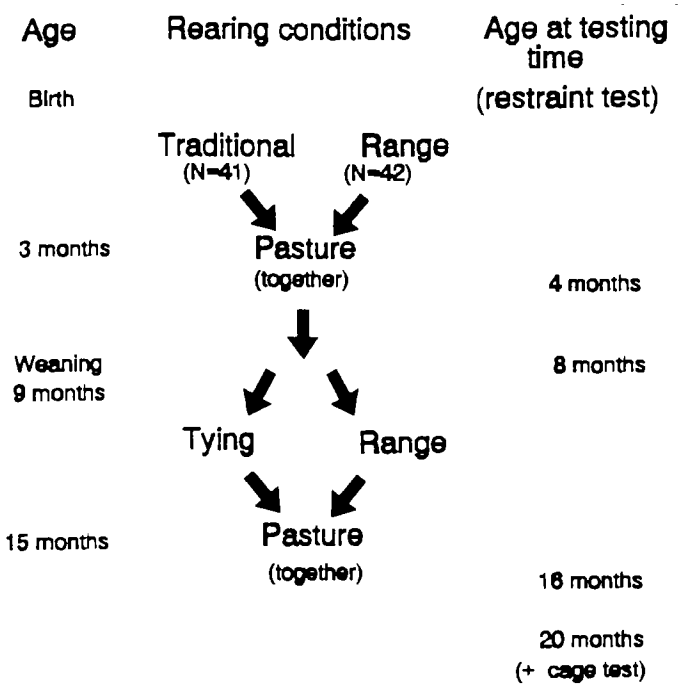


Figure 52:
Rearing conditions and experimental plan

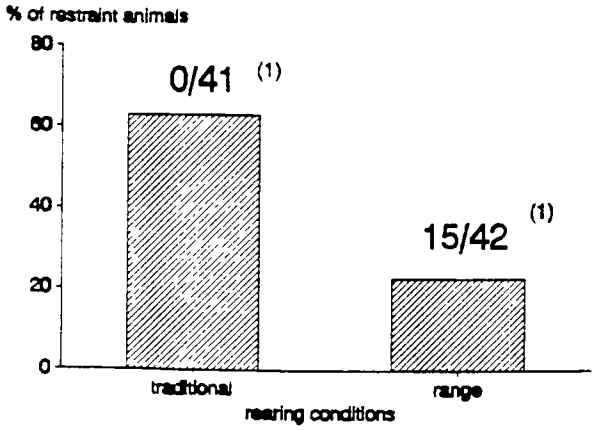


Figure 53:
Influence of the rearing conditions on the reaction of cattle in the restraint test during the whole period of experimentation

(1): proportion of aggressive animals

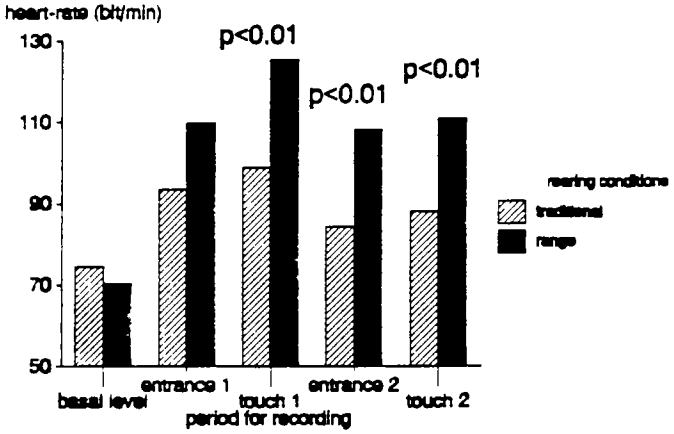


Figure 54:
Influence of the rearing conditions during the first three months after birth on the heart rate of cattle in a cage test

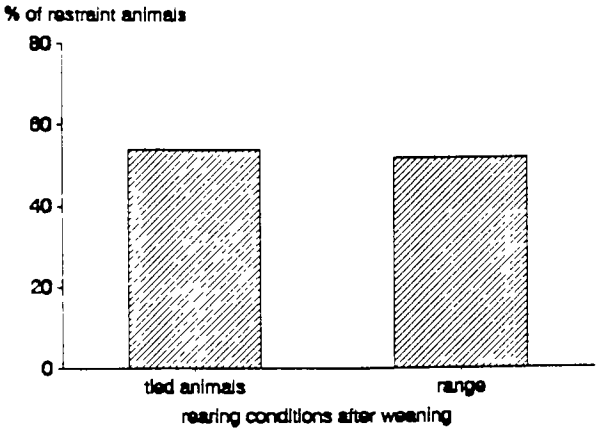


Figure 55:
Influence of rearing conditions after weaning animals tied or put in range conditions

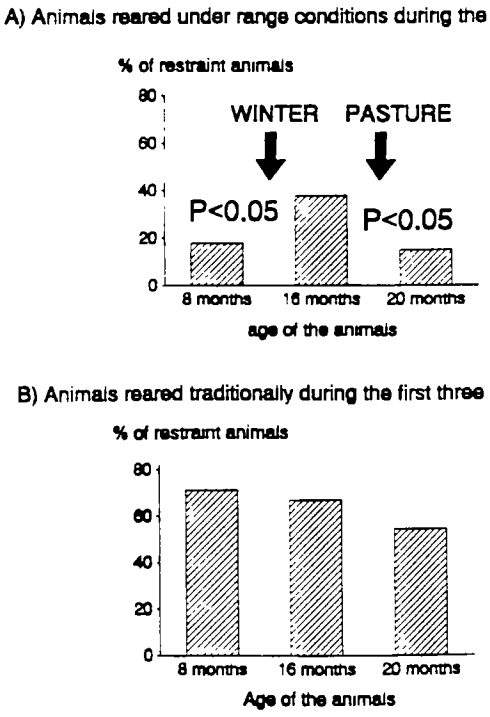


Figure 56:
Influence of the rearing conditions after the winter period and after pasture

3.2.2.3. Genetic variability of the reaction of cattle towards humans and handling

1) Breeds compared in this experiment

Two French mountain breeds (Salers and limousine) were used. They originate from the "Massif central", a mountain area in the south-central France. The Salers breed can be used for milk production but is today mainly used for meat production. The limousine breed is the second most important beef breed in France after the charolaise breed. This breed is reputed to react briskly to human handling. These two breeds have in common that they can easily adapted to living in hard mountain conditions. Both can live in range conditions.

The experimental schedule to compare these two breeds was the same as in the previous chapter. For the whole experimental period, Salers animals were more quiet (more motionless) during the restraint test than limousine animals (Fig.57). The cortisol response was also higher for the limousines during the cage test at 20 months of age than for the salers breed (Fig.57). Lastly, if the number of aggressive animals in the two breeds did not differ, the number of tests where the aggressive animals displayed aggressivity was significantly higher for the limousine animals (Table 3).
In addition and after looking for the paternity of the aggressive animals, we have found that they are born almost all from the same sire (Table 3).

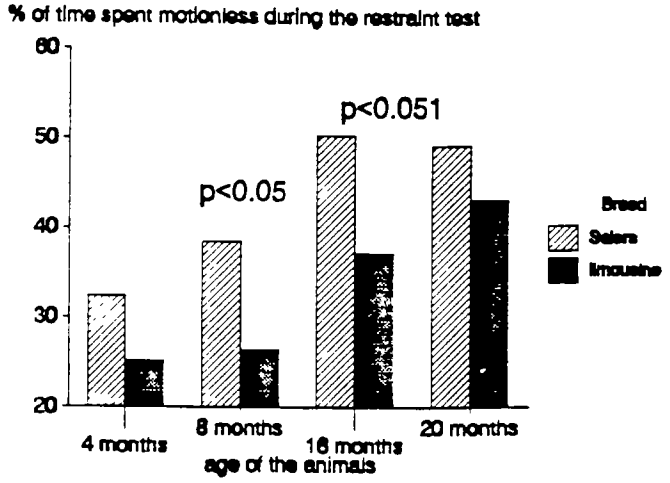


Figure 57:
Influence of the breed on the reaction of calves during the restraint test

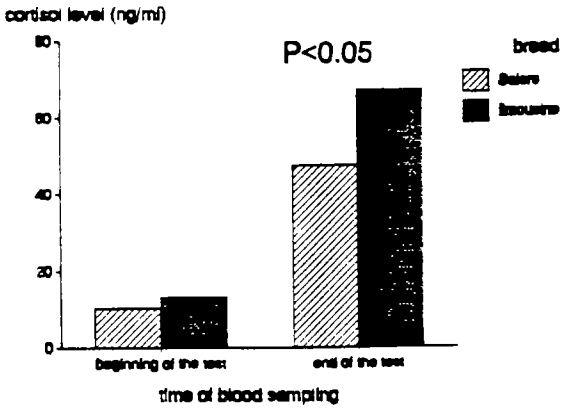


Figure 58:
Measure of the cortisol level in animals from Salers and limousine breeds before and after the cage test

A) Aggressive reaction of the animals towards humans during the restraint tests

	BREED		
	Limousine		Salers
Number of aggressive animals	9/41		9/43
for the aggressive animals:			
Average number of tests where they were aggressive	5.2	($p<0.05$)	1.78

B) Paternity of the aggressive animals from limousine breed reared in range conditions

	Number of daughters		
	aggressive		non-aggressive
Bull A	7	($p<0.05$)	4
Other bulls (n=4)	2		9

Table 3:

Genetic influence on the aggressivity of cattle towards humans during the restraint test

All these results confirm that there is a genetic variability of the reaction towards humans and handling in cattle, especially for the aggressive behaviour. Furthermore, the different proportions of aggressive daughters from the different sires lead us to suggest a heritability of this characteristic.

3.2.2.4. Research on sensitive periods of contact for habituating the cattle to humans.

In regard to the previous results, the existence of a particular period during the first three months in which contacts could be most effectively given was investigated. In addition, an experiment was performed to investigate the influence of human contacts at weaning. Indeed, Veissier (1987) has demonstrated a greater ability of cattle to learn a task at this moment.

All the animals used for these experiments were from the Aubrac breed. Aubrac breed is also a French mountain breed from the "Massif central". All the animals were reared

under range conditions.

a) Existence of a sensitive period during the first three months

In this experiment, calves were separated from their mother for two hours twice a day for ten days. They were handled individually for 15 minutes each time. The handling served to habituate the animals to human presence, by talking to and stroking them, especially between the hind legs as for the mother's licking.
This experiment was in fact divided in two parts. During the first part, calves were handled just after birth and at six weeks of age. Their reactions towards a human were compared to those of non-handled animals (control group) during restraint tests at 3.5 months of age. In the second part, others calves were handled at 1.5 months of age or three months of age and compared to control animals at 8 months of age.

E1) Comparison between handling at birth, 1.5 months after birth and non-handled animals

Handled animals were never aggressive towards the handler. In contrast, four animals among ten in the control group were aggressive (Fig.59). Furthermore, only the animals handled at 1.5 months of age were significantly different from the control animals when we consider animals that were restrained for 10 s and never aggressive. In addition, animals handled at 1.5 months were more quiet. They crossed significantly fewer squares than the animals from the two other groups (Fig.59). No significant difference was found between the group handled at birth and the control group.

E2) Comparison between animals handled at 1.5 months, 3 months and non-handled animals

Animals handled at 1.5 months were never aggressive towards the caretakers during the restraint test (Fig.60). In contrast, one from each of the other groups were aggressive. In addition, animals handled 1.5 months after birth were more quickly restrained than the two other groups. The difference is significant for the time necessary to restrain the animals for 20 s (Fig.60). No significant difference was found between the control group and the group handled at three months of age.

a) Existence of a sensitive period at weaning.

Aubrac range heifers were handled (talking, stroking, giving hay and concentrate) for five minutes in group and five minutes when isolated from the social group. The handling was performed twice a day during 13 days at weaning (eight months of age) for the first group (nine heifers) and 1.5 months after weaning for the second group (nine animals). The behaviour of the heifers during this handling period was recorded. The durable effect of this handling was tested seven months later and compared to non-handled animals (control group: seven heifers). After these tests, a new session of handling similar to the handling at weaning was performed. Figure 61 shows that animals accepted to be stroked

significantly easier at weaning ($P < 0.05$) than 1.5 months after weaning. This difference persisted seven months later. Moreover, animals from both groups ate easily the hay in the hand of the caretaker by the end of the handling period. But seven months later, few animals handled 1.5 months after weaning accepted to eat from the hand in contrast to the animals handled at weaning ($P < 0.01$; Fig.61).
During the restraint tests, previously handled animals were easier to restrain than the control group and they were never aggressive towards the handler (Fig.62). However, animals handled at weaning were significantly more motionless ($P < 0.05$) when the human was passive than the two other groups. It is important also to notice that four control animals among seven were aggressive towards the handler!!!

To conclude this chapter, we can say that a short period of frequent and non-aversive handling reduces almost completely the aggressiveness of the range animals towards humans under our management conditions. In addition, it seems that particular periods exist 1.5 month after birth and at weaning in which it is easier to adapt the animals to humans.

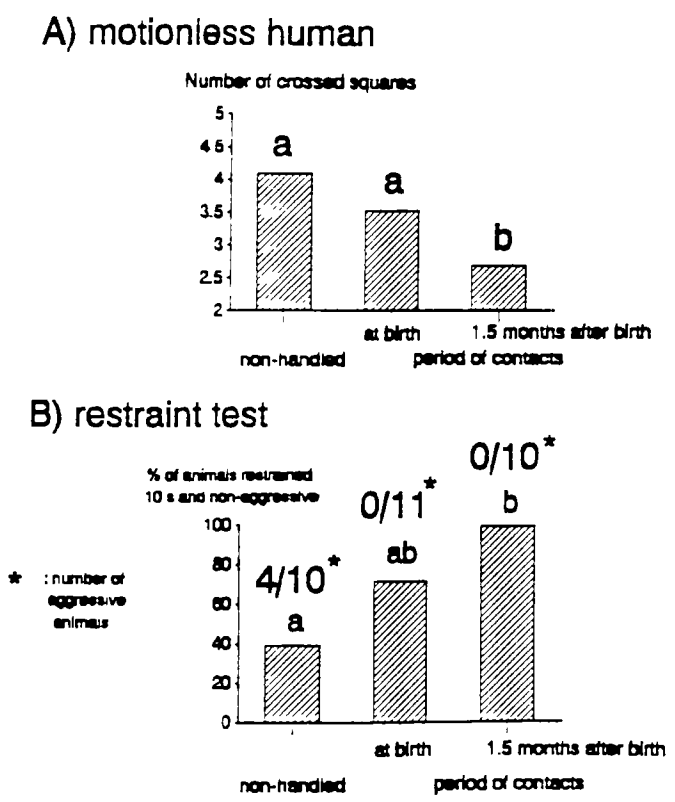


Figure 59:
Revealing a particular period to better establish the human/cattle relationship (E1)

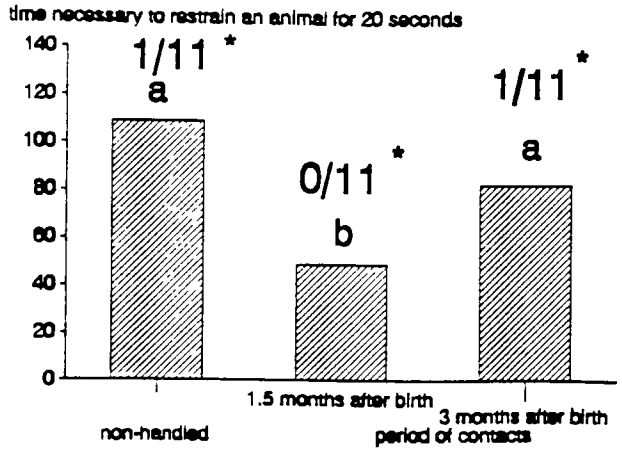


Figure 60:
Revealing a particular period to better establish the human/cattle relationship (E2)

* : number of aggressive animals

3.2.3. Conclusions

3.2.3.1. General process of establishment of the human/animal relationship.

Figure 63 adapted from Kretschmer and Fox (1975) shows the general process of transforming a population of wild animals to a domestic population and to obtain a "domestic animal". A wild population becomes domestic if a genetic adaptation to human environment occurs in the population (domestication). As we have shown in our experiment, the reaction to humans (especially the aggressiveness) seems to have a genetic component. But this process is not enough to obtain an animal completely well-adapted to humans. As we have found with cattle, animals like range animals that have not received a handling period of contact can be hard to handle and dangerous for the humans or themselves. They exhibit a "wild" behaviour. The adaptation process is sometimes called "socialization" to humans and is favoured by the existence of particular periods in the life of the animals (e.g. in our experiment, during the first three months or at weaning). Kretschmer and Fox (1975) considered that a socialized animal reached an emotional stability in its reactions towards the humans.

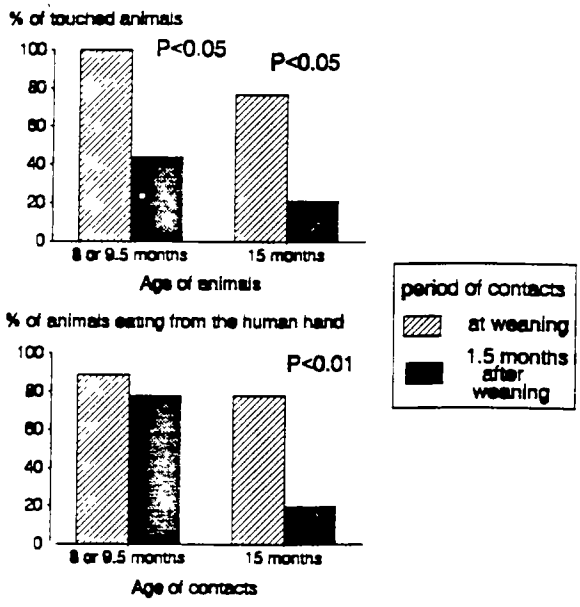


Figure 61:
Behaviour of heifers during periods of contacts at 8 or 9.5 months and at 15 months old

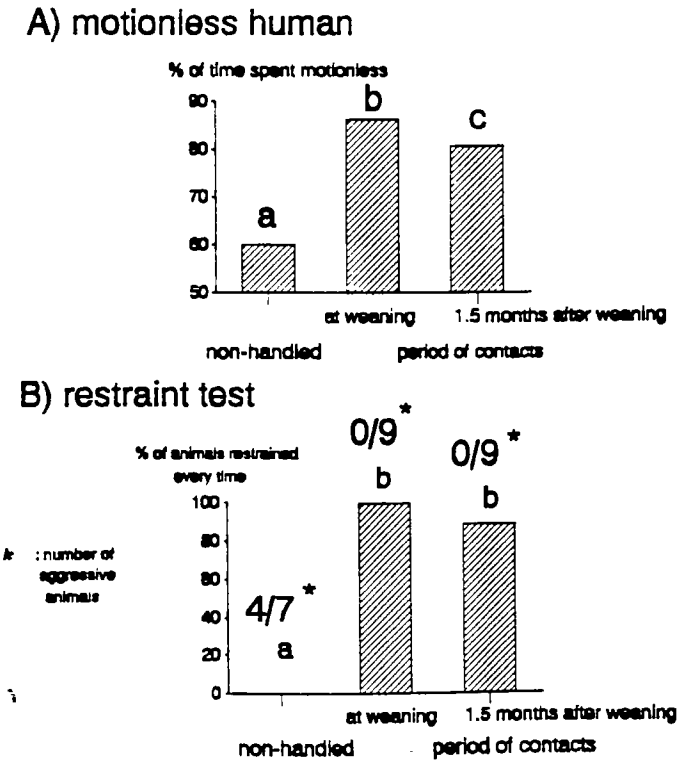


Figure 62:
Revealing a particular period at weaning to better establish the human/ cattle relationship

3.2.3.2. Consequences for the present development of modern cattle husbandry, especially in France.

The present development of the husbandry leads to an increase of the number of animals per caretaker and, then, a decrease in the amount of contacts between humans and animals. This evolution also leads to the use of the range or free-stall conditions. Our results indicate that this development could increase the number of problems related to handling of the animals. Then, it is necessary to solve these problems for the welfare and the security of both animals and caretakers. As it has been shown in the first part of this presentation, economical performance of the animals could also be influenced by the human/animal relationship. Then, 1) It is important to use the genetic types of cattle which are best adapted to these new conditions. 2) Selection of bulls in the testing centres must take into account the reactivity of their offsprings towards humans. 3) Particular periods in the animal's life (first three months, weaning) must be utilized to quickly establish durable and good relationships between humans and animals.

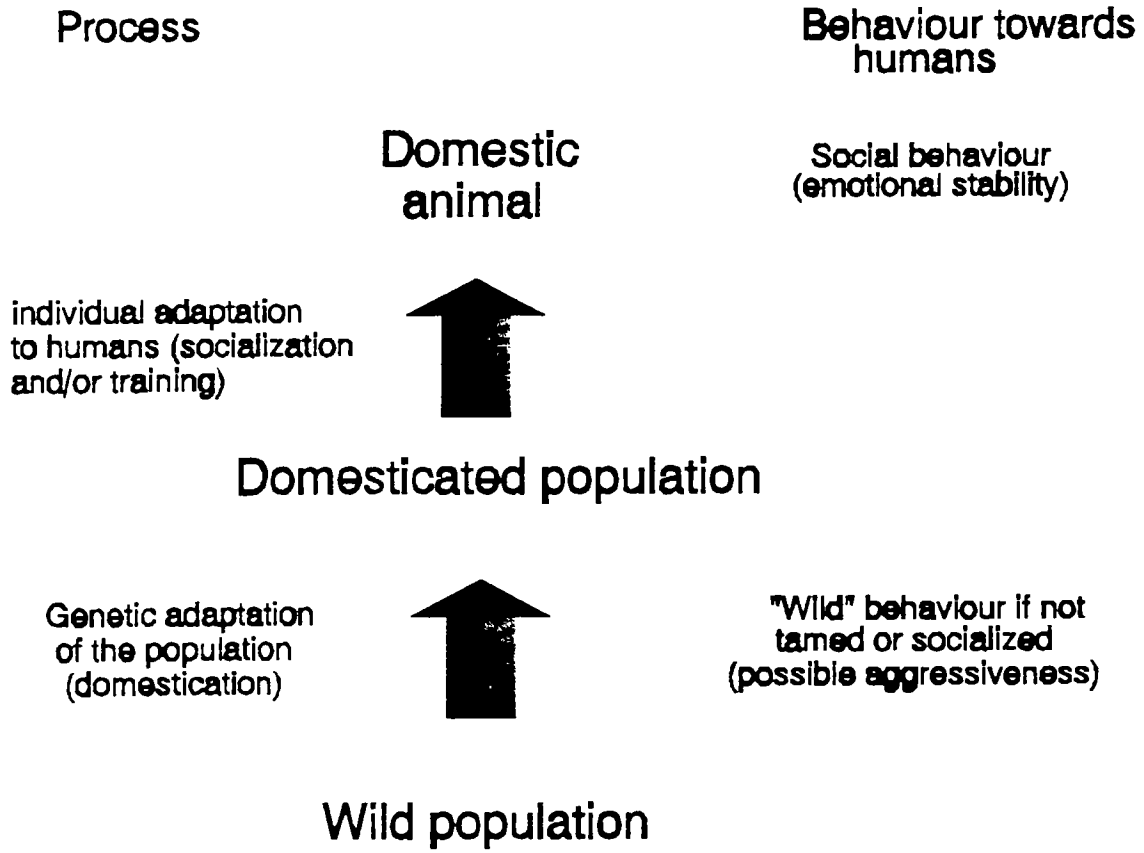


Figure 63:

Transition between "wild" state and domestic state (from Kretchmer and Fox, 1975)

3.2.3.3. Further research might be done!

The scientific bibliography about the human/animal relationship is not considerable. Thus, it is important to develop research about the animal's perception of the human (human perceived as a predator, a caretaker, a social partner, a master or a trainer,...)in order to understand the relevant parameters of the contacts between humans and animals.
More research about the sensitive periods of socialization are necessary to find the most effective stimuli, the physiological mechanisms, etc.
More research are also necessary on the genetic variability of the animal's reaction towards humans: Which anatomical or physiological differences could exist between the breeds (sensory perception, time and duration of the sensitive periods,...). These research projects could also help in understanding the processes of domestication in general.

4. General conclusions

Cattle are used for production of milk, beef, leather or work. Since millenia, humans have tried to obtain the highest rate of production. Especially during the last 40 years, the intensification of the production has sometimes led to considering animals as machines. As for a car, scientists have selected the best materials for the motor (research in genetics) and given the best fuel (research in nutrition). However this booklet demonstrates that behavioural characteristics are able to modify many management parameters. Particular farm situations (e.g. isolation from the social group) are able to stress the animals and decrease their adaptability to artificial structures. Affinities or hierarchy among cattle affect the quantity of food ingested by the animals and modify their daily rate. In addition, and it has been described above, the human/animal relationship affect milk production, reproductive performances and animal health. This relationship also influences the time necessary to handle the animals, the security and the welfare of both caretakers and animals, especially in cattle.
All these results show clearly that the caretakers have to consider under which conditions their animals are living. Then, humans could better adapt their behaviour and the rearing environment to the behavioural characteristics of their animals. Because they are playing the first fiddle in relation to the animals, caretakers could also be considered responsible of the animal welfare.

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