The Principles of Humane Experimental Technique

W.M.S. Russell and R.L. Burch

CHAPTER 2

THE CONCEPT OF INHUMANITY

A brief consideration of the outward signs of some of the stronger sensations and emotions ...

Pain and Distress

Throughout this book, the terms "humane" and "inhumane" and their derivatives will recur freely. That the word "humanity" has its secondary sense at all is interesting enough; it reflects the fact that man surpasses all other species in his capacity for social cooperation. A friendly and constructive attitude to lower animals, no doubt initially a by-product of this human capacity, is closely linked with it behaviorally, and may quite conceivably serve as a means for developing and refining it (Russell, 1956; cf. Russell and Russell, 1957). However, in this book we shall use the terms solely in relation to the treatment of lower animals, specifically vertebrates. Moreover, and this is important, the words will be used in a purely objective sense to characterize the kind of treatment actually applied to an animal--in terms of the effect on the latter. Our use of the terms henceforward, therefore, MUST NOT BE TAKEN TO IMPLY ETHICAL CRITICISM OR EVEN PSYCHOLOGICAL DESCRIPTION OF PERSONS PRACTICING ANY GIVEN PROCEDURE. We assume throughout (probably with good grounds, cf. Chapter 8) that experimental biologists are only too happy to treat their animals as humanely as possible. The central problem, then, is that of determining what is and what is not humane, and how humanity can be promoted without prejudice to scientific and medical aims (cf. Russell, 1955). We must begin by examining the concept of humanity (or inhumanity) as an objective assessment of the effects of any procedure on the animal subject.

"The aim of UFAW is to promote humane behavior towards wild and domestic animals in Britain and abroad so as to reduce the sum total pain and fear inflicted on animals by man" (from *The Aims and Methods of UFAW*, the terms of reference of that organization, on which see Chapter 8). This succinct and lucid statement has been tried over many years and found an admirable guide. We may notice two points which it clearly brings out.

First, the quantitative aspect of this applied science is plainly set out in the words 'sum total'. Ideally, if we could measure pain and fear on a perfected graded scale and with complete accuracy in practice, we should doubtless conclude that this sum total is made up by the sum of a number of products--each consisting of a certain definite amount of pain or fear multiplied by the number of animals exposed to it. In practice, without anything more than the barest approach to a realization of this idea, we may reasonably allot priorities in terms of *either* extreme unpleasantness *or* very large numbers of animals or a combined estimate of the two. Any applied science must have clearly defined aims, which in turn define priorities, and we have here at least a starting-point for discussing the quantitative aspect of the problem, which will be prominent in our own analysis.

Second, the statement relates the concept of humanity fairly and squarely to those of pain and fear. This aspect requires further discussion, and for our purposes we should like to replace these two specific conditions by the rather more general notion of *distress*. This notion, in turn, requires detailed examination of a number of facts and ideas, beginning with the notion of "consciousness". It is assumed that to be in a state of distress an animal must be in a certain state of consciousness, which may be eliminated by, for instance, deep general anesthesia.

We shall not waste any time on those philosophers who would forbid us to speak of consciousness in nonhuman animals. This confusion arises from a number of pathological factors, into which we shall not enter at length here (cf. Russell and Russell, 1958 and in press). In brief, if an individual was treated in his childhood as if he had no feelings of his own, he is liable as an adult to cast animals in this unenviable role, by "an unattractive perversion of the Golden Rule" (Russell and Russell, 1957). Beliefs of this kind, like solipsism (the fantasy that nobody is conscious except the solipsist himself) and Berkleian idealism (the fantasy that nothing exists when not in the sensory presence of the Berkleian himself), are all entirely pathological; they have been mopped up very efficiently at the level of rational criticism by Craik (1943).

In any case, it is now generally recognized that "consciousness" is a useless concept as an abstraction in its own right. All progress in this field has been achieved not by obsessional worry about what "consciousness" is (or, for the more fashionable philosophers, "means"), but by treating it as a *variable* and examining its different states. We owe much of this progress in understanding to the neurosurgeons (cf. e.g. Penfield and Rasmussen, 1952; Adrian et al, ed., 1954, *passim*; Sprague *et al*, 1955). States of consciousness can be markedly affected by surgical or pathological interference with visible structures, some of which are common to most or all vertebrates. Thanks to the work of Magoun, Jasper, Penfield, and many others, there has been a shift of emphasis where states of consciousness are concerned, from the cerebral neocortex itself. Fluctuations in consciousness are now seen, roughly and provisionally, in terms of interactions between this core and the forebrain. Interactions of this kind may well be supposed to occur in all vertebrates, though our knowledge of forebrain physiology is overwhelmingly limited to that of mammals (Erulkar, 1955; Russell, 1976b; see Chapter 7).

The variable *intelligence*, however, remains as firmly as ever structurally linked with the neocortex (Halstead, 1947; Sprague *et al*, 1955), and represents a mode of function almost restricted to man (Russell and Russell, 1957; Russell, in press, b). Attempts are often made, in the interests of humanity, to exaggerate the traces of intelligent function observable in the subhuman primates and the domesticated carnivores; such attempts are misdirected, for the conditions of fluctuation in conscious states, when intelligence is rudimentary, are such that lower animals have a special claim on our considerateness.

For if, as we legitimately may, we use evidence from overt behavior to build a tentative picture of the states of consciousness in a lower animal, our first conclusion is the remarkably *restricted* nature of these states (Russell and Russell, 1957 and in press). To make the main point, we are overlooking evolutionary gradations, which need not impair the generalizations that follows. The work of many ethologists, notable Baerends (Baerends, 1941; Baerends *et al*, 1955; Tinbergen, 1951; Russell, 1954; etc.), has shown that at any given moment a lower vertebrate is in a particular *mood* which drastically restricts the scope of its attention. In other words, it can only be aware of, or react to, certain very limited features of its internal and external environment, which are predetermined by the mood. At first sight, this seems analogous to a state of concentrated attention in ourselves, in which we scan certain inputs at the expense of others. It is, indeed, not unlikely that in both instances the mechanism of exclusion is fundamentally the same, involving the interception and censorship of messages at various stages from the periphery to the central analyzers (cf. e.g. Granit, 1955; Prechtl, 1956; Von Holst, 1950). But in so far as we are employing our intelligence, we can control from moment to moment the direction and focus of our attention. The sequence of moods in a lower animal, however, is rigidly controlled by internal and external changes according to a code of rules, largely preset for a given species.

In this respect, animals are functionally similar to neurotic humans, and, since we are all neurotic to some extent, most of us can recall states of mind (anxiety, depression, etc.) in which one or a few preoccupations absorbed our attention exclusively, and an unpleasant narrowing of our sensory, intellectual, and emotional horizons was impossible to combat for seconds, minutes or, in severe cases, hours. The lower animal, is therefore, specially vulnerable to unpleasant conditions. When it is in a distressful mood, this is very distressing indeed. There is good reason to suppose that distress is associated with paucity of information (see below), and an animal in distress can *only* attend to its own misery. Extreme pain, as well as neurosis, can produce this effect in man. As a practical point, it is worth noting that when our usual methods of attention-control fail, artificial sensory distraction may do the trick; dentists sometimes take advantage of this. In mammals, the role of external stimuli as mood-switches has become considerable, and distraction of this sort may perhaps be applicable to them as a humane technique (cf. Hagbarth and Höjeberg, 1957). But this would require deliberate assistance from the experimenter. In general, the lower animal is the slave of its own moods. Its behavior is very largely automatic, and we know that we ourselves are most vulnerable when our behavior is most automatic. Now can a lower animal obtain the precious relief of *verbalizing* its distress. Far from despising lower animals (as it is convenient to call them) for these deficiencies, we should logically treat them with special consideration. These points are stressed because similarities between man and lower animals are so often unduly emphasized, in a laudable endeavor to promote humanity. The differences are much more cogent. No sane person regards a baby as insentient, because he cannot talk.

With the single--and partial--exception of the male frog or toad when clasping an ovulating female (Spallanzani, 1785; cf. Russell, 1952), strong pain has the property in all vertebrates of overriding all other stimuli and immediately imposing a special mood with widespread motor and autonomic effects. The evolutionary reason is obvious. Pain is also unlike other sources of distressing moods (e.g. fear) in being associated with specific peripheral mechanisms. We, may, therefore consider it first.

Our knowledge of the pain periphery, and of cutaneous sensation in general, has been revolutionized in the past few years by the studies of Weddell and his collaborators (reviewed in Weddell, Pallie, and Palmer, 1954; Weddell *et al*, 1955). The work of Weddell has included the performance of extremely unpleasant and inhumane experiments on one of *his own* deliberately exposed digital nerves (he did not do anything like this to an animal) (cf. Pattle and Weddell, 1948). As an Italian scientist said of Sherrington in a different context (when the latter had been studying the cerebral localization of motor function in the gorilla), we do not know whether to admire the ability or the courage of the scientist (Wright, 1947).

Briefly (see especially Weddell, *et al*, 1954; Lele *et al*, 1954), it was formerly thought that four separate morphological types of nerve endings in mammalian skin subserved the four modalities of heat, cold, touch, and pain. It is now known that *all* sensory endings in the skin are morphologically identical, being naked, unsheathed exoplasmic processes. Their function is entirely determined by their spatial position and arrangements. Thus, one group are twined around hair follicles in such a way that their relations with their unsheathed parent-fibres are affected (and impulses liable to pass in the latter) by any deformation of the hair. A second group ramify within globes of epithelial cells (corpuscles) in such a way as to respond similarly to deformation of the globe in any dimension. These, and (possible) a group of very superficial endings in the epidermis, subserve touch. Warmth and cold may depend on the *relative* activation of structurally unspecialized processes in the deeper and more superficial layers of the skin. If the former are more active than the latter, cold is felt; if the converse, warmth. (Temperature receptors of a rather different and more specialized kind, with extremely complex properties, may be found elsewhere in the vertebrates where special kinds of efficiency are needed--e.g. in the mammalian tongue--cf. Hensel and Zotterman, 1951; Granit, 1955; Murray, 1955.) Finally, any endings not specially related to a hair or corpuscle may cause pain sensation, if they are activated by powerful stimuli of any kind (in principle, those stimuli whose protracted presence would be associated with tissue damage). The linkage (in one direction) of pain with unspecialized nerve endings is, therefore, still maintained, though "unspecialized" is now meant *spatially* rather than morphologically, and there may be a greater or lesser overlap with temperature reception. This seems to accord with the finding that pain and temperature modalities are not apparently spatially separated in the pathways from spinal cord to thalamus (White, 1954). We may suppose, however, that the *patter* of pain activation is specific for noxious stimuli.

Finally, there appear to be two kinds of cutaneous pain differing in their latency and duration--fast and slow, or sharp and burning. These may be carried in different fibres, but do not appear qualitatively different subjectively, apart from the difference in duration (Ruch, 1950; cf. Pattle and Weddell, 1948).

Substantially the same naked endings are found in other parts of the mammalian body, and in the lower vertebrates (cf. Whitear, 1952), though true hairs (of course) and the complex corpuscles seem to be lacking in fishes (which have other sensory arrangements of their own). The recent discoveries have, therefore, not in any way affected the overwhelmingly probable conclusion of Baker (1948) that specific pain sensation is present in all vertebrates.

So far we have been concerned with pain as a modality distinct from, e.g., touch or warmth. Its distressingness is another matter. This is in the last resort a matter of central nervous analysis, but it can be affected by both peripheral and central factors. Thus, in normal skin naked nerve endings overlap considerably (without actual contact). Hence, painful stimulation of a particular spot will cause impulses in a particular array of fibres, enabling the brain to estimate the position of the pain by a sort of triangulation. In certain cutaneous injuries and scars, areas of skin may for a time contain spots with endings from only one fibre each. Stimulation of such a spot results in a peculiarly distressing pain. It seems that the specific quality of pain is due to stimulation of free naked endings (other than those of the special systems described above), while its central *distressingness is inversely correlated with the amount of pattern* provided, or the amount of information transmitted, in the cybernetic sense (Weddell *et al,* 1948). A further peripheral variable, naturally enough, is the total amount of input (Pattle and Weddell, 1948).

As for central factors, it is possible in man (as already mentioned) deliberately to reduce the intrusion of pain into a mood, and the amount of distress experienced. This may be done by direct control of attention (e.g. as a result of autosuggestion), or by peripheral distraction, such as grasping the arm of the dentist's chair, a procedure which supplies rival highly patterned inputs (Bishop, 1946). Certain of the so-called tranquilizing drugs (Chapter 7) will selectively reduce distress without affecting responses to the modality of pain; the same result may be obtained surgically. Thus, one woman, bilaterally lobotomized on account of intractable pain from a wound stump, "stated that the pain was present but she gave it less attention and it did not concern her" (Wolff and Hardy, 1947). Similarly, a great many studies show that when graded stimulation is applied, the *thresholds* for pain and distress are not identical.

Pain itself can be, of course, selectively eliminated by various forms of pharmacological and surgical local analgesia--local infiltrations with conduction pathways in the spinal cord or brainstem. The course of ascending pain pathways from the spinal, trigeminal, and visceral afferent nerves is relatively well understood as far as the midbrain, though by no means are all problems solved, and as usual little is known of non-mammalian vertebrates (cf. Sprague *et al*, 1955).

As pain is conducted still higher, the problem of distress is at once raised. Some light has been shed on these matters in recent years by the work of Delgado and various colleagues, as a result of stimulation experiments with electrodes implanted in restrained or relatively free animals, especially cats and monkeys. It is pleasant to read that "special care was taken to minimize discomfort in the animals and for this reason short stimulations at threshold intensities were regularly used" (Delgado, 1955). A number of different central nervous regions were stimulated, and manifestations of distress (see next section) were evoked from some but not others. The positive regions included those in the ascending course of the spinothalamic tract and trigeminal lemniscus, a definite nucleus of the thalamus, and, most interesting, the areas in the rhinencephalon--that assemblage of structures tucked out of sight by the growth of the neocortex, which from its widespread mandate over autonomic functions has been called the "visceral brain". There is no doubt that pain inputs reach the neocortex in the post-central gyrus, but Delgado's work leaves a strong impression that the integration of pain inputs, in monkeys at least, may be a function of the rhinencephalon. The situation in non-mammalian vertebrates is, as usual, virtually unexplored.

So as far as overt behavior is concerned, one of the best criteria for distress is that of serving as motivation for conditioned reactions and various forms of learning--in other words, its capacity to serve as punishment (Hume, 1956). The results of Delgado and his colleagues are of special interest in this connection. After a few experiments, the experience of stimulation of the relevant regions was associated with definite expression of fear in both cats and monkeys. They tried violently to escape when placed in the chair or stage where they had previously undergone such stimulation. Control animals, in which other types of response, motor, and autonomic, had been obtained by stimulation of other brain regions, "showed no signs of anxiety when placed on the observation stage, and ... became quite reconciled to the experiments as they were repeated" (Delgado, 1955). In another investigation, a monkey was trained to turn over a cup to break an electrical circuit which was shocking his feet. It was found that stimulation of the relevant regions had no such effect. Finally, a systematic study of the problem was made in cats (Delgado *et al*, 1954). First, the animals were trained to turn a wheel (which broke an electrical contact), initially in response to the shock itself, later in response to a buzzer associated with the shock. On central stimulation of the relevant regions, they now turned the wheel. Next, cats were placed in an apparatus with two compartments, in one of which they were subject to stimulation of the relevant brain regions. They learned to avoid this compartment by jumping to the other through a hole. Finally, the cats were successfully trained to avoid a food dish where they had been stimulated just after touching the food. Throughout the investigation, stimulation of other parts of the brain was quite ineffective as punishment.

Pain, distress, and punishment are this closely linked together. It is, however, abundantly clear from general behavioral observations that pain is not the only source of distress. The other chief obvious sources are fear and conflict.

Considerations of the function of fear, and those drawn from human experience, suggest that, after a first alarm phase, fear need not be distressing, provided it has the opportunity for expression in effective action. In these conditions, it actually heightens and broadens awareness of environmental factors. This suggests that serious distress may not be present in experiments where an animal has already learned to eliminate a painful stimulus in advance--e.g. by turning a wheel or pressing a lever. Fear more generally aroused in the laboratory is another matter, for in these conditions avoidance by, e.g., flight is normally impossible. Again, in so-called experimental neuroses[1], the animal is normally driven into a situation where flight is either impossible or blocked by conflict with other drives. In such circumstances, fear must become an acutely unpleasant state which, by human analog may be termed *anxiety*.

Most conflict states in nature seem to include fear as one of two or more component drives, though this is not always the case (Russell, 1954; Van Iersel, 1953). In any case, except in the special conditions of primate societies (Chance and Mead, 1953), conflicts states never persist in nature. They are regularly modified in a short time by expression and reduction of one or other drive in displacement, redirection or compromise movements, and/or in removal from conflict situation (Bastock *et al,* 1953; Chance, 1957b, and in preparation). Thus, while lower animals in nature have no direct control over their moods, automatic mechanisms ensure that distressing ones do not persist. The natural sequence is disturbed in captive and domesticated animals (Lorenz, 1940; Hediger, 1955; Russell, 1956)--and all laboratory species are evidently one or the other. Both social and nonsocial environmental factors may often be organized in such a way in the laboratory, that they give rise, when combined with the restraint of a cage or hutch, to chronic complex moods (Russell *et al*, 1954), which the animal is quite unable to simplify by the means open to his fellows in the wild. Whether these states of mind are distressing, and how much so, raises further problems.

In mammals at least, there is some ground for postulating a convenient linear polarization of behavioral states, along a spectrum extending from complete well-being to acute distress. Mammalian behavior lends itself to description in terms of such general polar concepts as approach and avoidance (Chance and Mead, 1953; Miller, 1951). In relation to any specific drive, there seems to be some neurological polarization in the hypothalamus. Thus, feeding behavior may be governed by a balance between appetite and aversion (Craig, 1918), such that lesions in one hypothalamic locus cause anorexia (loss of appetite), while lesions in another lead to hyperphagia (overeating) (Stellar, 1954). Other brain control levels may be similarly organized (e.g. the control of breathing in the mammalian medulla--Pitts, 1950). What is more useful, there is a general polarity of the hypothalamus in relation to both overt behavior control and autonomic function. This is so dramatic that Hess (1948) has been led to divide the region functionally into two parts, anterior and posterior. These are associated respectively with *routine* and *emergency* functions (Russell, in press, c), or, in Hess's terms, with two functional divisions of the autonomic nervous system which he calls, respectively, trophotrope-endophylactic and ergotrope. These, in turn, correspond (roughly and with some overlap) to complex activation of sympathetic and parasympathetic responses on one hand, and the well-known mass sympathetic responses on the other. The latter includes activation of the adrenal medulla, and floods the system with the adrenal amines (cf. von Euler, 1956). The mammalian autonomic system is, of course, well adapted for delicate local adjustments (mainly parasympathetic, with sympathetic synergy) on one hand, and diffuse mass action (sympathetico-adrenal) on the other, with corresponding anatomical, physiological, and biochemical differences (e.g. Fulton, 1950; Gellhorn, 1943).

Now persistent activation of the mass sympathetic response is liable eventually to merge into the much more catastrophic stress syndrome associated with the adrenal cortex and other endocrines. (The two are linked by several circuits, cf. CIBA Colloquium, 1952.) We can therefore begin tentatively to think of a scale of well-being to distress, linked with a scale of relative predominance of the two autonomic modes of activity. So closely are the two scales linked, in fact, that the term "emotional mechanism" is often used in the literature (e.g. in characterizing brain regions) in a sense which turns out to mean simply the presence of exaggerated autonomic effects. There has been a curious tendency here to connect the term 'emotion' specifically with the emergency or distress end of the scale, as though emotions were always unpleasant. But we need not restrict ourselves to either end, or to exaggerated effects. All variations in mood with perceptibly different behavioral outcomes must also have perceptibly different autonomic effects. We can feel fairly confident that along the whole spectrum the two scales are kept perfectly in line, probably by such special mammalian integrating mechanisms as the hypothalamus and rhinencephalon. It may be more satisfactory to think in terms of a scale than of two poles. In this way we are led to set our sights high in removing inhumanity, and to attempt always to drive the animal up to the highest possible point on the scale. Thus, we can aim at well-being rather than at mere absence of distress. Everything we know of the phenomena of suggestion (cf. Baudouin, 1942) is in favor of such a policy.

We may, then, define distress of a certain degree (of whatever origin) as a central nervous state of a certain rank on a scale, in the direction of the mass autonomic response *which, if protracted, would lead to the physiological stress syndrome.* Inhumane procedures are those which drive the animal's mood down in rank towards this point. Removing humanity must ultimately mean driving the animal as near the *other* end of the scale as we can. "More humane" then means simply "less inhumane" in the above sense. Thus, at least we have an attractively clear-cut view of the situation. We need only add that inhumanity can take two forms--acute and chronic--with no doubt every possible gradation between the two.

The lower vertebrates will give us more difficulty. The marked polarity of the mammalian autonomic system is an outcome of evolution, though a similar trend has occurred independently in teleost fishes (Young, 1933, 1936; Nicol, 1952). The primitive forms of the system lack this clear-cut polarization. Correspondingly, we do not seem to meet any such obvious polarity in overt behavior, though general classifications into appetite and aversion were, in fact, originally made on birds (Craig, 1918). The possibility remains open that in lower vertebrates there may be many kinds of distress. But even here we should be on safe ground if we adopted the criterion of punishment. Moreover, even the moods of lower vertebrates could no doubt be ranked in principle--even, that is, in the absence of a unifying scale within the animal itself.

[1] These phenomena are not, of course, neuroses in the human sense, since rationalization, a specifically human property, is absent (Russell and Russell, 1957 and in press).