the bladder on the 24th day, while on the 78th day there was residual urine after 15- and 19-volt stimuli. In the other two dogs examined cystographically, one on the 15th and one on the 35th day, small amounts of urine remained after stimulation with 24 and 12 volts, respectively. The dog whose cystogram showed residual urine 15 days after transection was reoperated on the 23rd day, at which time marked hypertrophy of the bladder wall was found. When the cystometry was repeated the pressure rose to 93 cm-H_2O with a 34-volt stimulus, and to 115 cm with a 29-volt stimulus plus 1.0 mg of neostigmine. This finding suggests that failure of the chronic cord bladder to empty is not due to insufficient intravesical pressure during stimulation, but rather to increased intraurethral resistance because of high spasticity of the striated external sphincter muscles. Spasticity, probably associated with a mass reflex phenomenon, occurs with upper motor neuron lesions in which bladder hypertrophy is characteristic. This phenomenon was noted in two dogs that underwent relaparotomy. Bors (*9*) reported highly elevated sphincterometric values (70 to 197 cm-H_2O) in patients with lesions of the upper motor neuron. Following pudendal neurectomy the values dropped to between 27 and 54 cm.

Long-term results will have to be improved before direct electric stimulation of the detrusor can be applied clinically; however, the method is considered promising (*10*).

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Distress Call of the Bottlenose Dolphin: Stimuli and Evoked Behavioral Responses

Abstract. *Analysis of the many different vocal productions of pairs of bottlenose dolphins* (Tursiops truncatus *Montagu*) *and the related behavior patterns shows that one pair of specific short* (*0.2 to 0.6 second*) *whistles was consistently stimulated by physical distress. This call stimulated nearby animals to push the head of the distressed animal to the surface to breathe. After the animal breathed, a vocal exchange preceded other forms of aid.*

The bottlenose dolphin (*Turisops truncatus* Montagu) emits specific sounds under well-defined conditions (*1–3*). A special pair of whistles and the behavior associated with these whistles was first observed in 1955 and briefly described in 1958 (*3*). This account presents further evidence that this pair of whistles is a "distress call" (*2–4*). This call is one of many unique short whistle patterns (*1, 2, 4*) and is not to be confused with general "alarm whistling" (*5–7*); the latter is apparently the same as some of the more prolonged "vocal exchanges" between dolphins (*2, 5*) and similar to the secondary exchanges which occur as consequences of rescue actions.

Distress calls of animals other than the dolphin have been described in the literature (*8*). In the case of the dolphin, the responses of nearby animals of the same species may resemble, in general effects, those described in the literature for some terrestrial mammals but they differ from those described for some birds and some fish.

Behavior was visually and sonically recorded with motion pictures and tape recordings (*1, 2*). The underwater whistles were recorded by means of a hydrophone and the whistles in air by means of an air microphone (*1, 2*). The observations were made from 1955 into 1962 under a variety of environmental situations on 23 different animals captured from three regions of the shoal waters of Florida (the St. Augustine inlet to Jupiter inlet, the middle Florida Keys near Marathon, and at Naples on the west coast of Florida).

The call itself is similar to other whistles in the "vocal exchange" group of sounds (*2*). It is repeated many times until an appropriate response is elicited either from the other dolphins in the neighborhood or from a human. The call consists of a group of two whistles (Fig. 1). The first whistle starts at a relatively low fundamental frequency (3 to 5 kcy/sec) and rises to a relatively high fundamental frequency (8 to 20 kcy/sec). The second whistle of the pair starts at a relatively high fundamental frequency (8 to 20 kcy/sec) and falls to a relatively low fundamental frequency (3 to 5 kcy/sec). This pair is emitted repeatedly with a delay of only a few tenths of a second between pairs for several seconds or several hours and stops when appropriate relief is obtained.

The call is emitted underwater or in air depending on the circumstances. The intensity (measured at the dolphin's head) of the underwater call can be as low as the noise level of the electronic apparatus or up to 100 decibels higher. In the usual cases during underwater emissions the blowhole slit can either emit air or not emit air (*6*). Young, small (5 to 6 feet long) dolphins usually emit air; older ones may or may not.

In air the call was heard faintly, accompanied by bubbles, at the outer lips of the blowhole or heard loudly at the open blowhole from structures deeper in the airways. The sounds in air can be of such low intensity that they can be barely audible even near the head (closed or open blowhole) or they can be piercingly loud a few feet away from the head (open blowhole); the range from the lowest to the highest intensity is about 80 decibels. The animals vary individually in their abilities to whistle a distress call in air with high intensity. However, each animal was able to make quite loud whistles under water. While a dolphin was whistling under water we manually felt, over the skull, the vestibular sacs participating in the vocal process as these sacs filled and emptied during whistling.

There were individual differences in the voices of the animals (*2, 5*); trained human listeners could distinguish emissions from individual dolphins. Such differences did not affect the rescue responses of animals meeting for the first time. For example, the calls of an injured large female (8 feet 3 inches), newly captured from the Gulf of Mexico near Naples, Florida, elicited a rescue response at first meeting by a young (6 feet 9 inches) male captured from the East Coast of the Florida Keys.

The instances in which the call was observed are related to distress. The specific stimuli seem to be the result of real or potential physical damage. The most frequent situations which elicited this call were: (i) some condition which impedes or prevents surfacing to breathe; (ii) removal of a young (4 to 6 feet long) dolphin from the water; (iii) some painful stimulus to the body; (iv) a condition, in the case of infants, that isolates it from its mother; (v) excessively forceful contacts (with teeth or ramming or striking) by another animal; and (vi) electrical stimuli in specific (negatively reinforcing) brain areas (*4, 10*). Typically, the first response of the other individuals within hearing of the call was to stop the emission of all sounds and to start a search for the dolphin emitting the call. When the animal in stress was found, the finder pushed the head to the surface by placing its own head under that of the animal in distress. The rescued animal then took one or several deep breaths and sank again.

After this "first-aid" maneuver (primary tactics), an exchange of whistles (*2*) took place between the distressed dolphin and the rescuer(s). After such an exchange, the rescuer usually changed tactics from pushing up under the head to more singly appropriate action (secondary tactics) (*4*). A mother rescued its infant directly in an appropriate fashion, thus abolishing the distress call (primary tactics only) by steering it out of a corner, and driving off other animals, for example. Support of the infant by the mother may continue even after the death of the infant (*11*).

In several cases an animal fell over to one side for one reason or another, and was unable to reach the surface in order to breathe without inhaling water. These secondary tactics followed: the aiding dolphin swam (or held still) on the proper side of the distressed dolphin in order to prop it up. These tactics allow the blowhole to be raised to the surface either while both dolphins are stationary or in motion. This seems to be a common secondary maneuver for correction of asymmetrical propulsion and buoyancy problems, which may result from bloating of the rumen (two cases, gas expelled later), breaking of ribs, (one case at autopsy), injuries to flippers (six cases), and malfunctions of the central nervous system (two cases of prolonged anoxia).

The secondary correcting maneuvers are preceded by vocal exchanges. Recently, we were given a opportunity for continuous observations over a period of several days. A newly caught female began distress whistling after being alone for a few hours. She fell over to her side and water entered her blowhole with each breath. Two other animals were allowed to enter her tank. One of them propped her upright. She stopped distress calls and a rapid vocal exchange took place among the three. Immediately, one animal held her up and the other one stayed nearby. From then on, the two animals took turns propping the injured female against the wall of the tank to keep her from tipping her blowhole over to the left side, or they would hold her in the water between them in the center of the tank (*12*). Other appropriate maneuvers maintained the animal upright. One rescuing dolphin, for example, pressed the flukes of the sick dolphin flat against the bottom in the shallow water, thus straightening her up. In another effective tactic the rescuer put his head just behind the dorsal fin on the left side, and elevated the blowhole above the surface of the water. There were a variety of ways of keeping the animal upright in the shallow water. These tactics continued day and night for four days and were intermittent for 2 weeks until the distressed animal recovered.

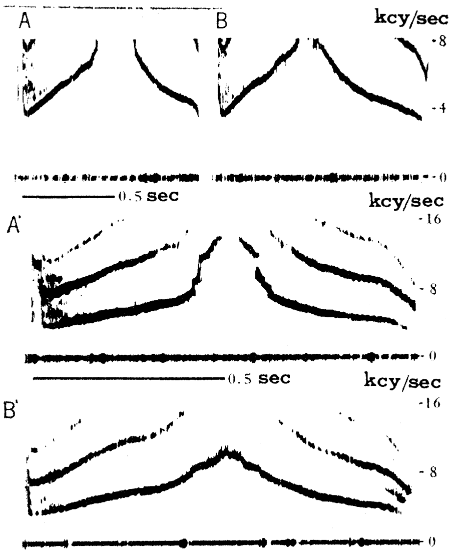

Fig. 1. Typical underwater distress calls of bottlenose dolphin. Two samples of sonic spectrographic records (*A* and *A'*; *B* and *B'*) are shown for each of two calls (two inverted *V*'s). In a typical sequence of such calls, *A* is separated from *B* by an interval of silence lasting 0.5 to 1.0 second. A representative group consists of 1 to 50 or more calls. The variations between the patterns of the two above calls are within the normally occurring range of variation. The amplitude varies somewhat during each whistle of each call; it reaches a maximum early in the rising frequency phase, falls somewhat as the frequency reaches peak, and rises again as the frequency falls. From one individual to the next the highest and lowest frequencies of the first partial vary from 8 to 20 and from 3 to 5 kcy/sec (*A' and B'*). The average rate of change of frequency with respect to time is typical (4 to 10 kcy/sec^{2}) for the first partials (*A* and *B*). The duration of each half of the call is usually equal to the other half and ranges from 0.2 to 0.6 second. With minor exceptions (at onset or offset *A'*), the first partials contribute more energy and are usually more continuous than the higher partials (*A'* and *B'*). With minor exceptions, the higher partials are integral multiples (2, 3, and so on) of the frequency of the first partial (*A'* and *B'*) at a given instant. The frequency scale in kilocycles per second is given at the right side of the figure; the time scale for *A* and *B* is under *A* and that for *A'* and *B'* is between *A'* and *B'*.

In three cases a sick animal isolated from a nonsick one sent out immediate distress calls. The isolated sick animal in each case was found dead in the isolation tank in the morning. Seven different sick animals were isolated briefly for injections of antibiotics and vitamins and returned to the group. In all but two cases when a healthy dolphin was allowed to care for the sick dolphin, the ill animal survived.

The meanings of each half of the distress call are still obscure; eventually meanings may be assignable to each half. A healthy dolphin in solitude may emit the first portion of the distress call repeatedly. This seems to be an "attention" call (without expressing distress) meant to reach any animals who may be within hearing distance. After spoor of other animals was released in the water of the isolation tank, this call was emitted by the solitaire.

Very rarely have we heard the falling tone pattern of the last half of the call without first hearing the preceding rising one. Dolphins emit many different kinds of complex whistles and whistle patterns in their vocal exchanges (*1, 2*) but this pure falling pattern is rarely found within such exchanges. The following phase (coupled to the rising one) seems to be reserved for real or potential physical distress.

The mechanism of production of this whistle as well as other whistles is still under investigation. The number of the observed areas of production (inside head with tightly closed blowhole, inside head with open blowhole, and at blowhole slit) suggests that these animals can use each of several parts of the nose for these whistles, rather than just a single area (*4, 6, 7, 9, 13, 14*).

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Developmental Pattern of Adrenal Ascorbic Acid in the Rat

Abstract. *Adrenal ascorbic acid was determined in nonstressed, newborn rats. The maturational pattern of the acid consists of high resting levels early in development, a marked decrease during a period between 8 and 12 days, and a subsequent return to high levels. The onset of the maturational pattern is accelerated by previous manipulation of the newborn rat.*

In a recent letter in this journal, Ader (*1*), in response to a paper of Schaefer *et al.* (*2*), discussed the use of ascorbic acid depletion scores as follows: "The main difficulty, however, lies in the fact that only *depletion* scores are presented. In this the authors are apparently following an unfortunate precedent [(*3*)], but a depletion score is a poor substitute for the actual values observed in stressed and nonstressed animals, since the same depletion score may be a resultant of a variety of actual values." In view of these comments, we reanalyzed the data from previous studies concerned with ascorbic acid depletion in response to cold stress in infant rats that had been manipulated from birth and in controls which had received no experimental treatment. What proved interesting from this analysis was the pattern of resting (nonstressed) values of ascorbic acid as a function of development and the differences in this maturational pattern with respect to infantile stimulation.

Previous research on the effects of infantile experiences on development have indicated that, in general, animals that have received some form of stimulation during infancy appear to exhibit an overall acceleration of growth and development. Adrenal ascorbic acid (AAA) depletion in response to cold stress (*3*) and the opening of the eyes (*4*) appear 3 to 4 days earlier in stimulated rats. Brain myelination also occurs earlier in stimulated rats (*5*), and there are differences in body weight, with the stimulated rats showing significantly heavier body weights both at weaning and in adulthood. The data presented here also indicate a difference in maturation with early experience and further demonstrate an interesting maturational pattern with respect to AAA. Some of these data are derived from previous studies.

One hundred and eighty-four infant Sprague-Dawley Holtzman rats were used as subjects. Approximately half (48♂, 47♀) the rats were subjected to a standardized manipulation procedure which consisted of removing the pups from the nest, placing them in a small compartment for 3 minutes, and returning them to the nest. The procedure was followed once daily until the infant was sacrificed. The remaining infants (48♂, 41♀) received no treatment and were not manipulated in any manner until the time they were sacrificed. Animals were sacrificed at 8, 10, 12, 14, and 16 days of age. At each of these ages, the pups were removed from their cages, killed quickly by cervical spinal separation, and weighed. Their adrenals were removed, weighed on a 25-mg Roller Smith balance, and analyzed for ascorbic acid content. Adrenal ascorbic acid was assayed by a modification of the technique used by Glick *et al.* (*6*). This procedure has been described in detail in a previous publication (*7*).

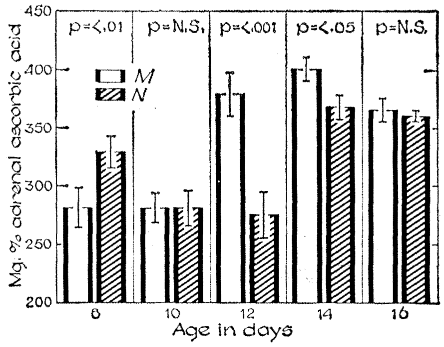

Fig. 1. Mean values of adrenal ascorbic acid at various ages. The open bars represent the values for the manipulated animals. The striped bars represent the values for the nonmanipulated animals. Small bars above and below the mean are the standard error of the mean.

The results are presented in Fig. 1. The initial analysis of sex differences proved insignificant. The data presented include both sexes and indicate that in the nonmanipulated rats the resting levels of AAA are high at 8 days of age, drop markedly at days 10 and 12, and then show a rapid rise at day 14, with an apparent leveling off after that period. In contrast, lower resting levels of AAA are apparent at 8 and 10 days of age for the manipulated animals, with rapid elevation occurring at 12 days of age and high AAA values thereafter. On the basis of these data alone, it would be difficult to plot a developmental curve of AAA values. However, Shapiro *et al.* (*8*) have recently presented values of AAA for the ages of 1 through 4 days. These data indicate that during the early periods of development AAA continues to be high. Figure 2 presents the maturational curve for AAA development in both manipulated and nonmanipulated rats. It should be noted that although the shape of the curve is essentially the same for both groups, there is a general displacement by 2 days, so that

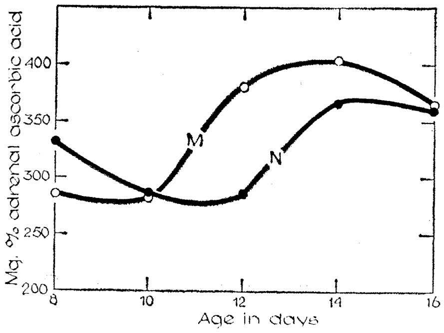

Fig. 2. Developmental curves for adrenal ascorbic acid. *M* represents the curve for manipulated infant rats, and *N* the curve for the nonmanipulated infant animals.