

H. A. Shillibeer and by Imperial Oil Limited to R. A. Burwash. The assistance of the members of the Geophysical Laboratory, University of Toronto, and the Rock Analysis Laboratory, University of Minnesota, is gratefully acknowledged.

2. H. A. Shillibeer *et al.*, *Phys. Rev.* 94, 1793 (1954).
3. G. J. Wasserburg and R. J. Hayden, *Geochim. et Cosmochim. Acta* 7, 51 (1955).
4. H. A. Shillibeer and R. D. Russell, *Can. J. Phys.* 32, 681 (1954).
5. A. O. Nier, *Phys. Rev.* 77, 789 (1950).
6. J. T. Wilson, *Trans. Can. Inst. Mining Met.* 52, 231 (1949); C. B. Collins *et al.*, *Bull. Geol. Soc. Amer.* 65, 1 (1954).

28 November 1955

## "Whirling Behavior" in Dogs as Related to Early Experience

In the course of 3 years of experimentation on the relationship of early experience in dogs (Scottish terriers) to their later behavior, there has appeared an interesting phenomenon that is worth reporting separately (1). This is the occurrence of "whirling fits" in a number of dogs that were restricted during early life.

Restriction is imposed by rearing the experimental animals from 1 to 8 or 10 months of age in isolation cages (one dog per cage) that are so constructed that the dog inside each can never see any more than the floor of the cage above or the ceiling of the room. By means of a small side compartment adjoining the living space and separated from it by a sliding panel, feeding and cleaning can be accomplished without exposing the restricted animal to the outside environment. After the period of restriction is over, the experimental "Scotties" are compared by means of psychological tests with their littermates which have been reared normally as pets in homes.

Many striking differences have appeared between the normal and the restricted dogs in all phases of behavior, including intelligence, activity, emotionality, and social behavior. These are reported in full elsewhere (2). More bizarre than any of these effects of early restriction are the afore-mentioned whirling fits. These have appeared in eight out of eleven severely restricted animals. The three exceptions, while highly active and excitable, have not, to our knowledge, shown the extreme behavior discussed here.

Whirling can be described as follows: very rapid, jerky running in a tight circle; shrill, agonized yelping; barking and snarling; and tail snapping and tail biting. The syndrome may last from 1 to 10 minutes. It is usually heralded by certain characteristic signs. The dog suddenly becomes motionless, cocking its head up and back, as if looking at its own tail. It begins to growl viciously, and its eyes take on a glazed expression.

These signs may continue for a minute or two, increasing in intensity until the full-blown fit occurs. To all appearances, whirling does not seem to be under voluntary control but to be "driven." The dog does not seem to be able to control its behavior and cannot usually be distracted even by fairly intense stimuli.

Whatever its nature and causes, whirling is a peculiar and striking form of behavior that is worth further investigation. Several points concerning it should be noted. In the first place, it seems to vary in degree, with respect to both intensity and duration.

Second, although many of the fits appear to occur spontaneously (in that the immediate causes are not known), they usually seem to be set off by some change in the stimulus-environment. This change may be anything from the mere introduction of a food dish into the cage to electric shock or restraint in a harness for a period of time.

Third, all the dogs showing whirling fits shared, to some degree, a common ancestry. All were descendants of three Scotties purchased from Hamilton Station, Bar Harbor, Maine, and bred, within themselves and to outside dogs, for several generations. However, the three animals not showing this behavior were also related to this strain. Consequently, it is difficult to make any obvious inferences concerning the possible genetic origin of the trait.

Fourth, all dogs showing whirling have had a background of severe restriction in early life. None of their normal littermates have shown such behavior. At the same time, since the three exceptions have also undergone restriction, this kind of early experience is not a sufficient condition for the appearance of the symptoms, although it may be a necessary one.

In view of the foregoing points, it is difficult to know what ultimate factors predisposed some animals to whirling fits. Diet is a possible explanation, although it could not be the only cause, since all the animals in the laboratory were fed the same amount and type of ration made up according to the specifications of several experts in dog care. All dogs received, during a typical week, meat (liver, Pard, hamburger), dog biscuits, Purina Dog Chow, vegetables, cod-liver oil, and milk while they were puppies. The restricted animals showed appetites as good or better than normals. At the same time, we cannot rule out the possibility that this diet might have been inadequate for dogs raised in severe restriction, even though it appeared to be adequate for dogs living in normal environments.

The possibility that whirling was caused by a specific irritation in the tail—thus causing the circling and tail

snapping—is unlikely. It does not seem reasonable to suppose that such extreme behavior could be set off so easily and set off only under special conditions involving a change in the sensory environment. When tail injuries did occur, they appeared definitely to be the result rather than the cause of whirling. Consequently, we are inclined to feel that the behavior is central and not peripheral in origin.

Finally, it must be mentioned that the dogs were constantly checked for signs of worms and distemper by examination of their feces and by noting any decline in appetite. There was no evidence of ill health among any of the experimental dogs during their period of restriction. After removal from restriction, they were examined more carefully by a veterinarian, with negative results.

Accordingly, there are considerable grounds for supposing that whirling is dependent, at least partly, on the conditions of restriction imposed during early life. Whether or not it can properly be described as epileptiform is a moot point. None of the parasympathetic components of true seizures were ever observed in the dogs. On the other hand, the gross features of its expression would suggest that it is essentially a related phenomenon.

WILLIAM R. THOMPSON  
*Queens University, Kingston, Ontario*

RONALD MELZACK  
*University of Oregon Medical School,  
Eugene, Oregon*

T. H. SCOTT  
*Canterbury College, Canterbury,  
New Zealand*

### References and Notes

1. The observations reported here are part of a project of the McGill Psychological Laboratory supported by a grant-in-aid from the Rockefeller Foundation. The behavior described in the article has been filmed, and the film will soon be available.
2. R. Melzack, *J. Comp. Physiol. Psychol.* 47, 166 (1954); W. R. Thompson and Woodburn Heron, *ibid.* 47, 77 (1954) and *Can. J. Psychol.* 8, 17 (1954).

1 November 1955

## Action of Some Centrally Acting Drugs on Ion Transport in Red Cells

Stimulation of excitable tissue is known to be followed by a decrease in membrane potential, which is accompanied by an increased permeability of the tissue to sodium and potassium (1). Thus, the cell, on stimulation, loses potassium and gains sodium. During recovery, sodium is removed from the cell and potassium is replaced. The recovery process depends on the active transport of one or both cations, since the movement is against the concentration gradient.

When human blood is refrigerated, the