tion of certain aromatic compounds, such as brombenzene and polycyclic hydrocarbons, have been implicated in hepatotoxicity (*19*) and chemical carcinogenesis (*18*).

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Resistance of Wild Norway Rats in North Carolina to Warfarin Rodenticide

Abstract. *Reports concerning the ineffectiveness of warfarin rodenticide, used at farms and stores in a rural area about 8 kilometers in diameter near Raleigh, North Carolina, prompted subsequent laboratory testing. All of the 25 Norway rats trapped from the area survived 6 days of no-choice feeding of bait containing 0.025 percent (by weight) warfarin.*

Inherited resistance to the anticoagulant rodenticides by Norway rats (*Rattus norvegicus*) in northern Europe, especially Britain and Denmark, has been well documented (*1, 2*). Despite intensive efforts to eradicate Norway rats, resistance, first recognized in 1958, has spread geographically (*3*). Recently resistance has also been found in roof rats (*Rattus rattus*) (*4*). In most populations of Norway rats studied a single, dominant allele appears involved; cross-resistance to all other anticoagulants is frequently, but not always, present (*5*).

In the summer of 1971 an apparently similar resistance was confirmed in Norway rats from a rural area near Raleigh, North Carolina. The local pest control operator (S. G. Flowers, Smithfield, North Carolina), who found it increasingly difficult to maintain control over the rat population, initially blamed poor technique and materials and then suspected resistance. Laboratory studies confirmed his suspicion.

Rats were trapped alive at six farms and two rural stores in the suspected resistance area (about 8 km in diameter) and shipped by air to our laboratory for testing. Standard test procedures recommended by the World Health Organization were employed (*6*). Rats were caged individually and, after a stabilization period of at least a week, were subjected to a no-choice, 6-day feeding test with bait (ground Purina rat chow) containing 0.025 percent (by weight) warfarin. Survivors, continued on placebo bait, were observed for a minimum of 22 days.

All of the North Carolina rats survived this test (and thus were declared resistant); several groups of Norway rats from Cleveland (the Hough district where anticoagulant rodenticides have long been employed) and several groups from rural northwestern Ohio died (Table 1). Resistant rats survived warfarin dosages (dosages were determined on the basis of the number of milligrams of warfarin per kilogram of body weight) up to five times those consumed by the controls. Lund's finding (*2*) that the amount of food consumed by resistant rats on test days

Table 1. Summary of the results of feeding tests of wild Norway rats subjected to 6-day, no-choice feeding tests with 0.025 percent warfarin in ground Purina rat chow. Only the North Carolina rats survived.

Source	*N*	Sex	Mean weight body (g)	Bait (g/day per kilogram)	Warfarin (mg/day per kilogram)	Total warfarin (mg/kg)
North Carolina	13	M	301	93.8	23.5	140.8
North Carolina	12	F	186	97.9	24.5	146.8
North Carolina (total)	25	M + F	246	95.9	24.0	143.9
Northwestern Ohio (rural)	4	M + F	227	61.6*	15.4*	107.3†
Northwestern Ohio (rural)	2‡	M + F	165	91.6*	22.9*	76.6†
Cleveland (Hough district)	11	M	233	77.3*	19.1*	67.4†
Cleveland (Hough district)	7	F	198	80.0*	19.8*	78.8†
Cleveland (Hough district) (total)	18	M + F	212	78.8*	19.5*	74.4†
Laboratory (white rats)	4	M	450	40.6*	10.1*	39.6†

* Based on the first 3 days of the test only, because there was a reduction in the amount of bait consumed per day shortly before death. † All rats were dead after 5 to 8 days. ‡ These rats were fed a prolin (warfarin plus an antibiotic) bait.

5 through 6 was no less than about 75 percent of that on days 1 through 2 was not true for three of the North Carolina rats.

This is the first confirmed case of resistance to anticoagulant rodenticides by Norway rats in the United States. It is not known whether cross-resistance to all anticoagulants occurs, or whether a single autosomal gene is involved, or whether the phenomenon is present but not fully recognized in other U.S. populations (*7*). Details of the North Carolina field and test data have been presented elsewhere (*8*).

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9. We appreciate the assistance of C. Wright in identifying the resistance site, of D. Patterson in collecting the rats in North Carolina, and of B. Walker and B. Marsh in collecting the rats in Cleveland. Supported by a grant from the research committee of the National Pest Control Association and by the Cleveland Health Department.

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Cardiac Change as a Function of Attention to and Awareness of Continuous Verbal Text

Abstract. *A 17-minute passage taken from a patient's talking in a psychoanalytic interview was played to 40 subjects, including trained therapists, therapists in training, and inexperienced undergraduates. Subjects were alerted to the organizing theme (termination of the patient's treatment) and asked to attend to direct and indirect references to this theme. Tonic heart rate, averaged over 30-second periods, was lower when clues were present on the tape than during control periods when clues were not present. Profiles of phasic heart rate were drawn for 11-second periods that overlapped the end of each clue and control passage. Profiles associated with clues were significantly lower than profiles for control passages; profiles for recalled and recognized clues showed a wave form distinct from that of profiles associated with unrecognized clues.*

Heart rate tends to drop when attention is directed to an external stimulus (*1, 2*). Two types of changes have been reported. A tonic decrease was found by Lacey *et al.* (*3*) in a study of the effect of different types of stimulus situations on mean heart rate; mean rates tended to decrease in situations that required attention outward (for instance, flashing lights) and tended to increase in situations that required attention inward (such as mental arithmetic). A phasic decrease was reported by Lacey (*2*) in a reaction-time experiment. Heart rate was monitored beat-by-beat from the time a warning signal flashed to the time the subject made a motor response; heart rate showed a systematic drop during the preparatory interval, and reached a minimum at the moment when the response was made. He also found that reaction time was inversely correlated with the size of the drop.

The stimuli used in most of these studies have been fairly explicit and isolated in time; examples are warning tones, flashing lights, and discrete pictures. We wanted to determine whether subtle differences in meaning, when embedded in continuous prose, would also be reflected in tonic and phasic changes in heart rate. If stable cardiac measures could be found, they might permit continuous monitoring of attention with a minimum of interference. Lacey's formulation would predict both the decrease and stabilization in mean heart rate and in beat-by-beat changes at time points when attention was being directed to parts of the stimulus. We also wished to determine how physiological changes interacted with conscious awareness. Were these changes always an accompaniment of awareness, or did they sometimes occur independently of it? If the latter were the case, could attention be gauged more sensitively by cardiac responses than by cognitive measures of awareness?

The stimulus consisted of a 17-minute, tape-recorded segment of a patient talking during a psychoanalytic session. Only the patient's voice was heard. Three practicing psychoanalysts listened to the tape and indicated those parts that, in their opinion, pertained to the theme of termination of treatment; from their ratings, 22 references were selected. Some were clear references to termination in a disguising context (*Independence* Day; *Liberty,* Kansas), and some used metaphor or analogy ("When do you wean the baby?"; "I dreamed of being on a long train trip and having to get off"). The clues were carefully spaced by filler words and silence so that the median separation was 22 seconds; only one pair of clues was less than 10 seconds apart.

Each of the 22 termination clues was marked by a tone on the second track of the stimulus tape (the text of the stimulus was on the first track). The 20 control clues were marked by a different tone. Neither tone was audible to the subject. None of the control clues had been chosen by any of the original judges as a reference to termination; these clues consisted of such filler phrases as "That doesn't happen very often," "Assuming it was obvious," and so forth. The control clues were spaced at least 11 seconds from each other and from any of the termination clues. The marker tones were positioned to coincide with the last word in each clue phrase. The tones were used in the data analysis to mark the heart beats associated with each clue; a special program searched for each tone and computed the beats-per-minute heart rate for the 5 seconds before and after each tone.

Forty subjects, about equally divided among professional therapists, therapists in training, and inexperienced undergraduates, were asked to listen to the tape and pay particular attention to references to termination of treatment. Examples of such references were not given; rather, the subjects were free to choose whatever appealed to them as a clue, but they were asked not to talk or make any motor response while the tape was running. The subjects were told to be ready to recall the references to termination in their original wording after the tape had stopped. Electrodes were then attached to the index and middle fingers of the left hand, to the right wrist, and to the left ankle; leads ran to an Electronic Industries data logging system, which made a digital