later blood samples were obtained by intracardiac puncture and C′ was determined (left-hand values). Five hours after the intradermal injections, four animals of the first group were injected intravenously with 0.5 mg pepsin-digested anti-HuGG and the remaining four, as well as the three previously injected with diluent, with 0.5 mg native anti-HuGG. A second sample of blood was obtained 10 minutes after the intravenous injection and C′ was redetermined (right-hand values). The serum from animals injected intradermally with diluent showed only slight changes after injection with native antibodies (negative control). Those sera from animals injected intradermally with HuGG and intravenously with native anti-HuGG showed marked drops (positive control). The sera from the experimental group, injected intradermally with HuGG and intravenously with pepsin-digested anti-HuGG showed only insignificant changes.

The experiments reported indicate that equivalent weights of pepsin-digested and native antibodies have equal capacities to produce the reverse PCA phenomenon in the guinea pig. In contrast, these studies do not demonstrate in vitro or in vivo C′ fixation by the pepsin-digested anti-HuGG-HuGG system. Splitting bivalent 5*S* antibody fragments into 3.5*S* monovalent fragments sharply decreases reverse PCA activity. Hence, the valence or the molecular weight of an antibody molecule or both appear to be of critical importance in the mechanism of the reverse passive cutaneous anaphylaxis reaction (*14*). Since this paper was submitted, a paper has been published which questions the role of naturally occurring nonprecipitating or "univalent" antibodies in immediate hypersensitivity (*15; 16*).

ZOLTAN OVARY
ANGELO TARANTA
Departments of Pathology and *Medicine* and *Rheumatic Diseases Study Group, New York University School of Medicine, New York 16,* and *Irvington House, Irvington-on-Hudson, New York*

References and Notes

1. A. J. Weil, A. M. Moos, F. L. Clapp, *J. Immunol.* **37**, 413 (1939); A. Taranta and E. C. Franklin, *Science* **134**, 1981 (1961); K. Amiraian and E. J. Leikhim, *Proc. Soc. Exptl. Biol. Med.*, **108**, 454 (1961).
2. K. Ishizaka, T. Ishizaka, T. Sugahara, *J. Immunol.* **88**, 690 (1962).
3. A. Nisonoff, F. C. Wissler, L. N. Lipman, D. L. Woernley, *Arch. Biochem. Biophys.* **89**, 230 (1960).
4. A. G. Osler, in *Advances in Immunology*, W. H. Taliaferro and J. H. Humphrey, Eds. (Academic Press, New York, 1961), vol. 1, p. 181.
5. A. Nisonoff, G. Markus, F. C. Wissler, *Nature* **189**, 293 (1961).
6. E. A. Kabat and B. Benacerraf, *J. Immunol.* **62**, 97 (1949); Z. Ovary and G. G. Biozzi, *Intern. Arch. Allergy Appl. Immunol.* **5**, 241 (1954).
7. W. O. Weigle and P. H. Maurer, *J. Immunol.* **79**, 211 (1957).
8. Z. Ovary, *Immunology* **3**, 19 (1960).
9. ———, in *Progress in Allergy*, P. Kallós, Ed. (Karger, New York, 1958), vol. 5, p. 459.
10. C. L. Christian, *J. Immunol.* **84**, 112 (1960).
11. E. A. Kabat and M. M. Mayer, *Experimental Immunochemistry* (Thomas, Springfield, Ill., ed. 2, 1961), pp. 149, 72, and 214.
12. K. Ishizaka and T. Ishizaka, *J. Immunol.* **85**, 163 (1960).
13. A. G. Osler, *Bacteriol. Rev.* **22**, 246 (1958).
14. P. Hartley, *Proc. Roy. Soc. London, Ser. B.*, **138**, 499 (1951).
15. A. G. Osler, in *Mechanism of Cell and Tissue Damage Produced by Immune Reactions—2nd International Symposium on Immunopathology*, P. Grabar and P. Miescher, Eds. (Schwabe, Basel 1962), p. 51.
16. Supported by the Health Research Council of the City of New York, contract No. I-140, and by grants from the U.S. Public Health Service (Nos. E-3075, E-2099 and A-5055) and from the New York Chapter of the Arthritis and Rheumatism Foundation.

21 February 1963

Lingual Vein Injection in the Rat

Abstract. *The difficulties encountered with repeated intravenous injections in rodents limit many experiments. A method is described which employs the lingual veins of anesthetized rats and which allows for repeated intravenous administration of fluids and cells in young rats and hamsters.*

The difficulties of surgery on small animals limit many experiments. In particular, the low number of repeated intravenous injections that can be given to small laboratory animals is a common restriction forced upon experimentalists by the fragility and paucity of superficial veins. The advantages of making injections into the lingual veins of the rat have been demonstrated and the technique is now described, since it is neither used commonly nor presented in standard works (*1*).

The anesthetized rat is placed on its back and the tongue is drawn out with fine-toothed forceps to one side of the incisor teeth. The body of the tongue is wiped dry with gauze and held between the left thumb and forefinger. Traction is applied without hindrance to respiration, so that the pair of veins on the under surface are exposed near the root of the tongue. If open ether anesthesia is used, it can be maintained by inserting the upper jaw and nostrils of the rat into a narrow glass or metal anesthesia cone; at the same time the injection is made easier by the stabilization of the head and neck. A sharp, 25-gauge needle easily enters even the small lingual veins of young 50- or 60-g rats. The point of the needle and the entering injection fluid can be seen readily through the thin wall of the vein. With the animal suitably placed on a small operating board and the operator's hands comfortable, the position can be held for 15 to 20 minutes while large volumes or slow infusions are given. Finger and thumb pressure is applied over the puncture as the needle is withdrawn and for 2 or 3 minutes thereafter. This prevents the formation of a perivenous hematoma which would jeopardize repeated venipunctures.

In one series of experiments, courses of intravenous injections were given to 45 rats by the lingual route. At least six injections were given to each rat on alternate days and into alternate lingual veins. All the injections were successful. The method is applicable to hamsters and to other small animals used in the laboratory (*2*).

J. MAXWELL ANDERSON
Department of Pathology, Dartmouth Medical School, Hanover, New Hampshire

References and Notes

1. R. E. Billingham and W. K. Silvers, *Transplantation of Tissues and Cells* (Wistar Institute Press, Philadelphia, 1961); J. Q. Griffith and E. J. Farris, *The Rat in Laboratory Investigation* (Lippincott, Philadelphia, 1942); Universities Federation for Animal Welfare, *Handbook on the Care and Management of Laboratory Animals*, A. N. Worden and W. Lane-Petter, Eds. (U.F.A.W., London, ed. 2, 1957); M. F. A. Woodruff, *The Transplantation of Tissues and Organs* (Thomas, Springfield, Ill., 1960).
2. Supported by U.S. Public Health Service grant GM 10210-01.

1 March 1963

Reaction Time as a Function of the Cardiac Cycle in Young Adults

Abstract. *Simple reaction times to auditory stimuli varied with the phase of the cardiac cycle in which the stimuli were presented, tending to be fastest to stimuli presented during the P-phase of the electrocardiogram. One hundred reaction times obtained from each of 56 men and women between the ages of 20 and 30 years were analyzed.*

Reaction time in human subjects is related to certain aspects of cardiovascular functioning, pulse rate (*1*), variation in pulse rate (*2*), and blood pressure (*3*). Also, earlier work has shown a relationship between reaction time and the electroencephalogram (EEG) (*4*). Arterial pressure fluctuations, by affecting the baroreceptors of

Table 1. Mean simple auditory reaction times according to the phase of the cardiac cycle in which the stimuli were presented; 31 men, 25 women.*

Item	Time (sec)			
	P	QRS	T	T-P
		Men		
Mean	0.1418	0.1502	0.1487	0.1481
S.D.	.023	.0276	.035	.0275
		Women		
Mean	.1482	.1568	.1574	.1546
S.D.	.0199	.0283	.0287	.0295

* Mixed-model analyses of variance were carried out separately for males and females and for the combined groups; the Hotelling T^2 statistics were significant at nearly the .10 level in each of the separate analyses (*9*) and at the .01 level for the combined sexes. The differences in mean reaction times to stimuli presented at QRS and P phases were tested by the Scheffe Multiple Comparison Procedure (*9*); significance obtained at the .05 level for males and at the .10 level for females, and at the .005 level in the combined analysis (*10*).

the arterial system (*5*), in turn affect the central nervous system and can thus influence not only the quantity of electrical activity in the efferent cardiovascular nerves—within the time span of a heart cycle (*6*)—but also the frequency and amplitude of the electrocorticogram (*7*). There also may be an association between the number of erroneous psychomotor responses and the phase of the cardiac cycle in which the stimuli are presented (*8*). These facts suggest that it is desirable to determine whether there is a relationship between simple reaction time and the cardiac cycle. Specifically, the speed of simple auditory reaction time was studied in relation to the phases of the cardiac cycle in which the stimuli occurred.

The experimental procedure required the subject to react as quickly as he could to an auditory signal by lifting his index finger from a telegraph key.

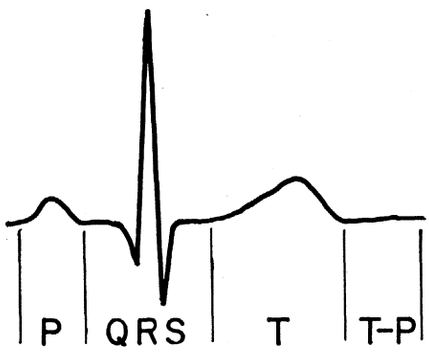

Fig. 1. Representation of the cardiac cycle by a normal electrocardiogram. Vertical lines arbitrarily divide the cycle into the four intervals used for the analysis of the reaction time data as shown in Table 1. Letters are those conventionally used to designate the principal deflections of the EKG.

A simultaneous electrocardiograph record was marked with a signal for the occurrence of the stimulus. Reaction times were read from a time clock which recorded to 0.01 second. After instructions and example stimuli, each subject had 100 reaction-time measurements. The auditory stimulus was a 1000-cycle tone presented through earphones at about 80 db. After each reaction the subject waited for 2 seconds after which a warning lamp glowed and the subject replaced his finger on the key. One second after he replaced his finger, the auditory signal was presented. As "catch stimuli" 10-second delays (10 percent) were included at random in the series in place of the regular 1-second intervals. Reactions to catch stimuli and the succeeding reaction times were not included in the analyses of the data. The reaction times of each subject were categorized according to four phases of the cardiac cycle in which the corresponding stimuli were presented. For each subject, a median reaction time was derived for each of the four phases of the electrocardiogram (EKG). A total of 31 men and 25 women between the ages of 20 and 30 years, were the subjects, of whom 9 were normal volunteers of the Clinical Center of the National Institutes of Health and 47 were employees.

Figure 1 shows the intervals into which the EKG was divided in the analysis. Mean reaction times corresponding to these intervals are given in Table 1.

The data show reactions to stimuli presented during the P-phase of the EKG were significantly faster than to stimuli presented during subsequent intervals. The difference between the P and QRS interval reaction times was 0.0094 second for the men and 0.0086 second for the women. These differences are about the same order of magnitude as previously reported for variations in reaction time as a function of the EEG (*4*). Apparently cyclical changes in alerting are associated with both the EEG and the EKG. Although the results clearly show a significant difference ($p < .01$) in favor of a faster reaction time when the stimuli are presented during the P-phase of the EKG, not all subjects displayed the phenomenon. This may be a matter of rather basic individual differences or possibly a matter of the degree of physiological arousal at the time the subjects were measured. A number of physiological mechanisms might account for the present results. Further studies are needed to identify mechanisms in this relationship. This variation in reaction time should not be confused with a relationship of reaction time and vascular disease which, because of damage to the nervous system, may result in a slowing of reaction time.

JAMES E. BIRREN
PHILIPPE V. CARDON, JR.
SHIRLEY L. PHILLIPS
National Institute of Mental Health, Bethesda 14, Maryland

References and Notes

1. J. J. van Biervliet, *Philosophische Studien* **10**, 160 (1894).
2. J. I. Lacey and B. C. Lacey, in *Proc. Assoc. Res. Nervous Mental Disease* **36**, 144 (1958).
3. J. W. Clark, *J. Gerontol.* **15**, 183 (1960).
4. E. Callaway, III, and C. L. Yeager, *Science* **132**, 1765 (1960); R. E. Dustman, R. S. Boswell, P. B. Porter, *ibid.* **137**, 533 (1962).
5. E. Neil, *Physiol. Rev.* **40**, Suppl. 4, 201 (1960).
6. D. W. Bronk, L. K. Ferguson, R. Margaria, D. Y. Solandt, *Am. J. Physiol.* **117**, 237 (1936).
7. M. Bonvallet, P. Dell, G. Hiebel, *Electroencephalog. Clin. Neurophysiol.* **6**, 119 (1954).
8. J. I. Lacey and B. C. Lacey, *Proc. Assoc. Res. Nervous Mental Disease* **36**, 206 (1958).
9. H. Scheffé, *The Analysis of Variance* (Wiley, New York, 1959).
10. We thank Donald F. Morrison for statistical consultation and assistance.

7 February 1963

Inheritance of Behavior in Infants

Abstract. *Mental and motor abilities and personality development were studied in 20 pairs of infant twins of the same sex on a monthly basis in their first year, that is, before mutual imitation becomes a factor. Blood group determinations, made after the study was completed, revealed an* N_1 *of 11 fraternal and* N_2 *of 9 identical pairs. Within-pair differences were significantly greater within fraternal pairs on all tests and rating scales.*

The majority of longitudinal studies of infants and children have indicated that there is consistency in personality within individuals over the years (*1*), but the role that heredity has played in this can only be surmised. We have applied the twin method to a longitudinal study in order to investigate the role of heredity.

Twenty pairs of twins of the same sex were examined on a monthly basis in their own homes in their first year. Zygosity was determined at the end of the study on the basis of non-concordance or concordance on 13 blood-group factors. We found an N_1 of 11 fraternal