resent its area, is proportional to $a \cos\alpha_1$, where α_1 is the angle $P_1M_2M_1$ and, as the attraction varies inversely with the distance, the attractive force exerted by each semi-circle on M_2 is, if g is a constant and since P_1M_2, the distance at which this force acts is $d \cos\alpha_1$,

$$\frac{ga\cos\alpha_1}{d\cos\alpha_1} = \frac{ga}{d}$$

The attractive force of the upper semi-circle is exerted on M_2 in the direction M_2P_1 and its component along M_2M_1 is $ga\cos\alpha_1/d$ while, for the entire circle, the attraction is $g\ 2a\cos\alpha_1/d = g\ A\cos\alpha_1/d$. If now, the circle AB is rotated through 180° it will generate the sphere AB and what is true for each of its sections will be true for its mass. The attraction of M_1 for M_2 therefore is, $gM_1\cos\alpha_1/d$ and, in an exactly similar manner, the attraction of M_2 for M_1 is $gM_2\cos\alpha_2/d$. The total force of attraction F, which is that of Gravitation, between the two spheres is, then, the product of the individual forces, thus,

$$F = \frac{g\,M_1\cos\alpha_1}{d} \times \frac{g\,M_2\cos\alpha_2}{d} = g^2\frac{M_1\cos\alpha_1 \times M_2\cos\alpha_2}{d^2} \quad (1)$$

and this, when G is written for g^2, is an advanced statement of the law of gravitation.

The relative acceleration f of the spheres M_1 and M_2 therefore is,

$$f = G\frac{M_1\cos\alpha_1 + M_2\cos\alpha_2}{d^2} \quad (2)$$

In nearly all cases $\cos\alpha_1$ and $\cos\alpha_2$ are so close to unity that no practical difference between the above formula and that of Newton can be detected. However, the value of $\cos\alpha$ for the Sun, at the distance of Mercury, is such as to point a reason for the observed "advance" of the perihelion of that planet. To this end the acceleration of Mercury has been computed for three positions with the center of gravity of the Sun's semi-circular area at 0.28 of its radius from its center and the following tabulation presents the values of the exponent of d in Newton's law which are necessary to produce the accelerations given by formula (2) above.

Position of Mercury	Necessary exponent of d in Newton's Law
Aphelion	2.00000013
Mean	2.00000019
Perihelion	2.00000031

Allowing for the longer time spent by Mercury in the outer portion of its orbit, the mean value of the exponent of d necessary to conform the law of Newton with formula (2) is 2.000000192 and this is comparable with the value of 2.000000161 which was suggested[1] in order to account for the then known advance of 42″ per century in the position of the perihelion point. Now, if the exponent 2.000000161 accounts for an advance of 42″, then the exponent 2.000000192 represents an advance of 50.″1 per century, which value compares with the recent determination[2] by Morgan of 50.″9.

The quantitative agreement which has been shown between the observed and the computed values for the advance of Mercury's perihelion is of especial interest and the principles on which this finding is based extend into many fields. The placing of the center of gravity of the sun's semi-circular section at the 0.28 point of its radius is merely a recognition that the density of the sun increases toward its center. In a homogeneous sun this ratio would be 0.4244.

A detailed outline of the studies on which the conclusions herein presented are founded is being prepared.

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NEW YORK CITY
December 14, 1932

SOME FACTORS INFLUENCING THE SUSCEPTIBILITY OF ALBINO RATS TO INJECTIONS OF SODIUM AMYTAL[1]

IN an earlier account[2] of the use of sodium amytal (Lilly) as an anesthetic for albino rats a sex difference in the reaction to the drug was noted. The concentration of the solution in which the anesthetic was given was found to have a marked effect upon its efficacy. These two facts have been investigated in an attempt to analyze further the action of the anesthetic.

A record has been kept of the amount of sodium amytal in a 10 per cent. solution required to produce anesthesia in male animals of weights ranging between thirty and four hundred grams. These animals have been anesthetized in experiments of various types during the past year and a half. From these individual records Fig. 1 has been composed. A total of over one thousand observations have been made on animals of varying weights.

In the graph the weight of the animals has been plotted against the milligrams of sodium amytal in a 10 per cent. solution necessary to produce a deep anesthesia from which the animal will recover. This extends the observations on the dosage required for

[1] Simon Newcomb, article, "Gravitation." Encyclopaedia Britannica, 9th Edition.

[2] H. R. Morgan, *Jour. Optical Society of America*, Vol. 20, p. 228.

[1] The sodium amytal used in these experiments was generously furnished by Eli Lilly and Company.

[2] J. S. Nicholas and D. H. Barron, *Jour. of Pharmacol. and Exper. Therapeut.*, 46: pp. 125–130, 1932.

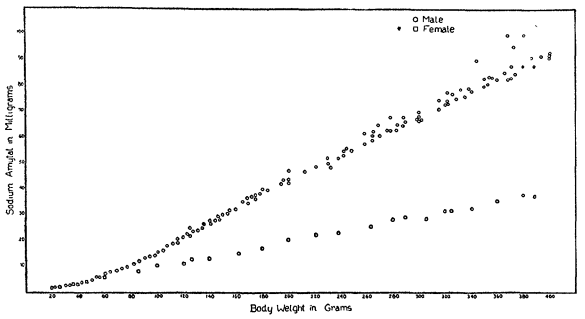

FIG. 1. A graph illustrating the relation between the body weights of albino rats and the amount of sodium amytal in milligrams necessary to produce deep anesthesia.

male rats which in a previous report were obtained only upon males ranging between one hundred and twenty-five and two hundred and fifty grams in weight. For comparison, the dosage for females of a corresponding range of weights has also been plotted. The graph therefore demonstrates the sex difference in the reaction to sodium amytal and defines clearly the weight at which this sex difference appears.

To determine whether or not the greater resistance of the male rats was to be associated with the presence of the gonads, ten adult male rats weighing about one hundred and seventy-five grams each were castrated. Six weeks later these animals were weighed and given the male dose normal for their weight. None of the animals survived. A second group of five adult animals about two hundreds grams in weight were castrated and anesthetized at the end of six weeks. These animals were more resistant to sodium amytal than females but were markedly less resistant than normal males.

A third series of ten young males about thirty grams each were castrated. Each week following castration the animals were anesthetized. The normal male dose for their weight was invariably necessary to produce deep anesthesia. These animals were castrated before they had developed the sex difference in their reaction to sodium amytal; nevertheless they retained the resistance normal to uncastrated males throughout their growth and development. The resistance of males castrated before the sex difference has appeared, therefore, is unaltered, but males castrated when adults become definitely more susceptible.

Although not more than suggestive, it is interesting to note that the weight at which the sex difference appears—between fifty and sixty grams—is also the weight at which the differential growth relation of both the hypophysis and the suprarenals first appear between the males and females.[3] The female rat has the heavier hypophysis and suprarenal glands.

The effect of the dilution of the solution of sodium amytal with which anesthesia is produced has been discussed earlier. The animals were much more resistant to equal quantities of the drug if administered in more dilute solutions. This fact suggested that injections of mammalian Ringer's into the blood stream of an over-anesthetized animal might reduce the effectiveness of the original dose and aid in the recovery of the animal.

Both males and females were injected with one and a half times the normal dose for their weight. After the animal was well under the anesthetic the femoral vein was exposed and eight cubic centimeters of mammalian Ringer's—either warm or cold—was injected into the blood stream. The controls were anesthetized in the same way but were not injected with Ringer's. All the animals that received the injection of Ringer's solution (ten) recovered from the anesthetic. The ten control animals, however, all died from respiratory failure typical of over-anesthetized animals. This method of reducing the effectiveness of the drug by injections of Ringer's into the blood stream has proved of value in saving an occasional animal which is more susceptible to sodium amytal than the normal.

These facts appear to be directly related to the action of sodium amytal, for rats demonstrate no sex difference to nembutal. The dose for both males and females is the same as the male dose of sodium amytal in a ten per cent. solution. The injection of Ringer's into the blood stream of rats over-anesthetized with nembutal is not effective.

The injection and dilution experiments indicate that resistance to sodium amytal is in some way related to the water metabolism of the animal. This is further supported by the correlation between the time of the development of the sex difference in rats and the differential growth rate of the hypophysis and the suprarenal glands. The castration experiments then imply that in the adult the testes influence the water metabolism control, although when removed before this function is developed, other factors within the body compensate for their loss.

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SIBLING RESEMBLANCE AND ITS RELATION TO AGE INTERVAL

STOCKS[1] has recently published an investigation in which the resemblance of siblings in a number of

[3] H. H. Donaldson, "The Rat: Data and Reference Tables." Memoirs of the Wistar Institute of Anat. and Biol., No. 6, Philadelphia, pp. 469, 1924.

[1] Percy Stocks, "A Biometric Investigation of Twins and Their Brothers and Sisters," *Annals of Eugenics*, 4: 49–108. 1930.