

RC 455

.R78

ALF

STUDY OF HEREDITY IN
INSANITY IN THE LIGHT OF THE
MENDELIAN THEORY

ROSANOFF

A STUDY OF HEREDITY IN INSANITY IN THE LIGHT OF THE MENDELIAN THEORY.

By A. J. ROSANOFF, M. D.,

AND

FLORENCE I. ORR, B. S.,

Kings Park State Hospital, Kings Park, N. Y.

From the earliest times physicians have recorded observations of the transmission of nervous diseases by heredity.

In modern times the accumulation of large amounts of material in the shape of clinical statistics published by hospitals has established beyond question the fact that heredity plays an essential part in the etiology of certain neuropathic conditions. Table I shows some statistical figures selected at random.

TABLE I.

	Total number of cases with known histories.	Cases showing heredity.	
		Number.	Per cent.
Report of New York State Commission in Lunacy for the year ending September 30, 1909.....	2,467	1,259	51.0
Report of Michigan Asylum for the Insane, at Kalamazoo, for the years 1859-1908.....	8,531	4,800	56.3
Report of Rhode Island State Hospital for the Insane for the year ending December 31, 1910.....	250	137	54.8

Figures such as these are for all forms of insanity, including those which occur on a basis of exogenous causes; yet even as they are, their significance becomes quite apparent when they are compared with figures representing the frequency of a neuropathic family history among normal subjects: 3 per cent according to Jost, 7.5 per cent according to Näcke.¹

Aside from statistical data, studies of individual cases have revealed, on the one hand, the facts of atavistic and collateral heredity, and on the other hand, the fact of the frequent failure of transmission of neuropathic traits. In other words, there

¹ Cited by Kraepelin, *Psychiatrie*, 7th ed., Vol. I, p. 116.

seemed to be no regularity in the working of heredity, and the generally accepted conclusion on the subject has been well voiced by Kraepelin: "We must therefore regard the statistics of heredity in insanity merely as facts of experience without finding in them the expression of a 'law' which should hold in every case."²

In recent years, however, it has been shown that human heredity, at least as far as certain traits are concerned, is subject to general biological laws. Special mention may be made of color of eyes,³ color of hair,⁴ form of hair,⁵ brachydactyly,⁶ some forms of cataract,⁷ and retinitis pigmentosa,⁸ as human traits which have been shown to be transmitted from generation to generation in accordance with the Mendelian theory.

As regards insanity and allied neuropathic conditions, the facts to which we have already referred, namely, the facts of atavistic and collateral heredity, direct heredity, and the frequent failure of transmission seem to point plainly to alternative inheritance. This suggests the likelihood of a mechanism of inheritance according with the Mendelian theory, and the present study has been undertaken with a view to determining whether indeed the neuropathic constitution is transmitted in the manner of a Mendelian trait.

§ I. THE MENDELIAN THEORY.⁹

Perhaps a brief statement of the Mendelian theory will not be out of place here.

The total inheritance of an individual is divisible into unit characters, each of which is, as a general rule, inherited independently of all other characters and may therefore be studied without reference to them.

² *Loc. cit.*

³ Davenport, *Science*, N. S., Vol. XXVI, Nov. 1, 1907. Hurst, *Proc. Roy. Soc.*, Vol. LXXX B., 1908.

⁴ Davenport, *The Amer. Naturalist*, Vol. XLIII, Apr., 1909.

⁵ Davenport, *Loc. cit.*, Vol. XLII, May, 1908.

⁶ Farabee, *Papers of Peabody Museum*, III, 3, 1905.

⁷ Nettleship, *Rep. Roy. London Ophth. Hosp.*, XVI, 1905.

⁸ Nettleship, *Loc. cit.*, XVII, Parts I, II, and III.

⁹ This section is for the most part reprinted from the Preliminary Report made shortly after the present study was begun. (Cannon and Rosanoff, *Jour of Nerv and Ment. Disease*, May, 1911.)

The inheritance of any such character is believed to be dependent upon the presence in the germ plasm of a unit of substance called a *determiner*.

With reference to any given character the condition in an individual may be *dominant* or *recessive*: the character is dominant when, depending upon the presence of its determiner in the germ plasm, it is plainly manifest; and it is recessive when, owing to the lack of its determiner in the germ plasm, it is not present in the individual under consideration.

The dominant and recessive conditions of a character are designated by the symbols D and R respectively.

Thus in the case of eye color the brown color is the dominant condition and the blue color is the recessive condition. In other words, the inheritance of brown eyes is due to the presence in the germ plasm of a determiner upon which the formation of brown pigment in the anterior layers of the irides depends, while the inheritance of blue eyes is due to the lack of determiner for brown pigment in the germ plasm, for the blue color of eyes is due merely to the absence of brown pigment, the effect of blue being produced by the choroid coat shining through the opalescent but pigment-free anterior layers of the irides in such cases.

It is obvious that as regards any character an individual may inherit from both parents—*duplex inheritance*, designated by the symbol DD,—or from one parent only—*simplex inheritance*, designated by the symbol DR,—or he may fail to inherit from either parent—*nulliplex inheritance*, designated by the symbol RR; in the last case the individual will exhibit the recessive condition.

We are now in a position to estimate the relative number of each type of offspring according to theoretical expectation in the case of any combination of mates.

There are but six theoretically possible combinations of mates. Continuing to make use of eye color as an instance of a Mendelian character, let us consider in turn each theoretical possibility.

1. Both parents blue-eyed (nulliplex): all the children will be blue-eyed, as may be shown by the following biological formula:

$$RR \times RR \infty RR.$$

2. One parent brown-eyed and simplex (that is to say inheriting the determiner for brown-eye pigment from one grandparent only), the other blue-eyed: one-half of the children will be brown-eyed and simplex and the other half blue-eyed:

$$DR \times RR \infty DR + RR.$$

3. One parent brown-eyed and duplex, the other blue-eyed: all the children will be brown-eyed and simplex:

$$DD \times RR \infty DR.$$

4. Both parents brown-eyed and simplex: one-fourth of the children will be brown-eyed and duplex, one-half will be brown-eyed and simplex, and the remaining one-fourth will be blue-eyed (nulliplex):

$$DR \times DR \infty DD + 2DR + RR.$$

5. Both parents brown-eyed, one duplex the other simplex: all the children will be brown-eyed, half duplex and half simplex:

$$DD \times DR \infty DD + DR.$$

6. Both parents brown-eyed and duplex: all the children will be brown-eyed and duplex:

$$DD \times DD \infty DD.$$

It will be seen from these formulæ that in attempting to predict the various types of offspring that may result from a given mating it is necessary to know not only whether the character is in each parent dominant or recessive, but in the case of the dominant condition also whether it is duplex or simplex.

Turning again to the example of eye color, a blue-eyed individual we know to be nulliplex, as he has no brown pigment in his eyes and therefore could not have inherited the determiner for brown-eye pigment from either parent. But how are we to judge in the case of a brown-eyed person whether he has inherited the determiner for that character from both parents or only from one? We can judge this only by considering the ancestry and offspring of the individual.

To put the whole matter in a nutshell, the essential difference between the dominant and the recessive conditions of a character lies in the fact that in a case of simplex inheritance the dominant condition is plainly manifest, while the recessive condition is not apparent and can be known to exist only through a study of ancestry and offspring.

This is important because it constitutes the criterion which enables us to determine whether any given inherited peculiarity or abnormality is, as compared with the average or normal condition, dominant or recessive.

§ 2. DESCRIPTION OF MATERIAL.

The total amount of psychiatric material which is available at this hospital is very large. We found, however, that for various reasons, to be spoken of presently, the greater part of the material could not be utilized in our study.

In selecting cases our aim has been to exclude all those forms of insanity in the causation of which exogenous factors, such as traumata, alcoholism, and syphilis, are known to play an essential part; and we have also systematically excluded psychoses which occur upon a basis of organic cerebral affections, such as tumors, arteriosclerosis, apoplexy, and the like. We are not inclined to dispute the possible influence of heredity in these conditions; we have excluded them merely for the purpose of simplifying our problem by avoiding the necessity of dealing with a complicating factor in the shape of an essential exogenous cause. Moreover there seemed to be reason to believe that the so-called functional psychoses and neuroses are more closely related to each other than to the conditions which we have sought to exclude; and since our material had to be largely massed together for statistical treatment it was important that it should be as homogeneous as possible.

More than half the patients at this hospital are either themselves foreign born or the children of foreign-born parents; and among those who were born in this country of American parents there are many whose homes are in distant states; thus but a small proportion remained whose families had for two or three generations resided in this country and were accessible to investigation.

Other difficulties in obtaining our data were due to the ignorance of some of our informants or to their reluctance or refusal to co-operate in the investigation; and in many cases the investigation had to be discontinued and the data already collected had to be discarded owing to incompleteness.

In the actual analysis of the data collected in the course of our investigation the problem in each case was to distinguish, on the

basis of the information obtained by questioning the relatives, neuropathic states from the normal state and in the case of a neuropathic state to identify, if possible, the special variety. Such diagnosis often enough presents great difficulty when there is opportunity for direct observation, but when it has to be based upon observations of untrained informants related from memory the difficulty is, of course, greatly increased and with it the chance of error. We have endeavored to reduce the amount of error from this source by interviewing personally as many as possible of the nearest relatives of the patients whose pedigrees were being investigated, and by the practice of tracing almost all the families not farther than to the generation of grandparents, for the farther back our inquiries extended the more scant and more vague was the information which we were able to obtain.

To the difficulty of diagnosis is added the further difficulty which results from the impossibility in the present state of psychiatry of precisely delimiting the conception of the neuropathic constitution. To this matter we shall have occasion to revert in subsequent sections.

In the analysis of data it was often necessary in the case of a normal subject to determine whether the case was one of duplex or of simplex inheritance, it having appeared early in the course of our study that the normal condition was dominant over the neuropathic condition. The fact of simplex inheritance we were able in some cases to establish on the basis of the existence of neuropathic manifestations in the ancestors or collateral relatives of the subject; in other cases this evidence was lacking as our information did not extend to the more remote generations, so that it was necessary to *assume* the fact of simplex inheritance on the basis of the existence of neuropathic offspring: the two types of material have been treated separately. On the other hand, the fact of duplex inheritance was in every case based upon the absence of neuropathic manifestations in ancestors and collateral relatives, as far as known, as well as in the offspring;—but inasmuch as in scarcely any case was the family history traced farther back than the third generation it is clear that the possibility of simplex inheritance was in no case positively excluded; we have here, therefore, another source of error which, fortunately, is slight, and affects the least important part of our mate-

rial, namely, the cases of matings from which no neuropathic offspring have resulted.

On the whole, no pretension is made here of total elimination of error; but we believe that whatever errors remain they are not sufficient to invalidate the material as a basis for our study.

§ 3. STATISTICAL ANALYSIS OF MATERIAL.

In the Preliminary Report, to which we have already referred and which was based upon an analysis of the pedigrees of twelve families, it was shown that the neuropathic constitution is transmitted by heredity probably in the manner of a trait which is, in the Mendelian sense, recessive to the normal condition.

Sixty other families have since been investigated; the entire material now includes the pedigrees of seventy-two families, representing two hundred and six different matings, with a total of one thousand and ninety-seven offspring. In Table II this mass of data has been arranged so as to show the proportions of normal and neuropathic offspring which resulted from the various types of mating alongside of figures representing theoretical expectation according to the Mendelian theory.

TABLE II.

Types of mating.	Number of matings.	Total number of offspring.	Died in childhood.	Data unascertained.	Neuropathic offspring.		Normal offspring.	
					Actual findings.	Theoretical expectation.	Actual findings.	Theoretical expectation.
a. RR × RR ∞ RR.....	17	75	11	0	54	64	10	0
b. DR × RR ∞ DR + RR.....	37	216	46	1	84	84½	85	84½
b ₁	58	284	20	4	108	180	164	180
c. DD × RR ∞ DR.....	14	61	13	8	0	0	46	46
d. DR × DR ∞ DD + 2DR + RR	7	34	5	0	8	7¼	21	21¾
d ₁	55	335	39	3	99	78¾	194	218¾
e. DD × DR ∞ DD + DR.....	20	92	12	8	0	0	77	77
f. DD × DD ∞ DD.....	0	0	0	0	0	0	0	0
Totals.....	206	1,097	146	14	351	359	586	578

Some of the data represented in the table require special explanation.

Among the offspring which resulted from matings of the first type, RR × RR, ten are recorded as being normal, although

theoretically all should be neuropathic. Of these ten one died at the age of thirty-eight years in an accident, during life suffered from asthma, had a son who died in convulsions; another is described as being easy going, is somewhat odd and possibly abnormal in make-up, is twenty-nine years of age; the rest are from eight to twenty-two years of age. In other words, in two of the ten subjects the neuropathic constitution is not positively excluded and the remaining eight have not reached the age of incidence.

The matings of the second and fourth types, DR \times RR and DR \times DR respectively, have been divided into two groups each, as already explained in the preceding section: thus groups *b* and *d* in the chart include the matings in which the simplex condition of either or both mates, as the case may be, is definitely ascertained, the existence of neuropathic manifestations either in ancestors or in collateral relatives of the subjects appearing in the pedigrees; groups *b*₁ and *d*₁, on the other hand, include the matings in which the simplex condition of either or both mates is assumed to exist on the basis of the character of the offspring. It is perhaps not surprising that groups *b*₁ and *d*₁ are larger than *b* and *d* respectively when we consider the great likelihood of a neuropathic taint, derived from an ancestor of a remote generation, being transmitted many times in the shape of a simplex condition, and at the same time the fact that our investigations extended in almost all cases no farther back than the generation of grandparents.

As is shown in the table the correspondence between theoretical expectation and actual findings is in some cases exact and in all cases remarkably close. *It would seem, then, that the fact of the hereditary transmission of the neuropathic constitution as a recessive trait, in accordance with the Mendelian theory, may be regarded as definitely established.*

The material represented in the table appears elsewhere in this paper in the shape of pedigree charts with detailed references to all neuropathic individuals. Among the subjects who have been counted as neuropathic were, on the one hand, those who were recognized as insane, epileptic, hysterical, or feeble-minded, and on the other hand, those who presented anomalies of conduct or disposition which were even in the conservative judgment of our

lay informants related to the neuropathic conditions. At the same time we have counted as normal all cases of mental or nervous disturbance resulting from arteriosclerotic disease with strokes, paralyses, aphasias, etc.

§ 4. DISSIMILAR HEREDITY. DEGREES OF RECESSIVENESS.

Heretofore we have dealt with the neuropathic constitution as a unit, comparing it with the normal condition. The great variety of neuropathic manifestations and the facts of dissimilar heredity show, however, that the neuropathic constitution in reality consists of a series of entities which are distinct, at least from the standpoint of clinical definition, though at the same time evidently in some manner related to each other.

The phenomenon of dissimilar heredity has, indeed, in the opinion of some cast a doubt upon the validity of conclusions which are in part based upon the assumption of the existence of an essential relationship between the most diverse clinical neuropathic manifestations. It must be admitted that the burden of proof rests upon those who assume that imbecility, epilepsy, deteriorating psychoses, periodic psychoses, paranoic conditions, involutional psychoses, the slighter psychopathic states, and certain eccentricities are all etiologically related. It is for them to explain why the neuropathic constitution leads in some cases to death from convulsions in early childhood, and in others to but a transitory depression at the involutional period, the subject being at least approximately normal during the greater part of his life. It is for them to explain why in some cases there is profound congenital mental defect, in others a dementing process coming on in early adult life, in still others recurrent but non-dementing insanity, and in others again a mere predisposition to mental disturbance which for many years remains latent and is brought to light only through the operation of some external cause.

Some parts of our material seem to throw some light upon the nature of the relationship which exists between various neuropathic manifestations. Thus the pedigree charts of at least four families point to the existence of *different degrees of recessiveness*. In other words, certain neuropathic conditions, though clearly recessive as compared with the normal condition, are at the same time dominant over other neuropathic conditions which

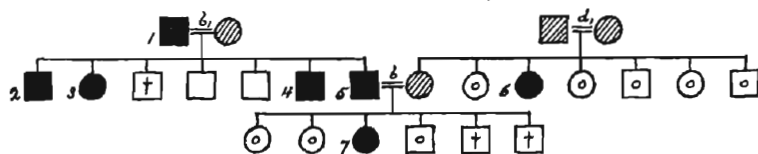
are, so to speak, of a more pronounced degree of recessiveness. It appears in a most marked way that recoverable psychoses are dominant over epilepsy and allied conditions.

It seems necessary to assume that the normal development and function of the nervous system is dependent not upon a single unit determiner in the germ plasm, but upon a group of determiners, and that the number of units lacking from that group determines the special type of defect to be observed clinically. It may be recalled that a similar assumption has been found necessary for the understanding of the inheritance of other Mendelian characters, notably various shades of skin pigmentation.¹⁰

For convenience in presentation conditions of slighter degree of recessiveness, like recoverable psychoses, may be designated by the capital letter R, and those of more pronounced degree of recessiveness, like epilepsy, by the small letter r.

In Chart I¹¹ we find an instance of the union of a manic-depressive subject, of a family heavily tainted with manic-depressive

CHART I. L. R. CASE NO. 4215.



1. Insane before death.
2. "Nervous prostration," in sanitarium four weeks, recovered.
3. Manic-depressive insanity, in State hospital.
4. Manic-depressive insanity, in State hospital.
5. Manic-depressive insanity, in State hospital.
6. Epilepsy, in State hospital.
7. Manic-depressive insanity, in State hospital.

insanity, with a mate who is normal but who carries the taint of epilepsy. That mating may be represented by the following formula:

$$RR \times Dr \infty DR + Rr.$$

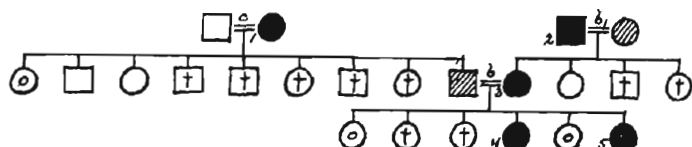
¹⁰ Davenport. *Heredity of Skin Pigment in Man*. The American Naturalist, Vol. XLIV, Nov. and Dec., 1910.

¹¹ In all charts the following symbols have been employed: a square indicates a male subject; a circle indicates a female subject; □ or ○ = normal subject with normal progeny; ◻ or ◯ = normal subject without progeny; ◼ or ◉ = normal subject with neuropathic progeny; ◼ or ◉ = neuropathic subject; ⊠ or ⊡ = subject died in childhood; ⊞ or ⊚ = data unascertained. The type of mating is in each instance indicated by a small letter: a, b, b₁, c, d, d₁, e, as in Table II.

In other words, the offspring from such a mating may be either normal or manic-depressive, but not epileptic,—and such in fact was the actual result as shown in the chart.

In Chart II we find an instance of the union of a normal subject, whose mother suffered from a psychosis described by our

CHART II. M. S. CASE NO. 6568.



1. Hysterical when a girl; had idea someone was trying to poison her.
2. Epilepsy.
3. Epilepsy.
4. Manic-depressive insanity, in State hospital.
5. Very nervous.

informant as being in the nature of hysteria, with an epileptic mate whose father was also epileptic. That mating may be represented by the following formula:

$$DR \times rr \infty Dr + Rr.$$

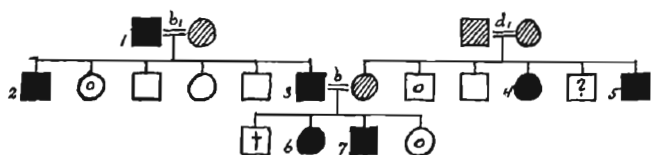
In other words, the offspring from such a mating may be either normal or having a psychosis recoverable in its nature and possibly resembling hysteria, but not epileptic; the chart shows that of the six offspring two died in childhood, two were normal, one had manic-depressive insanity, and one was "very nervous," but none were epileptic.

Similarly in Chart III we find a mating which may be represented by the following formula:

$$RR \times Dr \infty DR + Rr.$$

Of the four offspring one died in childhood, one was normal, one had manic-depressive insanity, and the remaining one is de-

CHART III. B. S. CASE NO. 7002.



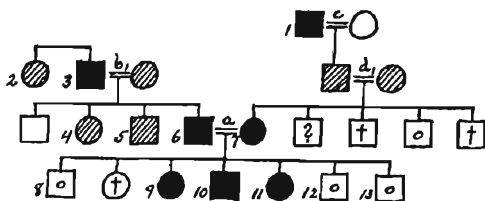
1. Senile deterioration.
2. Crank.
3. Recurrent melancholia with insomnia; five months in sanitarium.
4. Convulsions in childhood.
5. Convulsions in childhood.
6. Easily excited, nervous temperament.
7. Manic-depressive insanity, in State hospital.

scribed as being easily excited and of nervous temperament, but none had convulsions or epilepsy.

Finally in Chart IV we have an instance of the union of an epileptic subject, of a family tainted with epilepsy, with a mate who suffered from recurrent attacks of depression with insomnia; this mating may be represented by the following formula :

$$rr \times RR \infty Rr.$$

CHART IV. F. M. S. CASE NO. 6482.



1. Alcoholic, died from acute alcoholism.
2. Had feeble-minded, queer, insane daughter.
3. "Money mad," very cruel, very miserly though wealthy, left much of his money to housekeeper.
4. Daughter had fainting spells.
5. Has feeble-minded, queer son.
6. Fainting spells.
7. Recurrent attacks of depression.
8. 22 years old.
9. Recurrent attacks of depression, several suicidal attempts, in State hospital.
10. Manic-depressive insanity, in State hospital.
11. Attack of depression with suicidal tendency; recovery after three months.
12. 20 years old.
13. 15 years old.

In other words, all the offspring from such a mating should be neuropathic, suffering from a recoverable psychosis, but not from fainting spells or any other epileptic manifestation. The chart shows that of the seven offspring which resulted one died in childhood, three were normal being between fifteen and twenty-two years old,—probably below the age of incidence,—and the remaining three suffered from recoverable psychoses, but not from epilepsy.

It is probable that there are many degrees of recessiveness, but there is a great deal of evidence to show that degrees of recessiveness do not account for all varieties of clinical neuropathic manifestations.

§ 5. NEUROPATHIC EQUIVALENTS.

In studying any neuropathic defect one must bear in mind that its clinical manifestations will vary with the personality of the subject and with conditions of environment. It is indeed a

notorious fact that most of the so-called clinical entities are remarkable for the variety of their manifestations. This fact has necessitated the introduction in clinical practice of the conception of neuropathic equivalents. Thus notably in epilepsy it has long been found necessary to bring together such manifestations as fainting spells, convulsive seizures, psychical attacks, brief absences, spells of automatism, periodic dipsomania, etc.

More recently Kraepelin has shown that certain depressions, manias, circular and mixed states are but various phases of the same underlying constitutional disorder analogous to the various equivalents of epilepsy.¹² And Dreyfus has been able to establish the fact that the anxious depressions of the involuntional period are but a special variety of manic-depressive insanity.¹³

Similarly, in one immense group, under the general heading of dementia præcox we now, following Kraepelin, include such widely contrasted conditions as simple hebephrenia, catatonia, and *délire chronique à évolution systématique*—conditions which were long regarded as independent clinical entities.

Thus in clinical psychiatry progress has been marked by a simplification of classification through a far-reaching extension of the conception of clinical equivalents.

Some of the data furnished by our material seem to indicate the necessity for a still further extension of this conception. It is interesting to note that what we learn in institutional experience to recognize as insanity is a comparatively uncommon group of manifestations of the neuropathic constitution, for of our total of 437 neuropathic subjects (not counting the 21 who died in convulsions in early childhood) only 115, or 26.3 per cent, presented at any time in their lives indications for commitment to sanitariums or hospitals for the insane; moreover, it is obvious, where the facts are known in detail, that in most cases in which such indications have occurred they were in the shape of special reactions to special environmental conditions; and it seems equally obvious that our definition of the various types of neuropathic constitution must be in terms not of such special reactions, but rather of the more stable and more general underlying psychical traits and tendencies.

¹² Kraepelin, *Psychiatrie*, 7th ed., Vol. II, p. 558.

¹³ Dreyfus, *Die Melancholie, ein Zustandsbild des manisch-depressiven Irreseins*, Jena, 1907.

Thus in families of patients suffering from manic-depressive insanity we find not only subjects clearly recognized as insane, but also subjects described as follows: high-strung, excitable; dictatorial, abnormally selfish; awful temper; periodic drinker, a demon when drunk; committed suicide; had severe blue spells.

In the pedigrees of cases of dementia præcox we find ancestors and collateral relatives described in the following significant terms: cranky, stubborn; worries over nothing; religious crank; nervous, queer; restless, has phobias; suspicious of friends and relatives.

And in the families of epileptics we find, besides cases of actual epilepsy or convulsions in infancy, also cases of hemicrania, recurrent sick headaches, fainting spells, nervous fidgety make-up, and the like.

The limits of the legitimate extension of the conception of equivalents thus seem to be beyond even the widest limits established by clinical definition.

It is not to be assumed, however, that members of the same family necessarily suffer from the same neuropathic defect in the shape of various clinical equivalents, for even brothers and sisters, children of the same parents, may suffer from neuropathic defects representing not equivalents but different degrees of recessiveness. Theoretically there is, in fact, only one combination of mates of which all neuropathic offspring will necessarily suffer from equivalent defects. The third, fifth, and sixth combinations ($RR \times DD$, $DR \times DD$, and $DD \times DD$) need not be considered at all in this connection as from them no neuropathic offspring will result. But let us consider the remaining three combinations ($RR \times RR$, $RR \times DR$, $DR \times DR$) from which neuropathic offspring may result.

If it is true that neuropathic defects may represent different degrees of recessiveness, as we have endeavored to show in a preceding section, then in the case of any neuropathic subject we have no way of telling whether the inheritance of his defect is homozygous or heterozygous, unless we possess an exceptionally detailed pedigree extending far back to past generations; in other words, we cannot tell whether he inherits from the two parents defects of the same or of different degrees of recessiveness. Continuing to make use of the symbols R and r to represent, re-

spectively, lesser and more pronounced degrees of recessiveness, a given neuropathic condition may accordingly be represented either by the symbol RR or Rr; and similarly the condition of a normal subject who represents simplex inheritance, *i. e.*, who inherits the neuropathic taint from one parent, may be represented either by the symbol DR or Dr. It may be readily seen, then, that in the case of either the first or second combination there are possibilities of offspring with more than one type of neuropathic defect, *i. e.*, of defects of different degrees of recessiveness, as may be shown by the following formulæ:

$$1. Rr \times Rr \infty RR + 2Rr + rr.$$

$$Rr \times rr \infty Rr + rr.$$

$$2. Rr \times Dr \infty DR + Dr + Rr + rr.$$

The neuropathic conditions in the children resulting from such matings would not necessarily be equivalents.

But in the case of the fourth type of mating, that of two simplex individuals, *i. e.*, two individuals who are normal but carry the taint from their ancestors, the neuropathic offspring which may result would in any instance show defects which are theoretical equivalents; for from every theoretically possible variety of combination only one type of neuropathic offspring can result, as may be shown by the following formulæ:

$$DR \times DR \infty DD + 2DR + RR.$$

$$DR \times Dr \infty DD + DR + Dr + Rr.$$

$$Dr \times Dr \infty DD + 2Dr + rr.$$

Clinical manifestations will, of course, vary with the personality of the subject, the age at which the disorder makes its appearance, the nature of the exciting cause, and other environmental conditions; but in spite of such variations we are able, in the light of a better knowledge of the mechanism of heredity, to identify neuropathic equivalents at least when they occur in brothers and sisters who are the offspring of the matings of the fourth type.

In matings of this type only one-fourth of all the offspring, on the average, exhibit the neuropathic condition; therefore most such families have not more than one neuropathic subject and do not afford an opportunity of comparing neuropathic equivalents; but many large families, or some in which by an unlucky chance more than one neuropathic subject has resulted, do afford

such an opportunity, and *thus a new aid for the study of neuropathic equivalents becomes available.*

In our own material the pedigree charts from V to XXIX present instances of matings of the fourth type from each of which two or more neuropathic offspring have resulted. Comparisons of the brothers and sisters in these families reveal points of rather peculiar interest.

In some instances the manifestations clinically observed were either similar or identical; such instances are to be found in Charts VII, IX, XV, XVI, XVII, XX, XXIII, and XXV.

In other instances we find well defined psychoses alongside of cases presenting oddities of conduct or of disposition which are familiar to physicians as types of make-up constituting the characteristic soil upon which the psychoses develop.¹⁴ Thus in Chart XV we find a case of dementia præcox, in a brother "nervous hysteria when his sister died, had hallucinations of sight and hearing, was disturbed and had to be restrained," and in a sister "nervous temperament, easily excited, has weak spells." In Chart XXI we find in one case "nervous breakdown early in life, was unable to work, recovered," in a sister "awful temper." In Chart XXVI we find in one case the following note: "insane twice, very disturbed, recovered each time," and in a sister "odd, nervous temperament, easily excited." In Chart XXVIII we find a subject who was "insane a few months before death," in one sister "melancholy disposition, had nervous prostration," and in another sister "nervous temperament, melancholy."

Perhaps the most striking finding is that of fainting spells or convulsions in childhood alongside of dementia præcox; this occurs in Charts V, VI, VIII, XI, and XII. In this connection may be recalled the rather frequent occurrence of seizures of various sorts in dementia præcox—fainting spells, epileptiform convulsions, muscle spasms, etc.: according to Kraepelin in 18 per cent of all cases.¹⁵

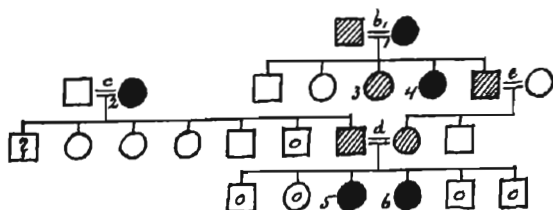
Finally we would point out the occurrence, as neuropathic

¹⁴ Aug. Hoch, *Constitutional Factors in the Dementia Præcox Group*, Rev. of Neurol. and Psychiatry, Aug., 1910.—Ed. Reiss, *Konstitutionelle Verstimmung und manisch-depressives Irresein*, Zeitschr. f. d. gesamte Neurol. u. Psychiatrie, Vol. II, p. 600, 1910.

¹⁵ Kraepelin, *Psychiatrie*, 7th ed., Vol. II, p. 188.

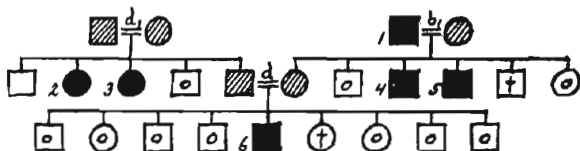
equivalents, of conditions which are clinically altogether dissimilar. For instance, in Chart XVII one subject is noted as having been "insane during pregnancy with second child, recovered," and her sister as a "religious recluse, nun in convent in Australia": perhaps in this instance the difference between the married state and celibacy accounts for the difference in manifestations. In Charts XIX and XXVII we find cases of senile deterioration related to peculiar psychoses occurring earlier in life; in one case we find the following note: "When a girl went to Washington, lost her money, could not tell why she went there, was placed in an institution; says a man has 'witched' her; has in her pocket a bottle of gin which she takes 'for blood poison'";—in another case: "Irritable in early years of marriage, had hysterical spells, ill-treated her step-children";—and in a third case: "Nervous after sister's death, was too nervous to be interviewed or visited by anyone." In Charts XXII and XXIX the following cases are associated as family equivalents with epilepsy: "Moderately alcoholic, ideas of persecution against relatives";—"Loquacious, rambling, odd, had severe attacks of depression following childbirth";—"Subject to spells of severe depression";—"Seems to have lost interest in life, when interviewed would say only 'I know nothing more than sister told you'";—"Moderately alcoholic, never settled down to anything but roamed around all his life until he died at the age of 62 years of pneumonia." It should be pointed out here that in classifying the matings there is always a possibility of error especially in the direction of overlooking neuropathic traits and, owing to misinformation or misjudgment of our informants, counting one or both mates as normal who should properly be counted as neuropathic. Thus in individual instances matings classified as belonging to the fourth type ($DR \times DR$) may in reality be of the second type ($RR \times DR$), in which case, as already shown, the neuropathic offspring may present defects of different degrees of recessiveness and not necessarily equivalents. Errors could be guarded against only with the aid of a large amount of material; in other words *any two dissimilar neuropathic manifestations should not be definitely classed as equivalents unless they are repeatedly met with in brothers and sisters of a large number of families resulting from matings of the fourth type.*

CHART V. F. R. CASE NO. 6803.



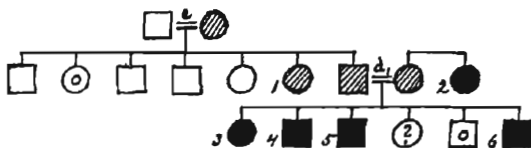
1. Died insane in State hospital.
2. Hysterical spells for about three years.
3. One daughter insane, in State hospital.
4. Insane, in State hospital, recovered, insane again at 76 years.
5. Died in convulsions in childhood.
6. Dementia præcox, catatonic, in State hospital.

CHART VI. E. C. CASE NO. 7048.



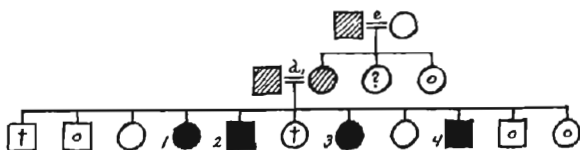
1. Nervous temperament, easily excited, moderately alcoholic.
2. Nervous, erratic, excitable.
3. Fainting spells.
4. Nervous temperament, easily excited.
5. Easily excited, moderately alcoholic.
6. Dementia præcox, catatonic, in State hospital.

CHART VII. J. C. CASE NO. 2921.



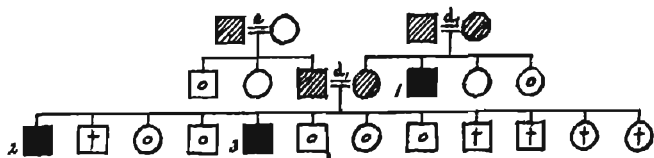
1. Daughter was sister of mercy in Australia; is said to have died of homesickness.
2. Feeble-minded, eccentric, laughs without cause, says "I don't know" in reply to simple questions.
3. Died insane at asylum in Cork.
4. Was insane at asylum in Cork; was discharged improved but is still queer.
5. Dementia præcox, at State hospital.
6. Dementia præcox, at State hospital.

CHART VIII. T. H. CASE NO. 6830.



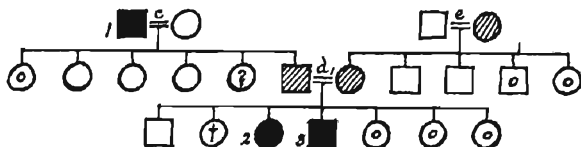
1. Nervous temperament, fidgety, has nervous son.
2. Dementia præcox, paranoid, in State hospital.
3. Convulsions following small-pox at the age of 5 years.
4. Died in convulsions at the age of 1 year.

CHART IX. M. O'T. CASE NO. 6115.



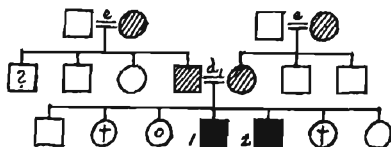
1. Very irritable, violent temper.
2. Dementia præcox, in State hospital.
3. Dementia præcox, in State hospital.

CHART X. R. M. CASE NO. 6459.



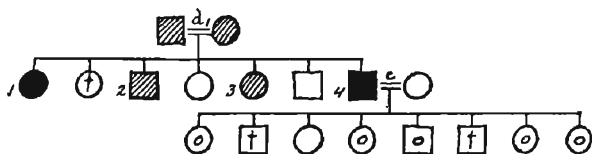
1. Quick tempered.
2. Became melancholy due to disappointment.
3. Dementia præcox, paranoid, in State hospital.

CHART XI. F. S. CASE NO. 6492.



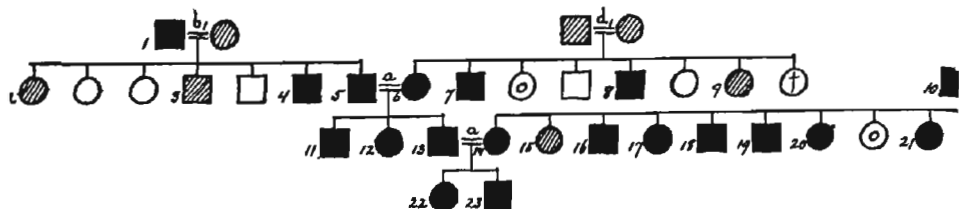
1. Dementia præcox, paranoid, in State hospital.
2. Died of convulsions during teething in childhood.

CHART XII. E. H. CASE NO. 01655.



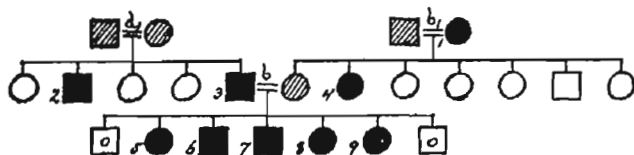
1. Fainting spells.
2. Son has dementia præcox, in State hospital.
3. Daughter has fainting spells.
4. Dementia præcox, simple, in State hospital.

CHART XIII. M. H. CASE NO. 6823.



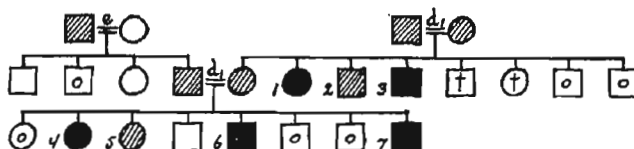
1. Committed suicide by hanging.
2. One daughter insane, another eccentric.
3. One son mentally defective.
4. Alcoholic.
5. Eccentric, quick-tempered, "crazy John."
6. Eccentric, traveled about alone at night, slept through the day.
7. Alcoholic, left his family.
8. Committed suicide by hanging.
9. Daughter committed suicide.
10. Nervous temperament, easily upset.
11. Nervous temperament, "fretter," son was insane and recovered.
12. Nervous temperament, son nervous.
13. Very peculiar, eccentric.
14. Epileptic.
15. One son mentally defective.
16. Nervous temperament, queer in spells, eccentric.
17. Eccentric, begs gloves, handkerchiefs, etc., with need.
18. Nervous temperament.
19. Alcoholic, nervous temperament.
20. Nervous.
21. Eccentric, never associated with anyone, lived round in outside kitchen.
22. Dementia præcox, paranoid, in State hospital.
23. Nervous temperament, easily excited, easily daughter also nervous and excitable.

CHART XIV. J. H. CASE NO. 7055.



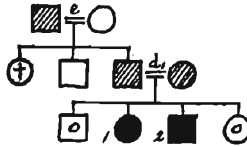
1. Senile deterioration.
2. Very alcoholic, died at age of 40 years of "paralysis."
3. Violent temper, ideas of persecution against friends.
4. Was nervous following the birth of first child, recovered.
5. Very nervous temperament.
6. Nervous breakdown several times.
7. Dementia præcox, catatonic, in State hospital.
8. Nervous temperament.
9. Nervous temperament.

CHART XV. F. E. CASE NO. 7183.



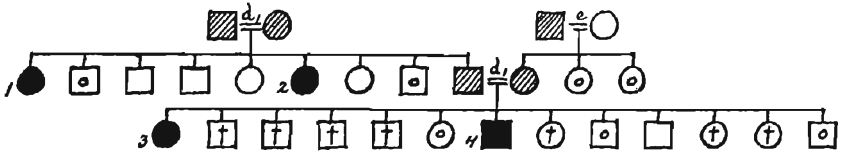
1. Nervous, little things bothered her, worried a great deal; her daughter was nervous and melancholy.
2. Son had convulsions in childhood.
3. Excitable, nervous, worries.
4. Nervous temperament; easily excited; has "weak spells."
5. Daughter had convulsions in childhood.
6. Dementia præcox, paranoid, in State hospital.
7. Had "nervous hysteria" when his sister died; had hallucinations of sight and hearing; was disturbed and had to be restrained.

CHART XVI. H. M. CASE NO. 6672.



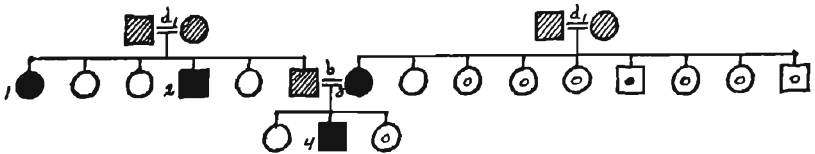
1. Dementia praecox, hebephrenic, in State hospital.
2. Dementia praecox, simple, in State hospital.

CHART XVII. D. H. CASE NO. 6690.



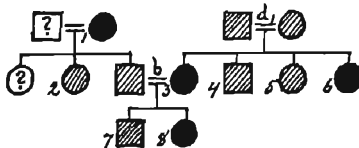
1. Insane during pregnancy with second child, recovered.
2. Nun in convent in Australia, "religious recluse."
3. Chronic psychosis, unclassified, in State hospital.
4. Dementia praecox, paranoid, in State hospital.

CHART XVIII. E. B. L. CASE NO. 6575.



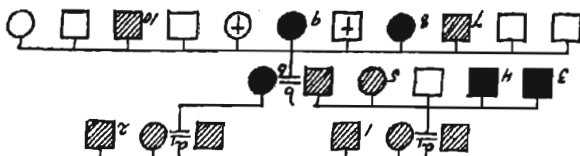
1. Deaf and dumb imbecile.
2. Sunstroke affected his mind, became childish and foolish.
3. Nervous temperament, fidgety.
4. Allied to manic-depressive insanity, in State hospital.

CHART XIX. E. F. CASE NO. 6529.



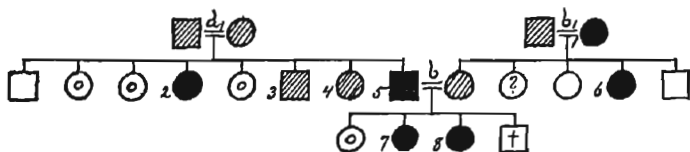
1. Senile deterioration shortly before death.
2. Son died of alcoholism.
3. When a girl went to Washington, lost her money, could not tell why she went there, was placed in an institution. Says a man has "witched" her. Has in her pocket a bottle of gin which she takes "for blood poison."
4. One son nervous, excitable, dull; one daughter mentally defective.
5. One son died of alcoholism.
6. Senile deterioration shortly before death.
7. Daughter had convulsions during teething.
8. Dementia praecox, paranoid, in State hospital.

CHART XX. A. M. B. CASE NO. 6723.



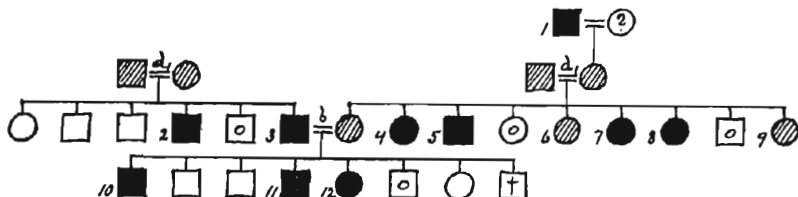
1. Insane children.
2. Insane daughter.
3. Nervous, queer.
4. Hot-tempered, queer, "nearly went insane over money losses."
5. Insane daughter.
6. Senile deterioration.
7. Child had convulsions.
8. Paranoic condition, in State hospital.
9. Paranoic condition, in State hospital.
10. Nervous daughter.

CHART XXI. M. F. CASE NO. 6917.



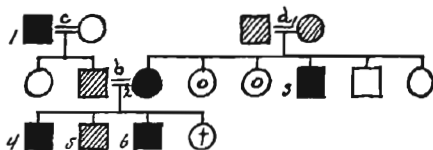
1. High strung, excitable.
2. "Awful temper."
3. Son died insane.
4. Daughter subject to attacks of depression.
5. Nervous breakdown early in life, unable to work, recovered.
6. Dictatorial, abnormally selfish.
7. Very queer, lives alone, boards cats for living.
8. Allied to manic-depressive insanity, in State hospital.

CHART XXII. B. A. CASE NO. 7263.



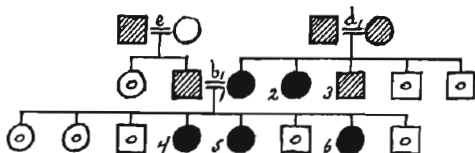
1. Very alcoholic.
2. Had nervous breakdown at the age of 58 years, died in a year.
3. Excitable temperament, abnormally suspicious, years ago periodically alcoholic.
4. Epileptic.
5. Moderately alcoholic, ideas of persecution against relatives.
6. Has feeble-minded son.
7. Loquacious, rambling, odd; had severe attack of depression following childbirth.
8. Subject to spells of severe depression.
9. Son is periodic drinker.
10. Water on the brain in childhood; stole money and worried about it greatly.
11. Slightly nervous, fainting spells.
12. Allied to manic-depressive insanity, in State hospital.

CHART XXIII. E. B. CASE NO. 710L.



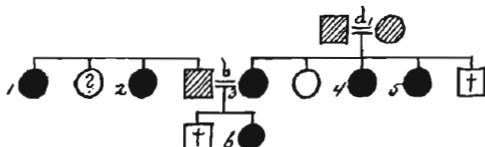
1. Senile deterioration.
2. Subject to "fits of paralysis," had one the day of the funeral (hysteria?).
3. Very alcoholic.
4. Was insane for sixteen years, died in State hospital.
5. Son had convulsions in childhood.
6. Allied to manic-depressive insanity, in State hospital.

CHART XXIV. J. M. CASE NO. 6426.



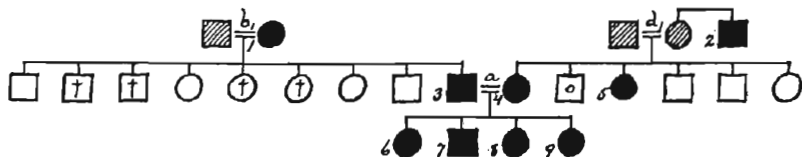
1. Was insane six months at menopause, depressed, "religious mania," recovered.
2. Had severe blue spells during menopause; daughter was treated for "nerves" at the age of 14 years.
3. Daughter had "nervous trouble," was under physician's care, recovered.
4. Quick tempered.
5. Dementia præcox, catatonic, in State hospital.
6. Nervous, fidgety, was "near collapse" and had to be sent away for two weeks about one year ago.

CHART XXV. E. H. CASE NO. 7253.



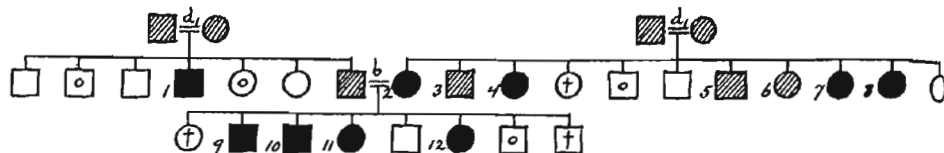
1. Nervous, fidgety.
2. Insane at menopause for one year, recovered, was in sanitarium.
3. Shallow woman, inferior intelligence, alcoholic, smokes.
4. Nervous, fidgety, treated by physician for "neurasthenia"; has eccentric, alcoholic son.
5. Shallow, frivolous woman, nervous, fidgety, easily excited.
6. Hysterical psychosis, in State hospital.

CHART XXVI. J. T. S. CASE NO. 7278.



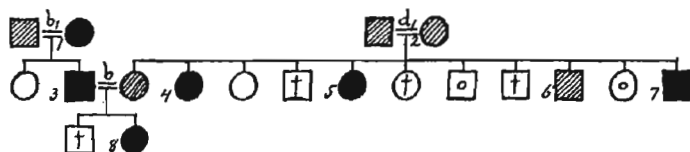
1. Ugly tempered at times, said to have been addicted to opium.
2. Insane before death; four out of seven children had manic-depressive insanity.
3. Senile dementia, ugly at times.
4. Odd, nervous temperament, easily excited.
5. Insane twice, very disturbed, recovered each time.
6. Nervous temperament, excitable.
7. Has been very nervous and melancholy for last two years.
8. Manic-depressive insanity, in State hospital.
9. Had nervous breakdown, hypochondriacal; son nervous.

CHART XXVII. S. S. CASE NO. 15177.



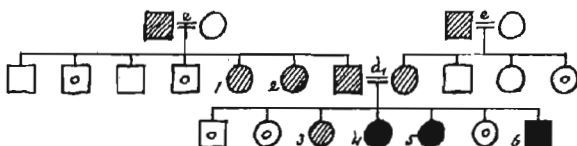
1. Cross and irritable; very alcoholic, took opium.
2. Irritable in early years of marriage, had "hysterical spells," ill-treated her step-children.
3. Several children were nervous, one son insane.
4. "Nervous" after sister's death; was too nervous to be interviewed or visited by anyone.
5. Had very nervous son.
6. One daughter had convulsions during teething, has hysterics when anything exciting occurs, is always nervous; another daughter is very nervous.
7. Senile deterioration for one year before death.
8. Senile deterioration last year and a half of her life.
9. Nervous, "especially when he had a cold or a headache."
10. Childish, has impediment in speech, has fits said to be epileptic.
11. Epileptic, in State hospital.
12. Very nervous, easily upset, poorly balanced.

CHART XXVIII. W. S. CASE NO. 6703.



1. Died insane in State hospital.
2. Cousin epileptic.
3. Nervous temperament, fidgety.
4. Melancholy disposition, had nervous prostration.
5. Nervous temperament, melancholy.
6. Daughter epileptic.
7. Insane few months before death.
8. Epilepsy, in State hospital.

CHART XXIX. M. J. CASE NO. 6295.



1. Daughter had melancholia for several years, recovered.
2. Daughter has nervous spells, mind rambles; has been in sanitarium for several years.
3. Daughter had manic-depressive insanity, was in State hospital, recovered.
4. Epilepsy, in State hospital.
5. Seems to have lost interest in life; when interviewed would say only "I know nothing more than sister told you."
6. Moderately alcoholic, never settled down to anything, but roamed around all his life until he died of pneumonia at the age of 62 years.

§ 6. PREVALENCE OF THE NEUROPATHIC TAINT IN THE GENERAL POPULATION.

It would be very difficult, not to say impossible, to estimate accurately the proportion of neuropathic subjects in the total general population in any large community.

In the report for the year ending September 30, 1909, the New York State Commission in Lunacy gives the number of insane patients in State hospitals and private institutions as 31,540 or one to 276 in the general population; this figure does not include the inmates of institutions for the feeble-minded and for epileptics, it does not include the neuropathic subjects who find their way into prisons, reformatories, almshouses, disciplinary schools, hospitals for incurables, general hospitals, neurological clinics, etc., and, above all, it does not include the many neuropathic subjects whose infirmities are latent or of such nature as not to incapacitate them for ordinary occupations and life at large.

An attempt to estimate the proportion of all mental defectives (idiots and imbeciles as well as the insane) in the general population was made in the Canton of Bern, Switzerland, in 1902. In the enumeration were included patients who lived in their homes as well as in asylums. The proportion was 1 to 117 in the general population.¹⁶

It is clear that the proportion thus estimated must fall far short of the figure that would represent the actual incidence of the neuropathic constitution, for in such an enumeration no account is taken of conditions like hysteria, abnormal disposition, and the like,—conditions which could be included neither with cases of feeble-mindedness nor with those of frank insanity.

So far as our own material is concerned we have already had occasion to state that of all subjects recorded as neuropathic, not counting those who died in childhood, only 26.3 per cent presented at any times in their lives indications for commitment to sanitariums or public institutions. If this percentage be regarded as fairly representative in general, then the total incidence of neuropathic manifestations would be roughly estimated as affecting between 1.5 and 2.0 per cent of the general population.

In order to form an idea of the real prevalence of the neuropathic taint in the general population it is necessary to know not only the proportion of individuals actually neuropathic, but also that of those who are themselves normal but carry the taint from their ancestors, as represented by the symbol DR. In our material, out of 172 matings which resulted in neuropathic offspring

¹⁶*Ergebnisse der Zählung der Geisteskranken im Kanton Bern, 1. Mai, 1902. Mitteilungen der Bernischer statistischen Bureaus, 1903.*

only in 17 were both mates neuropathic, in 93 one mate was neuropathic and the other normal, and in 62 both mates were normal.

Our material affords a means of estimating the probable proportion of individuals, in the communities in which our study was made, who carry the neuropathic taint.

It will be borne in mind that an individual who is normal but who carries the neuropathic taint and is capable of transmitting it, can have neuropathic offspring only when his mate is either neuropathic or normal but, like himself, carries the taint; for if his mate is normal and of pure normal ancestry no neuropathic offspring will result, as has already been shown, and as is illustrated by the following formula:

$$DR \times DD \propto DD + DR.$$

A group of subjects who are capable under the above-mentioned conditions of producing neuropathic offspring, who marry freely into the general population, selecting mates more or less at random, will show, by the relative frequency with which they produce neuropathic offspring, how common in the general population are persons who carry the neuropathic taint.

Among the subjects who figure in our charts and statistics there are 466 who are theoretically classed as simplex, represented by the symbol DR, namely, all the normal subjects who have resulted from matings of the second and third types, two-thirds of the normal subjects who have resulted from matings of the fourth type, and one-half of those who have resulted from matings of the fifth type. From this number must be deducted 179 who have not married or have married but have had no children. From the remainder must be deducted further 66 subjects who are among the direct ascendants of our patients, all of whom have, of course, had neuropathic offspring, and who should obviously not figure in such statistics. Of the remaining 221 subjects, all of whom, if mated with neuropathic or simplex subjects, were capable of producing neuropathic offspring, 70 actually had such offspring and 151 had normal offspring.

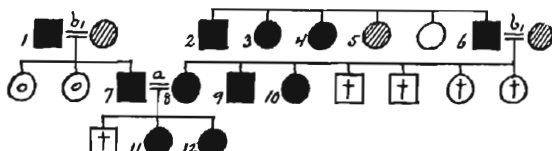
In other words, our data seem to show that no less than 31.6 per cent of the general population carry the neuropathic taint!

It is interesting to note here that the districts in which our investigations have been carried out are, according to the statistics

of the State Commission in Lunacy, among those showing comparatively low or moderate incidence of insanity."

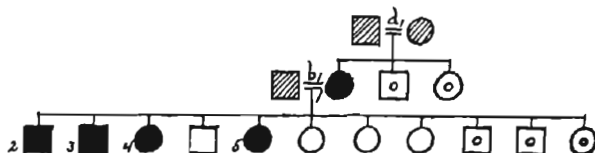
Our material is presented in detail in the shape of pedigree charts, some of which have already appeared in connection with § 4 and § 5; the rest are appended here.

CHART XXX. R. G. CASE NO. 6873.



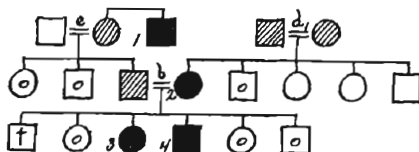
1. Alcoholic.
2. Feeble-minded.
3. Feeble-minded.
4. Hypochondriacal, had nervous prostration.
5. Daughter insane, died in State hospital.
6. "Visionary, had no idea of the value of money, always trying big schemes, became a complete wreck from drink."
7. Eccentric.
8. Allied to manic-depressive insanity, in State hospital.
9. "Visionary, unsound, goes wild in arguments, imagines he owns everything."
10. "Crazy," fits of temper, gets wild; violent headaches.
11. Dementia præcox, paranoid, in State hospital.
12. Microcephalic, defective, died in infancy.

CHART XXXI. F. N. CASE NO. 7452.



1. Nervous temperament, easily excited.
2. Nervous temperament, easily excited.
3. Excessively alcoholic early in life, had cirrhosis of the liver.
4. Has spells of rigidity and twitching "only when she can't have her way"; always queer, never lived with husband, finally divorced; "worse than the patient herself (sister) sometimes."
5. Dementia præcox, paranoid, in State hospital.

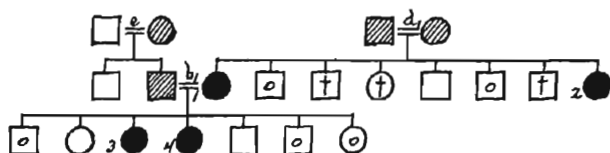
CHART XXXII. L. P. CASE NO. 6234.



1. Epilepsy.
2. "Great talker"; inferior make-up.
3. Very nervous following birth of son, recovered.
4. Dementia præcox, paranoid, in State hospital.

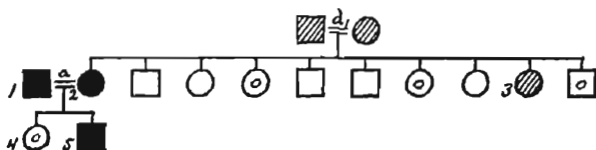
¹⁷ Report of the New York State Commission in Lunacy for the year ending September 30, 1909.

CHART XXXIII. M. D. CASE NO. 6946.



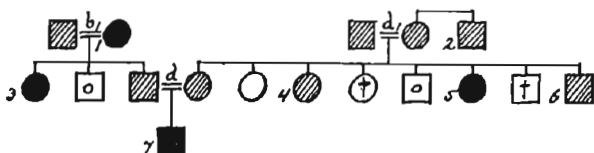
1. Attacks of depression, was in State hospital, recovered.
2. Convulsions in childhood.
3. Insane for four months following birth of child, was in State hospital, recovered.
4. Manic-depressive insanity, in State hospital, recovered.

CHART XXXIV. A. P. CASE NO. 7278.



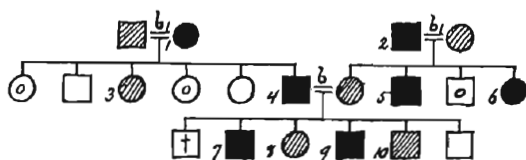
1. Attack of depression, recovered.
2. Hysteria.
3. Son feeble-minded.
4. 18 years old.
5. Dementia præcox, paranoid, in State hospital.

CHART XXXV. F. L. CASE NO. 7295.



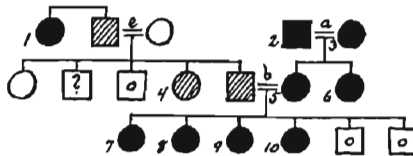
1. Senile psychosis.
2. Daughter insane.
3. Insane, was in State hospital, discharged as recovered but is still very eccentric.
4. Son had convulsions in childhood, later in life committed suicide.
5. Alcoholic.
6. Son epileptic.
7. Dementia præcox, paranoid, in State hospital.

CHART XXXVI. F. T. CASE NO. 7218.



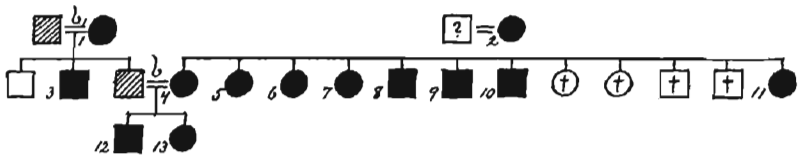
1. Senile deterioration.
2. Very alcoholic, disappeared from home, suspected suicide.
3. Daughter nervous, restless, has phobias.
4. Melancholia for several months; make-up restless and worrisome.
5. Restless, fidgety, "lack of repose," moderately alcoholic.
6. Chronic delusional psychosis; died in State hospital.
7. Restless.
8. Child died in convulsions; another has violent fits of temper.
9. Dementia præcox, paranoid, in State hospital.
10. Child had convulsions while teething.

CHART XXXVII. C. S. CASE NO. 7068.



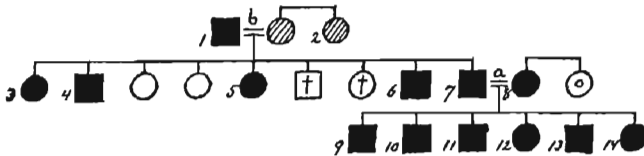
1. Nervous, flighty, "talks about things she knows nothing of."
2. Alcoholic, had delirium tremens.
3. Sick headaches.
4. Has epileptic children.
6. Sick headaches, unilateral.
6. Sick headaches.
7. Epileptic, in State hospital.
8. Convulsions in childhood, sick headaches.
9. Died in convulsions.
10. Nervous, fidgety.

CHART XXXVIII. A. L. McM. CASE NO. 7802.



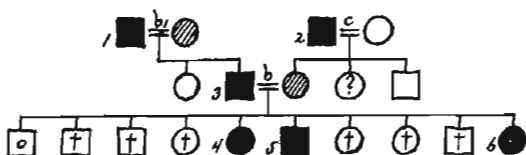
1. Died insane at an advanced age.
2. Eccentric.
3. Died insane; son also died insane in an asylum.
4. } Eccentric, "very queer."
5. }
6. }
7. }
8. }
9. } Eccentric, alcoholic.
10. }
11. Eccentric, "very queer."
12. "Peculiar."
13. Manic-depressive insanity, in State hospital.

CHART XXXIX. I. W. CASE NO. 7008.



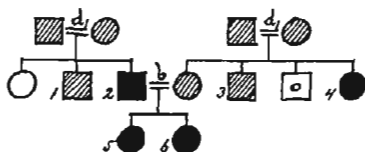
1. Violent temper, very alcoholic; became violently insane, had to be tied down; died insane.
2. Daughter was somewhat feeble-minded.
3. Chronically insane, in State hospital; daughter had screaming spells when a baby, is of nervous temperament.
4. Not considered bright.
5. Not very bright.
6. Always feeble-minded.
7. Violent temper, "always fighting, almost an animal now."
8. Extremely alcoholic.
9. Quick-tempered, severe headaches.
10. Very alcoholic, not very bright.
11. Quick-tempered, not very bright; son died in convulsions in infancy.
12. Paranoid condition, in State hospital.
13. Chronically insane, in State hospital; son had convulsions.
14. Bad temper, eccentric.

CHART XL. J. H. CASE NO. 6283.



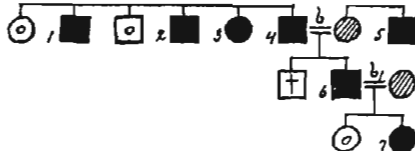
1. Very alcoholic.
2. Alcoholic.
3. Very irritable, nervous, disagreeable; children afraid of him.
4. Nervous temperament, severe blue spells.
5. Dementia præcox, in State hospital.
6. High strung, cries very easily.

CHART XLI. M. L. CASE NO. 6120.



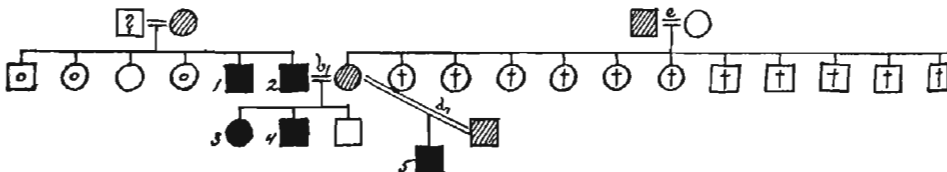
1. Son is of "nervous make-up."
2. Following business reverses he worried, doctor said he was insane and sent him to a sanitarium.
3. Son deformed, nervous, "very odd."
4. Extremely nervous, "nervously exhausted"; has son who is also extremely nervous, eccentric, has severe headaches.
5. Always nervous.
6. Manic-depressive insanity, in State hospital.

CHART XLII. M. W. P. CASE NO. 6687.



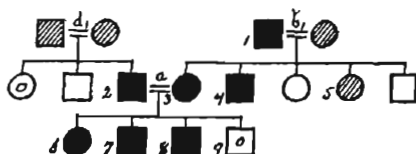
1. Very alcoholic.
2. Very alcoholic.
3. Melancholy through trouble, was in State hospital 18 months.
4. Alcoholic, left home, son saw him only three times.
5. Very alcoholic, daughter had epilepsy.
6. Periodic drinker.
7. Dementia præcox, in State hospital.

CHART XLIII. J. C. McM. CASE NO. 3664.



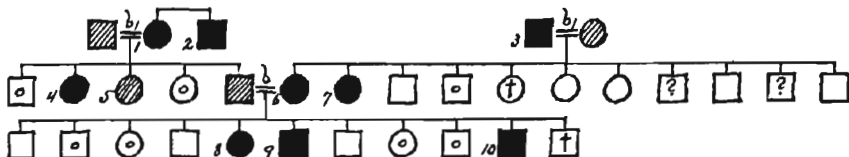
1. Had some mental trouble, was in sanitarium for several months about seven years ago, recovered.
2. Eccentric, cross, cranky, irritable, very alcoholic, wife was afraid of him.
3. Nervous temperament, excitable.
4. Epilepsy, in State hospital.
5. Melancholy, was in State hospital for four months.

CHART XLIV. E. L. CASE NO. 7325.



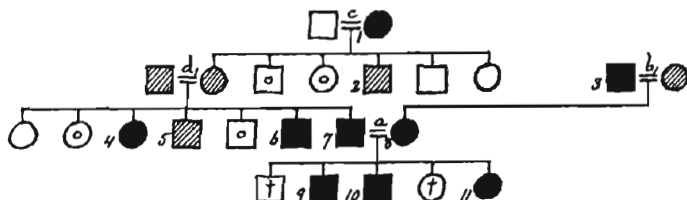
1. Violent, quick temper.
2. Periodic drinker.
3. Spells of "nervous weakness" after son became insane, was under physician's care.
4. Periodic drinker.
5. Daughter "odd," very quiet disposition.
6. Died in infancy of convulsions ("inward spasms").
7. Died in infancy of convulsions ("inward spasms").
8. Dementia præcox, paranoid, in State hospital.
9. 20 years old, apparently normal.

CHART XLV. B. B. CASE NO. 1278.



1. Violent temper, screamed when she got angry, flighty, "if anything ails her it goes to her head."
2. Insane.
3. Alcoholic.
4. Epilepsy; daughter nervous.
5. One daughter had nervous prostration following childbirth and died; another daughter is nervous.
6. Nervous, eccentric.
7. Is nervous, has fainting spells, suffers from neuralgia, had nervous prostration at menopause; one child died in convulsions.
8. Nervous.
9. Dementia præcox, in State hospital.
10. Died in convulsions in childhood.

CHART XLVI. C. R. S. CASE NO. 17242.



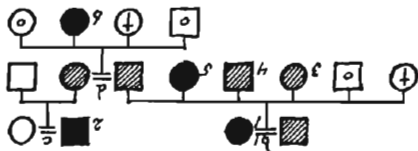
1. Nervous and queer.
2. Two sons were insane; one had melancholy spells, was in an asylum, committed suicide; another is still in an asylum.
3. Very irritable and eccentric, had spells when he was violent and ill-treated his wife, was by some considered insane.
4. "Nervous."
5. Has feeble-minded, nervous son.
6. Was insane, committed suicide.
7. Nervous, irritable, very eccentric, religious crank.
8. Spells of eccentricity, "out of her mind at times."
9. Epileptic, alcoholic, criminal, in State hospital.
10. Dementia præcox, paranoid, in State hospital.
11. Died in convulsions in infancy.

CHART XLVII. C. R. S.'S STEP-BROTHERS AND STEP-SISTERS. CASE NO. 17242.



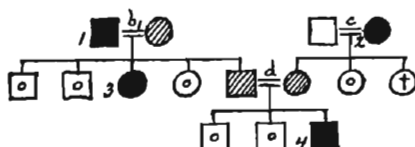
1. Nervous, irritable, very eccentric, religious crank; C. R. S.'s father.
2. Has fainting spells, fits of craziness at monthly periods, tears her hair, etc.
3. Irresponsible criminal, committed theft several times, not well-balanced, degenerate, moderate drinker.
4. Nervous, has fainting spells, "nervous prostration."

CHART XLVIII. O. D. CASE NO. 5894.



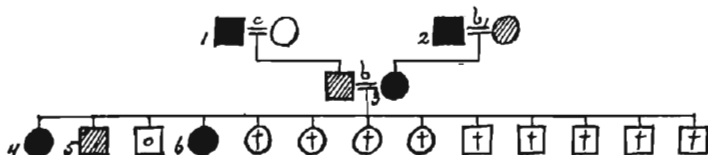
1. Nervous, "not right," ideas of jealousy, "subject to fits of unreasonable anger, turned guests out of the house."
2. Eccentric, irritable.
3. Has very nervous daughter.
4. Has nervous son.
5. Very eccentric in dress and manners; one daughter has fainting spells; another is "out of her mind by spells."
6. Dementia præcox, paranoid, in State hospital.

CHART XLIX. H. N. CASE NO. 8962.



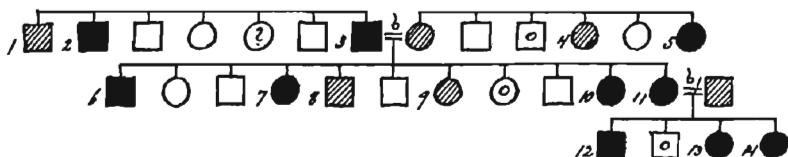
1. Was insane for eight years before he died.
2. Nervous.
3. Nervous, insomnia, neuralgia.
4. Dementia præcox, in State hospital.

CHART L. M. E. S. CASE NO. 4455.



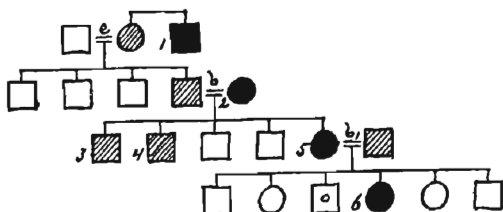
1. Insane.
2. Queer, intemperate.
3. Chronic psychosis "caused by worry" at the age of 62 years; in State hospital.
4. Died at the age of 23 years, was "nervous invalid" for two years before death.
5. One son queer.
6. Nervous, excitable, queer.

CHART LI. L. W. CASE NO. 14840.



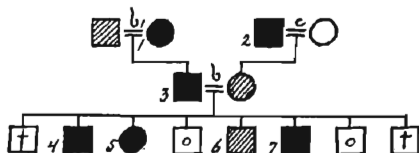
1. One daughter nervous and odd.
2. Violently insane for six months before death; three children had convulsions.
3. Suffered several years from "nervous trouble," was too ill to work; became insane just before death; to escape law suit committed suicide.
4. Two daughters very nervous.
5. Nervous and odd; three children had water on the brain, one died in convulsions.
6. Nervous, suffered from nightmares.
7. Was insane for six months, in State hospital, recovered; one child is nervous, three had convulsions in childhood.
8. Son had convulsions in childhood.
9. Four children, all nervous, two had convulsions in childhood.
10. Nervous, eccentric, spells of depression with crying.
11. Chronically insane, in State hospital.
12. Nervous, convulsions in infancy.
13. Queer, dull and stupid, mind affected, "not right."
14. Very nervous, especially at time of pregnancy, "her mind is affected at times."

CHART LII. A. E. S. CASE NO. 2998.



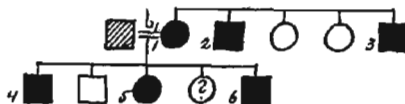
1. Eccentric, religious fanatic.
2. Very excitable and nervous, violent temper, threw things at people when angry.
3. Daughter has nervous spells, probably petit mal.
4. Daughter had convulsions in childhood.
5. Dementia præcox, paranoid, in State hospital.
6. Fainting spells, "lump in throat; knew what was going on but could not speak while spell lasted";—probably hysteria.

CHART LIII. E. C. P. CASE NO. 6322.



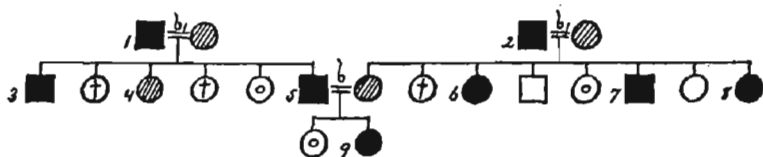
1. Senile dementia.
2. Senile dementia, weak spells.
3. Insane, in State hospital for a short time.
4. Restless, fidgety.
5. Dementia præcox, in State hospital.
6. Two daughters suffered from sick headaches.
7. Nervous, restless, worrisome.

CHART LIV. M. M. CASE NO. 6290.



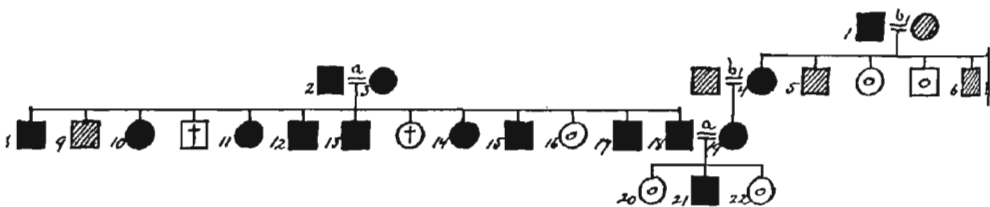
1. "High-tempered."
2. "High-tempered," alcoholic.
3. "Bad temper," moderately alcoholic.
4. Very alcoholic.
5. Dementia præcox, catatonic, in State hospital.
6. Very alcoholic.

CHART LV. F. B. CASE NO. 6874.



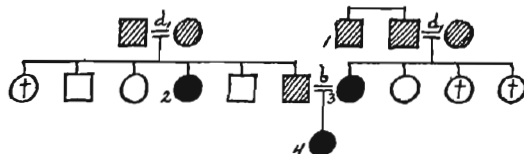
1. "Worrier."
2. Nervous temperament, fidgety, depressed spells, was in sanitarium.
3. Nervous breakdown, "hysterical," a few years ago, recovered.
4. Child has nervous temperament, doctor says "should be kept outdoors."
5. Nervous temperament, worries, at times pessimistic, considered queer though bright.
6. Nervous temperament, worries.
7. Insane, depressed, "religious mania," in State hospital four months, recovered.
8. Insane, in State hospital about six years, onset after birth of sixth child; imagines she is a detective and has immense treasures.
9. Dementia præcox, paranoid, in State hospital.

CHART LVI. G. G. CASE NO. 6880.



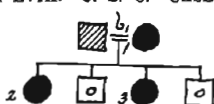
1. Easily excited, bad temper, very alcoholic.
2. Very bad temper, whipped his children brutally.
3. Eccentric, odd crank, lived all alone.
4. Nervous temperament, easily frightened, insane at menopause, committed suicide.
5. Two daughters have melancholy spells.
6. Son committed suicide.
7. Insane twice, "religious mania."
8. Convulsions during teething.
9. Suffered from asthma; died at age of 83 in an accident; son died in convulsions.
10. Died in convulsions in infancy.
11. Bad tantrums, bad temper; two children had convulsions, one was fidgety.
12. Bad temper; one son had convulsions in infancy, other is fidgety.
13. Very stubborn.
14. Peculiar temper.
15. Very alcoholic, very bad temper.
16. 29 years old, "easy going," weighs 300 pounds.
17. Stuttered, nervous.
18. Very easily excited, quick-tempered, "nags repeatedly."
19. Nervous, gets confused easily; when pregnant imagined things; has melancholy spells.
20. 15 years old.
21. Dementia præcox, hebephrenic.
22. Eight years old.

CHART LVII. M. B. CASE NO. 4931.



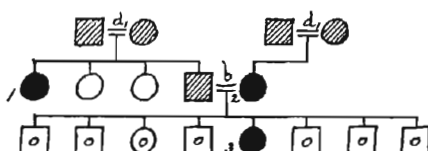
1. Had feeble-minded child.
2. Insane for one year following injury to spine, was in sanitarium, recovered without trace of organic trouble.
3. Nervous temperament.
4. Paranoid condition, in State hospital.

CHART LVIII. C. L. C. CASE NO. 6381.



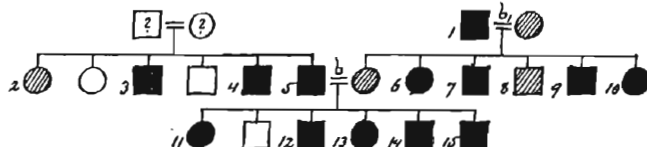
1. Eccentric, feeble-minded, epileptic.
2. Insane epileptic, in State hospital four years.
3. Insane epileptic, in State hospital.

CHART LIX. E. A. CASE NO. 6429.



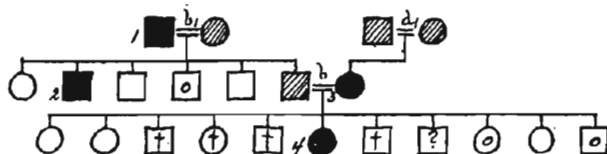
1. Feeble-minded.
2. Queer, never saw neighbors, stayed in the house, kept doors and windows locked.
3. Dementia præcox, in State hospital.

CHART LX. A. W. CASE NO. 6172.



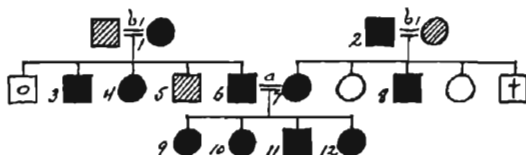
1. Very alcoholic, cranky, stubborn, convulsions.
2. Daughter nervous, "worries over nothing."
3. Highly nervous temperament, "crosses bridges before he comes to them."
4. Nervous temperament, moderately alcoholic.
5. Highly nervous temperament, irritable nature, worries over little things.
6. Fainting spells.
7. Shiftless, alcoholic, periodic aprees.
8. Children have epilepsy and fainting spells.
9. Religious crank, alcoholic.
10. Inferior make-up, possibly epileptic.
11. Worries over things; blue spells; "way up then way down."
12. Highly nervous temperament, "worries over things which never happen," alcoholic.
13. Dementia præcox, inferior make-up, in State hospital.
14. Very alcoholic.
15. Formerly very alcoholic; had a convulsion at the age of 21 years.

CHART LXI. F. M. CASE NO. 7277.



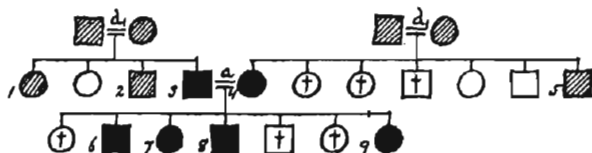
1. Periodic drinker, "a demon when drunk."
2. Rambler.
3. Delusional psychosis at menopause lasting nine years.
4. Recurrent delusional psychosis allied to manic-depressive insanity, in State hospital.

CHART LXII. M. C. CASE NO. 6868.



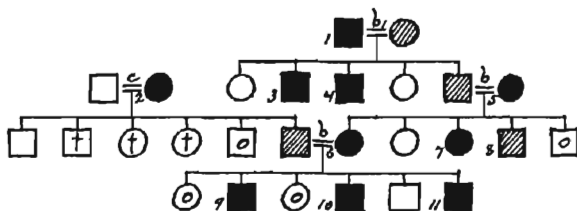
1. High-tempered, excitable, impulsive.
2. High-strung, excitable, alcoholic.
3. Alcoholic, daughter high-strung.
4. Extremely nervous, eccentric.
5. Daughter has nervous temperament, fidgety, easily excited.
6. High-strung, periodically alcoholic.
7. Had nervous prostration eleven years ago, lasted two years, never fully recovered.
8. Alcoholic, wanderer.
9. High-strung, nervous temperament.
10. Very excitable, high-strung.
11. Constitutional inferiority, in State hospital.
12. Fidgety, cannot keep still.

CHART LXIII. E. McG. CASE NO. 7180.



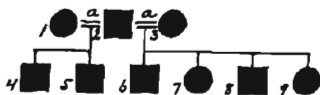
1. Had very alcoholic son who was found dead.
2. Son had neuralgia.
3. Fainting spells.
4. Fainting spells.
5. Child died in convulsions.
6. Died in convulsions in infancy.
7. Died in convulsions in infancy.
8. Dementia præcox, paranoid, in State hospital.
9. Fainting spells; child died in convulsions in infancy, other children normal.

CHART LXIV. S. W. CASE NO. 6965.



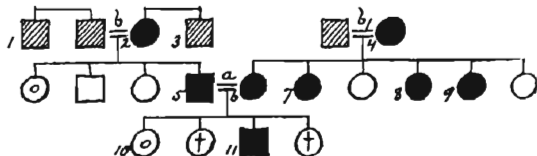
1. Epilepsy.
2. Insane for a time, recovered.
3. Epileptic imbecile.
4. Imbecile.
5. Melancholia in early married life, recovered.
6. Insane five years, was in State hospital, recovered.
7. Insomnia, neuralgia.
8. Daughter had spells of excitement.
9. Feeble-minded.
10. Dementia præcox, catatonic, in State hospital.
11. Died of marasmus, had one convulsion.

CHART LXV. E. K. CASE NO. 6529.



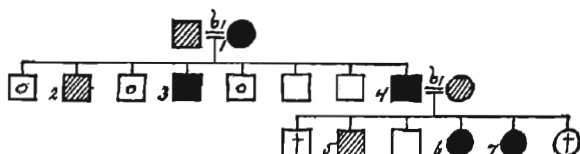
1. "Ignorant, queer."
2. Insane, was in sanitarium, committed suicide.
3. Eccentric, violent temper, ideas of persecution against neighbors and relatives.
4. Eccentric, not well-balanced.
5. Alcoholic, lazy, indolent.
6. Dementia præcox, paranoid, in State hospital.
7. Violent temper, queer, extreme dolichocephaly.
8. Defective, cranial malformation.
9. Inferior, "slow."

CHART LXVI. C. VAN C. CASE NO. 6470.



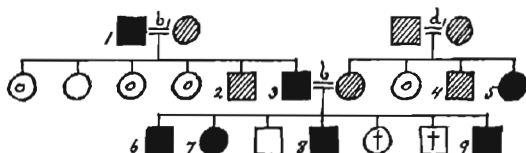
1. Some children queer.
2. Eccentric, very suspicious.
3. One daughter insane, another eccentric.
4. Nervous, irritable, quick-tempered; suffers from neuralgia.
5. Very eccentric, suspected wife of trying to poison him, later suspected others as well.
6. Insomnia for two years during menopause, extremely nervous.
7. Nervous, quick-tempered; has insane son.
8. Very irritable, nervous, quick-tempered.
9. Very irritable, nervous, quick-tempered.
10. 17 years old.
11. Constitutional inferiority, in State hospital.

CHART LXVII. A. H. CASE NO. 6005.



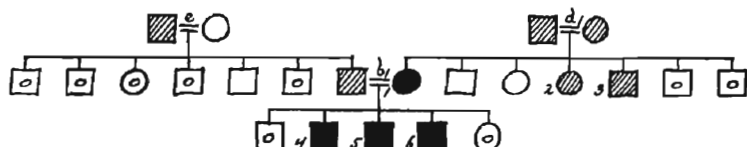
1. Eccentric, "very queer," morphine fiend.
2. Son drank heavily, was dissipated, "black sheep."
3. Very alcoholic, mind failed toward the last.
4. Religious crank, very eccentric.
5. One son and one daughter had convulsions in childhood.
6. Dementia præcox, paranoid, in State hospital.
7. Nervous temperament, high-strung.

CHART LXVIII. J. McK. CASE NO. 7121.



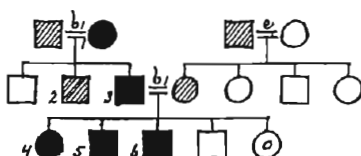
1. Insane for four or five years following money losses, died in hospital.
2. Two daughters insane.
3. Eccentric crank, high-strung.
4. One daughter insane.
5. Nervous temperament, fidgety.
6. Nervous temperament, easily excited; one daughter is nervous, imagines things; son nervous, easily irritated, periodic drinker.
7. Nervous, easily excited, easily frightened, periodically alcoholic.
8. Psychasthenia with impulses and fears, in State hospital.
9. Nervous, has choking spells, easily excited.

CHART LXIX. T. H. CASE NO. 6931.



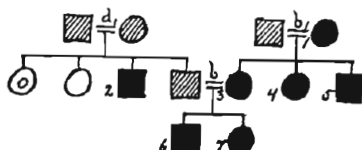
1. Nervous, emotional, "very distant"; had an attack of melancholia, sat in corner, would not eat, smelled peculiar odors, now well.
2. Child had convulsions "from teething" and died.
3. Child died in convulsions in infancy.
4. Periodic alcoholic; daughter had convulsions in infancy.
5. Dementia præcox, paranoid, in State hospital.
6. Convulsions in infancy; son nervous and had one convulsion in infancy.

CHART LXX. J. L. CASE NO. 7254.



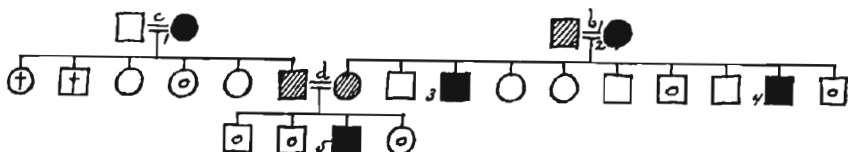
1. Senile dementia.
2. Daughter had migraine.
3. Feeble-minded.
4. Two attacks of nervous breakdown, was melancholy, recovered.
5. Alcoholic.
6. Dementia præcox, paranoid, in State hospital.

CHART LXXI. W. G. CASE NO. 6263.



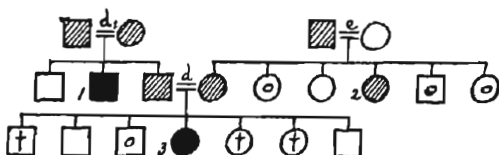
1. Eccentric, probably insane.
2. Very alcoholic.
3. Eccentric, miserly, seclusive, lived in filth, probably insane.
4. Insane, in State hospital.
5. Eccentric, very alcoholic.
6. Dementia præcox, paranoid, in State hospital.
7. Miserly, "like her mother," had spells of yelling, insane.

CHART LXXII. P. S. E. CASE NO. 6794.



1. Had spells of depression at 25 and 41 years respectively, would not talk, recovered each time.
2. Depressed, hypochondriacal.
3. Always worried about his health, imagined he had heart trouble.
4. Alcoholic, "has had every disease."
5. Imbecility with maniacal attacks, in State hospital.

CHART LXXIII. A. J. G. CASE NO. 6611.



1. Insane twice, in State hospital, recovered each time.
2. Daughter had convulsions in childhood; later had "nervous collapse" due to overwork at school, was in sanitarium two weeks.
3. Dementia præcox, in State hospital.

§ 7. CONCLUSIONS.

1. The neuropathic constitution is transmitted from generation to generation in the manner of a trait which is, in the Mendelian sense, recessive to the normal condition. Rules of theoretical expectation are accordingly as follows:

a. Both parents being neuropathic, all children will be neuropathic.

b. One parent being normal, but with the neuropathic taint from one grandparent, and the other parent being neuropathic,

half the children will be neuropathic and half will be normal but capable of transmitting the neuropathic make-up to their progeny.

c. One parent being normal and of pure normal ancestry and the other parent being neuropathic, all the children will be normal but capable of transmitting the neuropathic make-up to their progeny.

d. Both parents being normal, but each with the neuropathic taint from one grandparent, one-fourth of the children will be normal and not capable of transmitting the neuropathic make-up to their progeny, one-half will be normal but capable of transmitting the neuropathic make-up, and the remaining one-fourth will be neuropathic.

e. Both parents being normal, one of pure normal ancestry and the other with the neuropathic taint from one grandparent, all the children will be normal, half of them will be capable, and half not capable of transmitting the neuropathic make-up to their progeny.

f. Both parents being normal and of pure normal ancestry, all the children will be normal and not capable of transmitting the neuropathic make-up to their progeny.

2. Various clinical neuropathic manifestations bear to one another the relationship of traits of various degrees of recessiveness; in a most marked way recoverable psychoses, though recessive as compared with the normal condition, are dominant over epilepsy and allied disorders.

3. Various other clinical neuropathic manifestations bear to one another the relationship of neuropathic equivalents; that is to say, they are conditions of the same degree of recessiveness varying in their clinical manifestations with the personality of the subject, environmental conditions, etc.

4. All the neuropathic children which result from a mating of the fourth type (both parents normal, but each with the neuropathic taint from one grandparent) can have theoretically only equivalent defects and not defects of different degrees of recessiveness.

5. Among the actual results from such matings the following have been met with:

a. Brothers and sisters suffering from clinically identical neuropathic manifestations.

b. Psychosis in one subject and peculiar or abnormal disposition, but no actual psychosis, in brothers or sisters.

c. Psychosis in one subject and isolated but clinically related symptoms in brothers or sisters; we find with particular frequency dementia præcox=fainting spells or convulsions in childhood.

d. Psychoses clinically not known to be related: senile deterioration=peculiar hysteriform psychoses.

6. Neuropathic conditions show only in about one-fourth of the cases indications for commitment to sanitariums or public institutions. The total incidence of neuropathic conditions may be roughly estimated as affecting between 1.5 and 2 per cent of the general population.

7. It is further estimated that about 30 per cent of the general population, without being actually neuropathic, carry the neuropathic taint from their ancestors and are capable under certain conditions of transmitting the neuropathic make-up to their progeny.

ACKNOWLEDGMENTS.

Many persons have assisted us in various ways in collecting data for our study. We are indebted above all to our informants who have confided to us most intimate family secrets for a purely altruistic purpose.

We owe a large debt of gratitude to Dr. William Austin Macy, the superintendent of this hospital, whose unfailing sympathy with the spirit of scientific research has made possible the present study.

And we are also indebted to Dr. Charles B. Davenport, of the Carnegie Institution of Washington, for some suggestions, a good deal of general advice, and actual assistance.