STATISTICS OF SOCIAL CONFIGURATIONS*

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SYNOPSIS

This paper presents a technique for the statistical treatment of social configurations. It discusses the validity of sociometric procedure. Deviations from chance are taken as a reference base in the measurements. Quantitative analysis of choices is used as a method of studying the frequency distributions of choices. Statistics of configurations are found fundamental to the measurement of social organization. Statistical calculations confirm the evidence for the sociodynamic effect and the network. Constructs of sociometric scales are given as suggestive schemes.

I. THE PROBLEM OF SOCIOMETRIC STATISTICS

Sociometry deals with social configurations, aggregates of individuals. Owing to its specific characteristics, this new field demands a new appropriate treatment. It was evident from the start that existing statistical techniques could not be automatically transferred from other fields to this new field. The problem is therefore what kind of statistical methods can be constructed for the new purpose. A critique of sociometric procedures is first advisable to clarify the direction in which to search.

II. CRITIQUE OF SOCIOMETRIC PROCEDURE

Experimental procedures are often set up and put into operation without a careful, epistemological critique of their meaning in relationship to the phenomena studied. An experimental procedure may be accepted by its originator, who, fascinated by its apparent usefulness, may blindly go through the statistical treatment of the data, anxious to find that the experiment is a reliable approach. We begin with a critical analysis of the experimental procedures which have elicited the facts here treated.

The most general critique of sociometric procedure, is that it is an *invention* fashioned to fit certain social phenomena. The data may be therefore to a large extent determined by the frame of the procedure used in fact-finding. To this frame of testing, the tested individuals submit themselves for various reasons. As the individuals submit themselves freely to the

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procedures, the tester knows, *a priori,* the theoretical distribution and possibilities of relationships. The materials to be correlated are the responses of the individuals within the frame of the procedure which has been invented. The single elements of which the configurations can consist are as theoretical possibilities familiar in advance. The resulting configurations can be treated statistically and rationally because there is already knowledge of the single elements of which they are composed.

These sociometric configurations are not what is usually called a Gestalt. They have characteristics which might be attributable to Gestalt. One part of the structure is interdependent with another part; a change in position of one individual may affect the whole structure. But it is known with analytical exactitude how the whole configuration is built up by its single elements. It has some characteristics of a Gestalt but not the crucial one. The single elements of a sociogram are determinable analytically.

The sociometrist and student of social configurations is in a different situation from the Gestalt theorist. He does not approach something given, a Gestalt; he is himself the framer of a Gestalt and therefore the inventor of the framework. And it is within these frameworks that he approaches the social phenomena he studies and not outside of them. The creator of a Gestalt may know the single elements which he manipulated in the original framework and he alone may understand why the configurations resulting look as they do. A later observer who did not know the original creation might have reasons to develop a Gestalt theory, but the originators of a frame are in a different position. For the original maker and inventor of music, for instance, if we may visualize such a supreme mind, the melody may not be a Gestalt. He would know about the units which go into its formation. The units of which he would know, however, may be totally different from the parts into which *we* divide melody, the single tones. Sociometric structures, like musical notations, are languages, symbolic references, not the process itself. They are analogous to the frames of time and space in the sense of Kant. The conceptual mind uses them to align the phenomena.

III. Sociometric Procedure

There are two forms of experimental procedure which may be considered here. One is a procedure which is carried out

in a laboratory. The potentialities of life are in this case reconstructed in a comparatively artificial situation. The effect is to bring the participating individuals with maximum closeness to the experimental situation. The other type is entirely different. The experimental procedure is so constructed that it is able to become the life pattern itself, the one in which the individuals are. The laboratory is gone. This procedure is continuously molded and remolded through critical evaluation and thus brought nearer and nearer to an identity with the life setting. Finally, only the historian of the procedure may be aware that the frame of the setting and the life pattern have ever been two different things. The experimental setting has become a social institution.

The closer a procedure is to the life setting the more accurate and comprehensive may the fact-finding become. Studies can be carried out at different distances from the life setting and from the point of view of comparative research each may have a special value. There are methods in which the investigator elicits from the subjects verbal or non-verbal responses in regard to their inter-personal relations or can use observational methods for their study. In these instances, the test groups, that is, the sum of individuals composing them, remain in a research status. Such methods fall under the general category of a *research sociometry*[1]. They have to be differentiated from other methods in which the subjects' responses and desires are made active and put into operation. Because of the fact that the individuals forming the group know in advance the meaning of the procedure and accept it, they can make it their plan of action, they are identical with it. They are in full consciousness operators in their own behalf. Such methods fall under the general category of *operational sociometry*[2]. In addition to operational sociometry which is often carried out for pure research objectives, procedures have been developed which have therapeutic aims exclusively. *Assignment therapy*[3] in which the factor of spontaneous choice is merely one contributory factor illustrates the purely therapeutic aspect of sociometry.

The most characteristic feature of sociometric procedure in

[1]Research Sociometry and "Near Sociometric" procedures are not identical notions. Near sociometrics is an evaluation of procedure and results. Research sociometry is a classification of method. See references 1, 5, 9, 13, 15, 16, 17 for examples of the research type.

[2]See references 4, 6, 13, 14 for examples of this type.

[3]See references 13, pp. 269-331 and 5, pp. 402-421 for examples of this type.

its operational form is that it tries to warm up the individuals to the experimental setting, until the experimental setting and the life pattern of the individuals have become one and the same thing. The experimental setting is a construct of our mind, its frame is known and its propensities can be visualized, but the life pattern in which these individuals interact is unknown. With the sociometric device we succeed in penetrating a domain which otherwise would remain incomprehensible.

When operational techniques are applied, something happens not figured on at the start. The procedure used in time changes the position of individuals and the structures which we are trying to measure and thus what we try to measure escapes our test. The longer the sociometric procedure is applied, the better we understand the changes of the structure, and the more accurate and complete our knowledge becomes.

To classify operational apart from research methods is an aid in considering more specifically the distance which the frame of an experiment has from the life pattern. Such distance may account for the great difference in results obtained. The nearer to the life scene the frame is constructed, so that it may reach into all manifest and fantasy levels of inter-personal relations, the better will be the opportunity to get the data required. The greater the distance the construct is from the life pattern, and the more rigid it is as such, the less adequate and complete will be the data.

It is evident that a simple procedure setup and the complex inter-personal pattern which it attempts to reach are by no means always congruent. A "choice" may never emerge in the activities of an individual, or the warming-up to a clear and decided feeling of preference may emerge only in a limited number of cases, and where it emerges it may remain inconsequential because of a lack of decisive action towards the person desired. The choices may often be half-conscious, often mere wishes. A person may not know towards whom he is "drawn." Sociometric tests therefore, ought to be constructed more and more in such fashion that they are able to embrace as far as possible the full complexity of the actual interrelations existing in the population. The more flexible the procedure is made, the more it becomes capable of tapping these concrete actualities.

When, however, the complexities of a social aggregate reach the most comprehensive patterns of living, with all the implica-

tions of the fully mature mental processes, statistical treatment may tend to over-simplify the procedure and the data to such a degree that the resulting statistical findings become impermissible and unscientific. This is why techniques of presentation derived from the arts, such as the psycho-drama[4] seem sometimes more appropriate than statistics.

IV. FRAMES OF REFERENCE

There is some confusion in sociometric work in regard to the frames of reference. The experiences, feelings and decisions of the individuals forming a certain social aggregate are one class of facts to which we refer. They are a psychological frame of reference. The social situations—families, churches, industrial units, or whole cultures,—in which these social aggregates take part are another class of facts to which we refer. They are a sociological frame of reference. Similarly a biological frame of reference, an ecological frame of reference, and others can be discerned as affecting social structure. Methodical scrutiny shows that none of these classes of facts is separable from another. The facts that belong to these realms are raw, preparatory materials, but not the frame of sociometric reference itself. The reference which is sociometrically valid is the composite of individual and symbolic responses which represents the living social aggregates, into the weaving of which many factors have contributed.

It is undeniable that the social configurations as portrayed in our sociograms are elementary and rough in texture compared with the complex relationships, rhythms and tempos operating within a living social aggregate. With the devising of new sociometric techniques and with the improvement of the present instruments, the more subtle and more mature processes—the economic milieu, the religious milieu, the cultural milieu, which operates within social aggregates—will be made increasingly comprehensible. It is our contention that these entities, economy, religion, or culture, whatever the logic of their existence may be, cannot be so impersonal as to exist independent of the societies in which the persons actually think, live and act. These processes must express themselves within living social aggregates although their interaction may be more difficult to trace. It is to the comprehension of these richly textured, integrated and fully matured configurations that sociometric work aspires.

[4]See references 10, 11.

As the object of sociometric study is not a single series of data, a series of psychological data, a series of sociological data, of cultural or biological data, but the whole configuration in which they are interwoven; the ultimate sociometric frame of reference could be neither of these series of data exclusively, but the social configurations in which they are interwoven as a whole. Therefore, a pertinent form of statistical treatment would be one which deals with social configurations as wholes, and not with single series of facts, more or less artificially separated from the total picture.

V. STATISTICS OF CONFIGURATIONS

A population of 26 was taken as a convenient unit to use in comparison with a chance distribution of a group of 26 fictitious individuals, and three choices were made by each member. For our analysis any size of population, large or small, would have been satisfactory, but use of 26 persons happened to permit an unselected sampling of groups already tested[5]. Without including the same group more than once, seven groups of 26 individuals were selected from among those which happened to have this size population. The test choices had been taken on the criterion of table-partners, and none of the choices could go outside the group, thus making comparison possible.

The chance experiments were set up as follows: Fictitious individuals—Mr. 1, Mr. 2, Mr. 3, etc. to Mr. 26,—were written on ballots. The chance ballots, except that for Mr. 1, were placed in a shuffling apparatus and three drawings were made for Mr. 1's choosing—the first drawing being called his 1st choice, the second drawing being called his 2nd choice, and the third drawing, his 3rd choice. The three ballots were then replaced in the shuffling apparatus and drawings similarly made for Mr. 2, Mr. 3, etc. The 26 fictitious individuals, each having three choices, produce 78 blind choices. Seven such chance tests were made, using a total of 546 choices, the same number as in the sampling of actual sociometric tests. An analysis of the chance choices is recorded in Table 1. An analysis of the chance structures is recorded in Table 3. An analysis of the

[5]At the New York State Training School for Girls, periodical sociometric testing for dining-table partners at meals is made at intervals of 8 weeks, and three choices are allowed, a 1st, 2nd, and 3rd, to each girl. Only 10 cottage groups happened to have a population of 26 at the time table choices were made and 3 of these were omitted in order not to include the same group more than once. Thus the sampling covers seven different cottage groups.

choices resulting from the sampling of seven cottage groups is given in Table 2. An analysis of the actual structures is recorded in Table 4.

TABLE 1
Chance Experiments with the Sociometric Test
Statistical Analysis of the Choices

No. of Choices	0	1	2	3	4	5	6	7	8	9
Chance Balloting 1	2	4	4	4	8	2	2	..	..	..
Chance Balloting 2	2	3	6	3	8	3	..	1	..	..
Chance Balloting 3	1	1	10	5	4	4	1	..	..	..
Chance Balloting 4	..	3	10	5	2	4	2	..	..	..
Chance Balloting 5	3	5	2	9	2	3	2	1	..	..
Chance Balloting 6	1	3	8	5	5	1	2	1	..	..
Chance Balloting 7	2	2	5	8	5	2	2	..	..	..
Total	10	21	45	39	34	19	11	3	..	..
Average	1.4	3.0	6.3	5.6	4.9	2.7	1.6	.4	..	..

TABLE 2
Actual Sociometric Test
Statistical Analysis of the Choices

No. of Choices	0	1	2	3	4	5	6	7	8	9	10	11
Test 1	4	7	4	3	..	2	2	2	1	..	1	..
Test 2	6	3	4	3	2	4	1	1	1	1	..	..
Test 3	5	4	3	4	4	1	2	1	2	..	..	..
Test 4	3	5	4	6	3	1	..	3	..	1	..	..
Test 5	7	3	5	1	2	4	..	2	..	1	..	1
Test 6	3	2	5	8	3	2	2	..	1	..	..	..
Test 7	7	5	5	1	2	..	1	1	1	1	..	2
Total	35	29	30	26	16	14	8	10	6	4	1	3
Average	5.0	4.1	4.3	3.7	2.3	2.0	1.1	1.4	.9	.6	.1	.4

TABLE 3
Statistical Analysis of Configurations Occurring in Chance

	Isolated	Unreciprocated	Mutual	Chain Relations	Closed Structures (triangles, etc.)	Leader Structures
Chance Balloting 1	2	68	5	..	..	4
Chance Balloting 2	2	74	2	..	..	4
Chance Balloting 3	1	64	7	2	..	5
Chance Balloting 4	..	72	3	..	..	6
Chance Balloting 5	2	68	5	2	..	6
Chance Balloting 6	1	70	4	1	..	4
Chance Balloting 7	2	70	4	1	..	4
Total	10	486	30	6	0	33
Average	1.4	69.4	4.3	0.9	0	4.7

TABLE 4
Statistical Analysis of Configurations Occurring in Actual Sociometric Tests

	Isolated	Unreciprocated	Mutual	Chain Relations	Closed Structures (triangles, etc.)	Leader Structures
Test 1	4	54	12	4	1	8
Test 2	6	48	15	1	1	8
Test 3	5	56	11	4	..	6
Test 4	3	46	16	2	2	5
Test 5	7	48	15	1	2	8
Test 6	3	44	17	2	1	5
Test 7	7	62	8	2	..	6
Total	35	358	94	16	7	46
Average	5	51.1	13.4	2.3	1	6.6

Study of the findings of sociometric tests showed that the resulting configurations, in order to be compared with one another, were in need of some common reference base from which to measure the deviations. It appeared that the most logical ground for establishing such a reference could be secured by ascertaining the characteristics of typical configurations produced by chance balloting for a similar size population with a like number of choices. It became possible to chart the respective sociograms of each experiment, so that each fictitious person was seen in respect to all other fictitious persons in the same group; it was also possible to show the range in types of structures within each chance configuration of a group.

As soon as the results of chance balloting were secured, the problem of the theoretical computation of the data arose[6].

[6]We presented the mathematical aspects of the problem to Dr. Paul F. Lazarsfeld to whom we are indebted for working out the following theoretical analysis:

"Under the conditions of this study the probability of a certain child's being selected by any other child is $p = \frac{3}{25}$

The probability of not being chosen is:

$$q = 1 - p = \frac{22}{25}$$

The two values, p and q, are basic for the whole analysis.
The *first* question to be answered reads: What is the probable number

Theoretical analysis, secured by carrying out the binomial expansion $(\frac{22}{25} + \frac{3}{25})^{26}$ and multiplying by the number of persons, 26, gives the following findings:

No. of Times Chosen	0	1	2	3	4	5	6	7	8 or more
No. of Persons	1.1	3.6	5.9	6.2	4.6	2.7	1.2	0.5	0.2

The average number of mutuals in the chance experiments is 4.3; see Table 3. The theoretical findings show 4.68 under these conditions of 3 choices within a population of 26 persons.

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of children who, by mere chance-selection, would be picked out by their fellows, not at all, once, twice, and so on? The corresponding probabilities can be derived from the binominal formula (3, chapter 9).

The first ten members of the series $\left(\frac{22}{25} + \frac{3}{25}\right)^{25}$ have been computed and give the following values:

$\left(\frac{22}{25}\right)^{25} = .0409$

$25\left(\frac{22}{25}\right)^{24}\frac{3}{25} = .1395$

$300\left(\frac{22}{25}\right)^{23}\left(\frac{3}{25}\right)^{2} = .2291$

$2300\left(\frac{22}{25}\right)^{22}\left(\frac{3}{25}\right)^{3} = .2383$

$12650\left(\frac{22}{25}\right)^{21}\left(\frac{3}{25}\right)^{4} = .1787$

$53130\left(\frac{22}{25}\right)^{20}\left(\frac{3}{25}\right)^{5} = .1023$

$177100\left(\frac{22}{25}\right)^{19}\left(\frac{3}{25}\right)^{6} = .0465$

$480700\left(\frac{22}{25}\right)^{18}\left(\frac{3}{25}\right)^{7} = .0172$

$1081575\left(\frac{22}{25}\right)^{17}\left(\frac{3}{25}\right)^{8} = .0053$

$2042975\left(\frac{22}{25}\right)^{16}\left(\frac{3}{25}\right)^{9} = .0014$

The general formula for n children, each child being permitted a choices, reads:

$$(p+q)^{n-1}$$

$$p = \frac{a}{n-1} \qquad q = 1-p$$

The *second* question to be answered reads: How many mutuals are likely to occur; mutuals being two children who select one another.

The chance that two specific children choose one another is:

$$p^2 = \left(\frac{3}{25}\right)^2$$

That one child is "mutually" chosen by any other child is 25 times as probable. With 26 children in the group, the number of mutuals will be:

$$m = \frac{26 \times 25}{2}\left(\frac{3}{25}\right)^2$$

as the mutual choice of A by B, and B by A, give the same "mutual." Under the condition of this experiment the probable frequency of "mutuals" originating by chance is then: m = 4.68.

The number of unreciprocated structures in the chance experiments is 69.4; see Table 3. The theoretical results show 68.64 under the same conditions. The experimental chance findings so closely follow the theoretical chance probabilities that only the experimental findings will be used for comparison with actual sociometric findings.

The general formula for "n" children, each making a choices by chance, is:

$$m = \frac{n(n-1)\cdot p^2}{2} \qquad p = \frac{a}{n-1} \qquad a = \text{no. of choices}$$

The *third* question to be answered reads: "How many unreciprocated choices can be expected on a mere chance basis?" An "unreciprocated" between two specific children has the probability:

$$p = \left(\frac{3}{25}\right)\cdot\left(\frac{22}{25}\right)$$

By the same reasoning we used in the previous problems, we derive therefrom the probable frequency of "unreciprocated" among 26 children as:

$$u = 26 \times 25 \times \frac{3}{25} \times \frac{22}{25} = 68.64$$

(The fraction, 2, is to be omitted here because an unreciprocated choice of A by B is to be counted separately from an unreciprocated choice of B by A.)

The general formula for the probable frequency of unreciprocated choices originating by mere chance is:

$$u = n\,(n-1)\;p\,q$$

$$p = \frac{a}{n-1} \qquad q = 1-p$$

The Chi-Square test was applied in comparing how much the computed chance values and the experimental chance values (E) differ. For the purpose of the test the computed chance values were figured for the case that there were 7 repetitions, as in the original chance experiments. The test value (see 2, chapter IV) is:

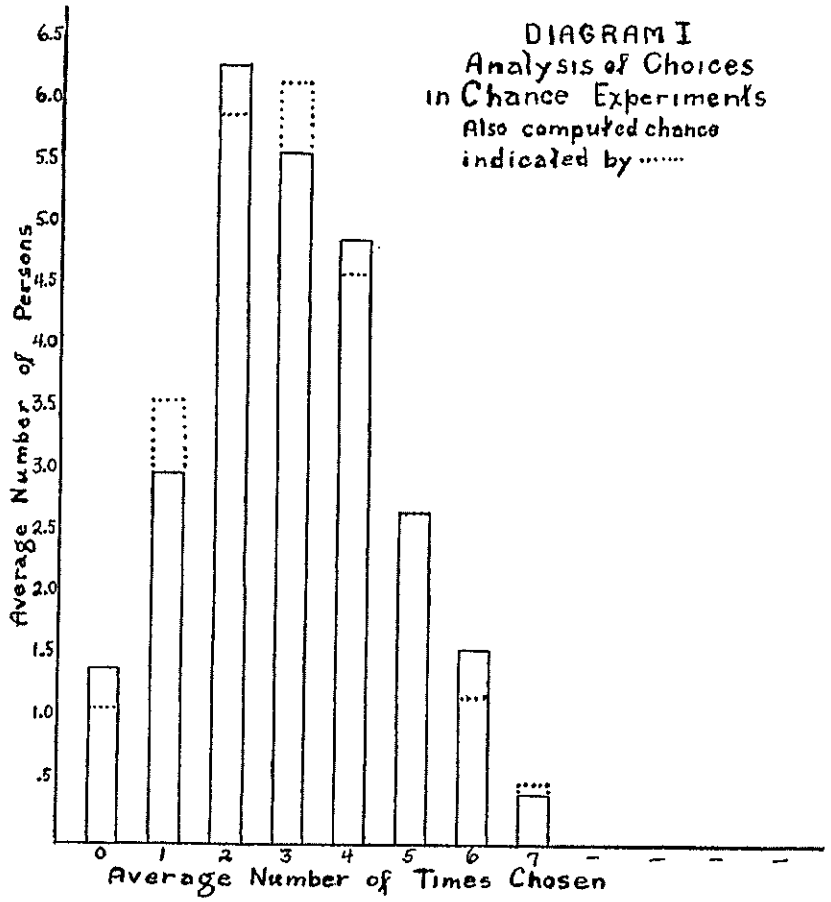
$$\chi^2 = \frac{(E-C)^2}{C}$$

For this table the chi-square value is 4.055, which corresponds to a probability of 85%. That means that in five out of six chance experiments we are likely to get a distribution which deviates even more from the computed one than the one obtained in the chance tests. As a result of the close fit of the chance experiment with the theoretical distribution we have, of course, an equally close matching when it comes to the figures for "mutuals" and for "unreciprocated" choices.

By an extension of the considerations carried through in the foregoing examples, we could get the probable values for any other choices, for instance three or more children forming a ring, or one child being selected by a great number of children, but selecting none of them on her part, and so on."

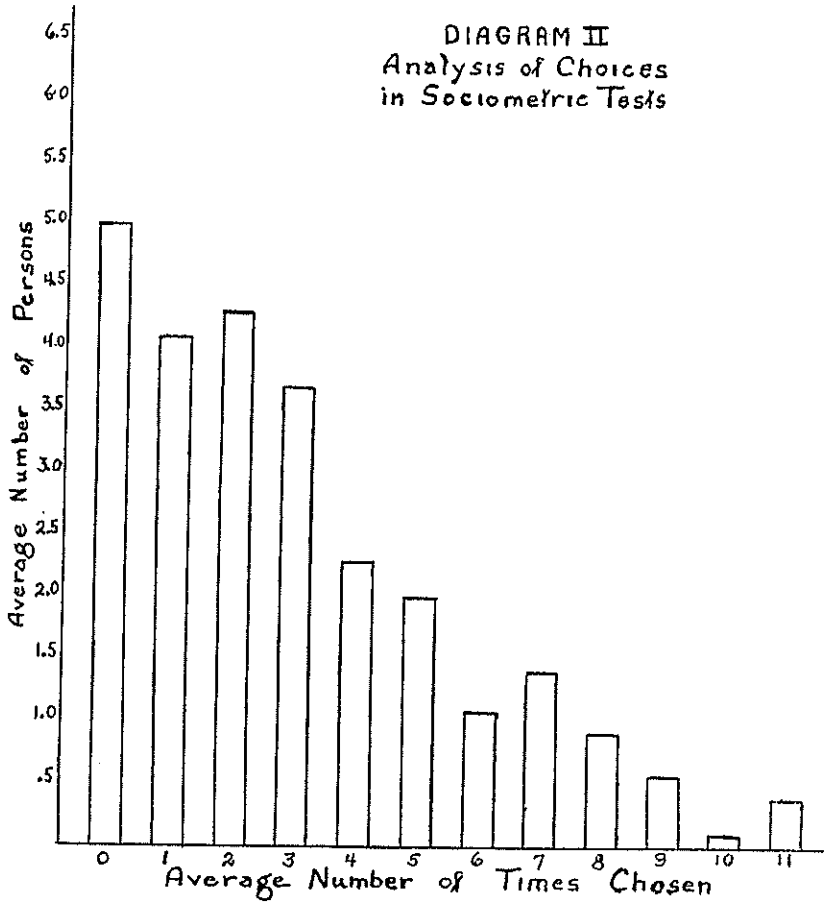
VI. COMPARISON OF ACTUAL SOCIOMETRIC FINDINGS WITH CHANCE EXPERIMENTS

Study of the actual frequency distribution of the seven different social configurations shows that the two extremes are more excessively developed than in chance. See Diagram I. The number of isolates and others at the lower end of the distribution are many more than they are in chance. There are fewer in the middle portions of the distribution who are moderately well-chosen than there are in the chance experiments. But the number who are over-chosen are many more than in chance, not only in number but in their volume of choices received. Whereas in chance one can seldom be chosen more than

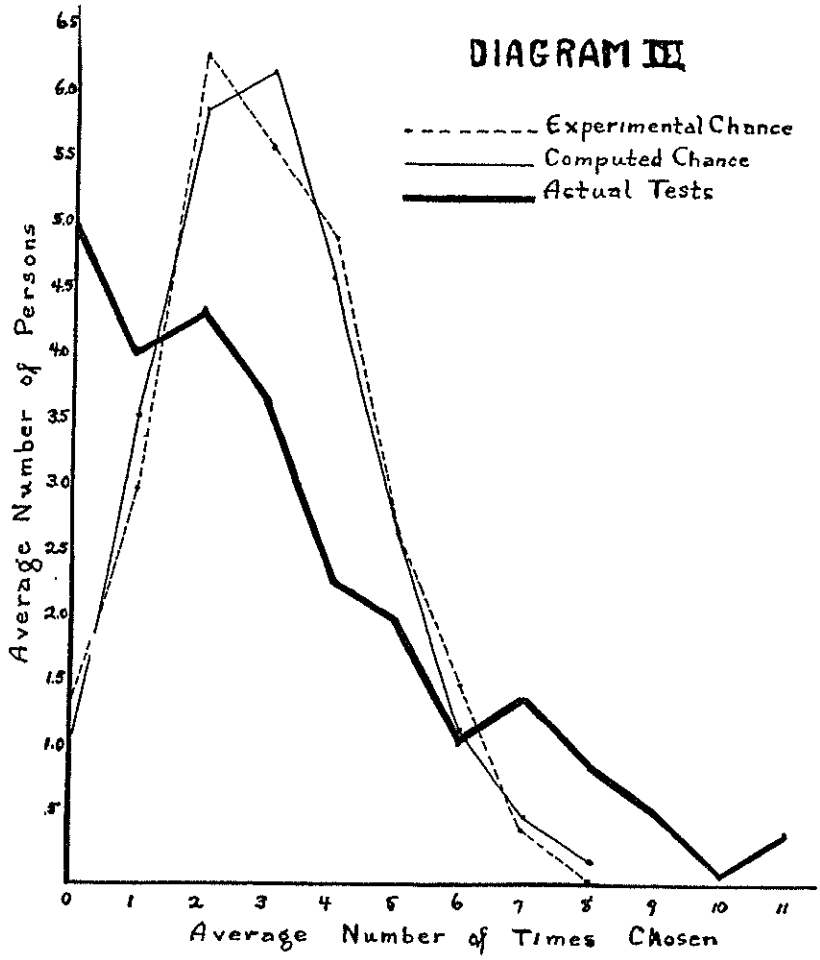


six times, the actual tests show persons chosen 7, 8, 9, 10, and 11 times. In fact, the range is practically 5 points greater in the actual distribution than in the experimental chance distribution. On the other hand, the probability to receive no choice at all is much greater than in chance. See Diagrams II and III.

A greater concentration of many choices upon few individuals and of a weak concentration of few choices upon many individuals skews the distribution of the sampling still further than takes place in the chance experiments, and in a direction it need not necessarily take by chance. This feature of the distribution is an expression of the phenomenon which has been called the *sociodynamic effect*. The chance distribution seen as a whole is also



normally skewed, but the middle portions are higher and the extremes less pronounced. The actual frequency distribution compared with the chance frequency distribution shows the quantity of isolates to be 250% greater. The quantity of over-chosen individuals (receiving 5 or more choices) is 39% greater, while the volume of their choices is 73% greater. Such statistical findings suggest that if the size of the population increases and the number of choices remains constant, the gap between



the chance frequency distribution and the actual distribution would increase immensely[7].

Comparison of the chance sociograms with the actual sociograms shows other differences. The probability of mutual structures is 213% greater in the actual configurations than in the chance and the number of unreciprocated structures is 35.8% greater by chance than actually. The more complex structures, such as triangles, squares, and other closed patterns, of which there are seven in the actual sociograms, are lacking in the chance sociograms. Even structures of chain-relations are found only in six instances and in each instance the reciprocations connect no more than three individuals (i. e. A and B mutually choose each other and B and C reciprocate each other). In the actual configurations, the number of chain-relation structures consisting of three persons each is 9; the number consisting of four persons is 2; the number consisting of five persons is 4; and there is one chain-relation structure consisting of 8. Linked to various members of these chains here and there other mutual structures branch out.

The question may be raised whether all structures of which a configuration is composed have to be determined or whether a minimum of crucial structures can be a reliable index of their measure. If only the isolates in each configuration were counted up, this would be an insufficient basis of comparison. It would not be known if the remainder consists of chosen but unreciprocated persons or whether it consists of pairs. If, on the other hand, only the number of mutual pairs were counted up, this also would be an unreliable basis of comparison. It would not be known whether the remainder of the configuration consists of entirely unchosen ones because their choices go to those who form the pairs, or whether the individuals who form the pairs are practically isolated from the rest because they choose each other but are cut off from others. As discussed elsewhere, the number of chain-relations, squares, triangles, etc., seems to depend upon the number of mutual pairs. This needs some explanation. There may be many mutual pairs in a structure and no chain-relations or more complex structures. But if there are many complex structures, then a relatively large number of

[7]If 500 individuals with five choices each were compared with the corresponding chance structure under these conditions, there would be shown a gap vastly greater than the one here reported for 26 individuals with three choices.

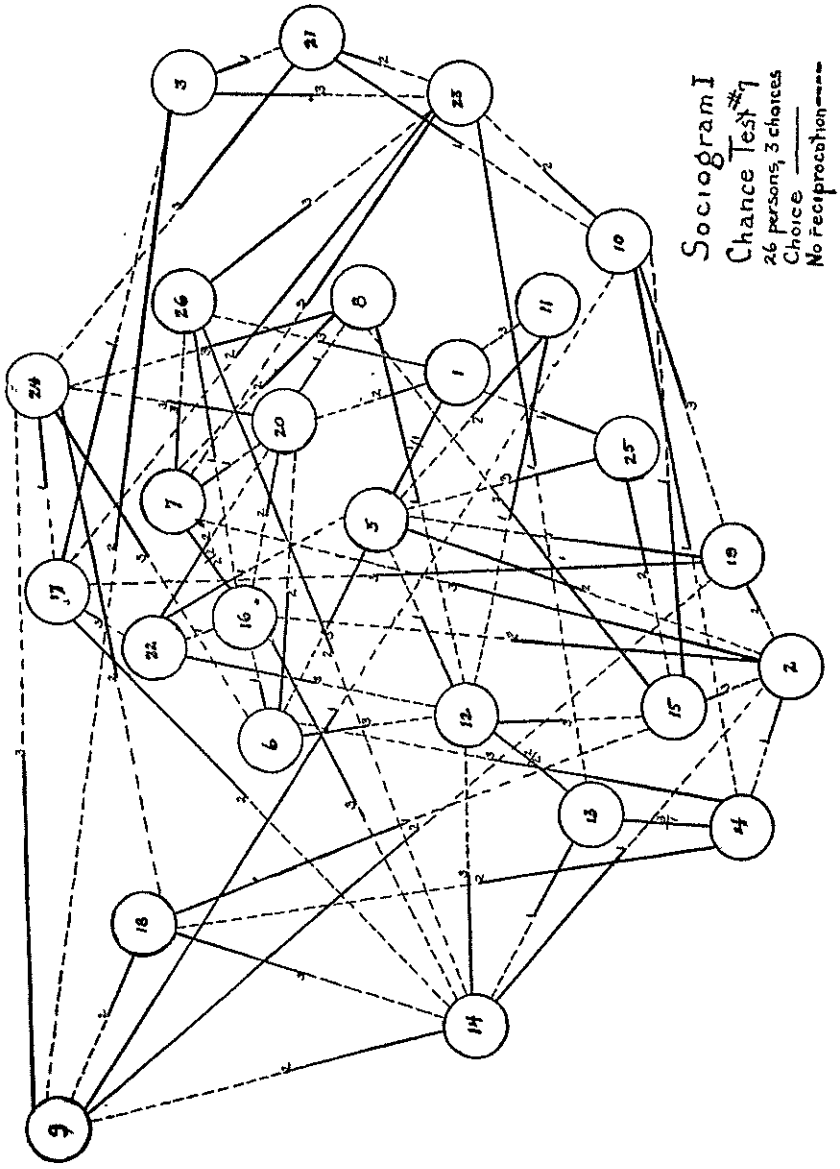
pairs is present. Hence, in order to be adequate this statistical technique has to treat social configurations as a whole. Statistics of single structures apart from the configuration as a whole may offer a distorted view of the whole.

If we select from Table 1 and Table 2 two populations which have almost identical quantitative results, the selection of Choice Ballot No. 7 and Sociometric Test No. 6 is suggested. They have the same number of persons who receive 1 choice, the same number receiving 2 choices, the same number receiving 3 choices, a like number receiving 5 choices, and a like number receiving 6 choices. There is only one more person receiving no choice in the Sociometric Test No. 6; only 2 more receiving 4 choices than in Chance Ballot No. 7; and the only other difference is that the range of receiving stops at 6 in the Chance Ballot No. 7, while one person receives 8 in Sociometric Test No. 6.

The structural analysis of the configurations produced by the choices shows a fundamental contrast, a contrast which is not heralded by mere choice analysis. Chance Ballot No. 7 produces the following structures: 2 isolated, 70 unreciprocated, 4 mutual relations, 1 chain-relation, no closed structures, and 4 leader structures (persons receiving 5 or more choices). Sociometric Test No. 6 produces 3 isolated, 44 unreciprocated, 17 mutual relations, 2 chain-relations, 1 closed structure, and 5 leader structures.

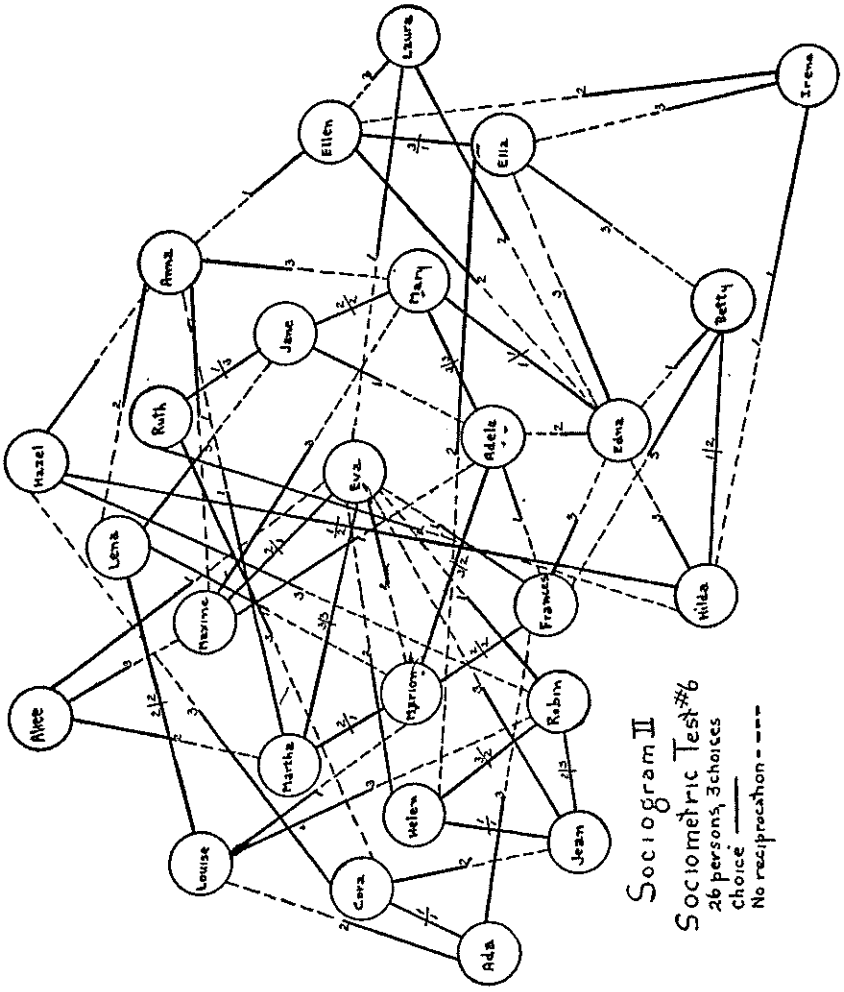
Just as the tabulation of structures is superior to the tabulation of choices, sociogram reading is able to add to the tabulation of structures. It aids in uncovering still farther-reaching differences. Examining the sociograms of these configurations (see Sociograms I and II), we find that the chain-relation structure built by the Chance Ballot No. 7 consists of 3 persons (Person 4 and Person 13 and Person 12), while the chain-relation structures produced by the Sociometric Test No. 6 in one instance consists of 3 persons (Hazel, Hilda, Betty), and in the other of 8 persons (Maxine, Eva, Martha, Marion, Adele, Mary, Jane, and Ruth), with other mutual-relations linked to members of this structure (Marion and Mary are mutual respectively with Frances and Edna). The closed structure is found to involve none of these individuals but to be a closed triangle of three different persons (Helen, Robin, and Jean). Only two of the leader individuals in the Chance Ballot No. 7 configuration have a mutual-relation structure with anyone (Per-

son 5 and Person 12 have one each), whereas in the sociogram of Sociometric Test No. 6 two leader individuals (Mary and Marion) are seen to have three mutual structures (the maximum possible since only three choices are allowed), two other



leader individuals (Adele and Eva) have two each, and the other leader (Edna) has one.

This is a significant illustration of the value of the sociogram in sociometric work. It proves to be not merely another means of schematic representation of data, but an invention for exploratory aims. It is an accurate reproduction of the results of a sociometric test on the level of inquiry and can be well compared with the constructs in the geometry of spaces. It accomplishes



our original search for a spatial science[8] which would do for ideas, things, and persons what the geometry of spaces accomplishes for geometrical figures[9]. From the early beginnings of sociometric work, charting the data in the form of a sociogram and following the sociogram as a trail has led from one discovery to another, to the tele, to the social atom, the network, and in this paper to a method of its own statistics.

The comparisons given above illustrate that it is necessary to approach sociometric material in its intrinsic form, that is, in the form of the social configurations themselves and not in the form of their single elements. *Quantitative analysis of choices is of limited value; it appears as an artificial and abstract view of the configurations studied. Structural analysis of the configurations as such gives a better picture*[10].

VII. INTERPRETATION

The Sociodynamic Effect

The statistical analysis gives new clues for the interpretation of the theory of the sociodynamic effect. A distortion of choice distribution in favor of the more chosen as against the less chosen is characteristic of all groupings which have been sociometrically tested. It might be anticipated that increasing the chance probability of being chosen by allowing more choices within the same size population and thus lessening the chance probability to remain unchosen will gradually bring the number of unchosen to a vanishing point and likewise reduce more and more the number of comparatively little chosen.

However, in actuality, this does not take place. Instead a persistent trend in the opposite direction is observed. The further choices allowed go more frequently to the already highly chosen and not proportionally more to those who are unchosen or who have few choices. The quantity of isolates and little chosen comes finally to a standstill whereas the volume of choices continues to increase for those at the upper end of the range.

[8]See reference 10, page 3-5.

[9]A construction problem in geometry when formulated analytically is found to be equivalent to that of a system of simultaneous equations. A construction problem in sociometry, when presented as a sociogram, is also found to be analogous to a system of simultaneous equations. Geometry deals with the properties of physical space, sociometry deals with the properties of social space.

[10]Such statistical treatment is applicable also to other types of configurations, for instance, to aesthetic configurations, configurations of musical tones, of colors, etc.

It appears on close analysis that once certain individuals become highly over-chosen that they begin to draw the choices of many members of the community less and less as individuals and more and more as symbols. The *"surplus" choices* become analogous to the *surplus value* observed by Marx in the process of production and accumulation of capital. It is at times a pathological distortion beyond the normal process of differentiation.

The sociodynamic effect apparently has general validity. It is found in some degree in all social aggregates, whatever their kind, whether the criterion is search for mates, search for employment, or in social-cultural relations. It is found in populations of children as soon as they begin to develop societies of their own, as well as in adult populations, in groups of various levels of chronological age and mental age and in populations of different races and nationalities. Its effect may change in degree, but it is universally present, appearing like a halo effect inherent in every social structure. It may be pronounced where differences of any sort are intensely felt by the participants, whether these are aesthetic differences, racial differences, sexual differences, economic differences, cultural differences, or differences between old and young.

An example of the degree of distortion which the sociodynamic effect has contributed within the seven cottages of 26 individuals each (182 persons) is the following: 20% of the population have to be satisfied with no choice at all; 35% of the population have to be satisfied with 5% of the choices; on the other hand, 2% of the population control 8% of the choices, 8% control 23%, and 25% control 58%. (See Table 2, p. 348)

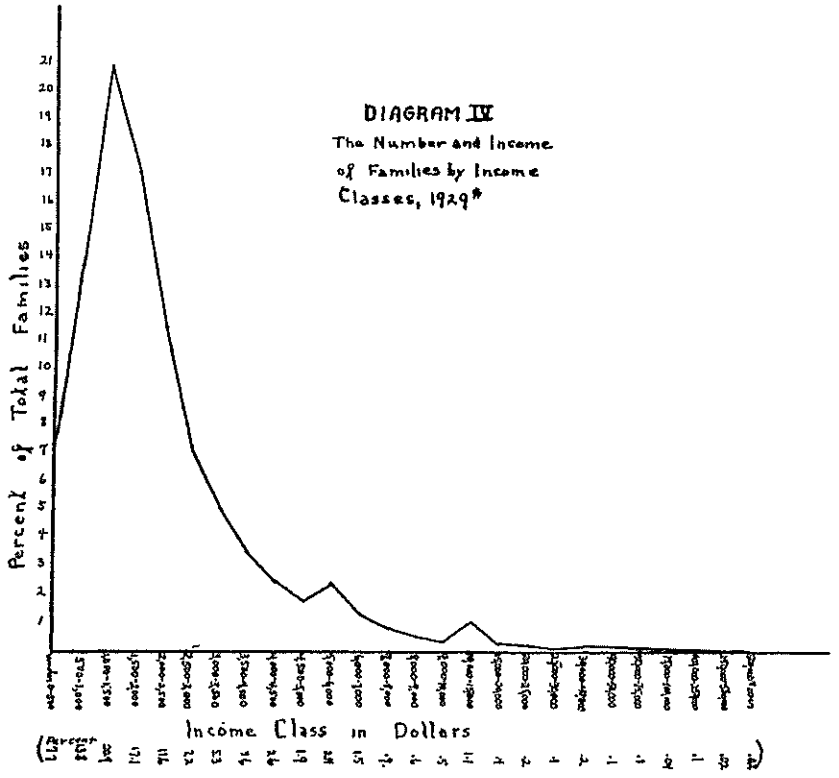
The frequency distribution of choices shown by sociometric data is comparable to the frequency distribution of wealth in a capitalistic society[11]. (See Diagram IV.) In this case also the extremes of distribution are accentuated. The exceedingly wealthy are few; the exceedingly poor are many. The question can be raised whether the similar characteristics of the economic and sociometric curves are accidental occurrences or whether they are both expressions of the same law, a law of sociodynamics.

Network Theory

There are certain structural processes observable in the groups studied which are best explained if it is assumed that networks

[11]See reference 8, p. 54 or 7, p. 145.

exist. One of these structural phenomena is the chain-relation. Chain-relations, are rarely found in structures formed by children of kindergarten and First or Second grade age, but develop at times gradually with an increased number of mutual pairs. Increase in pair structures does not force the formation of chain-relations. In young children's groups, for instance, pair-structures appear frequently without connection with any other pair-structures. However, among the individuals who develop a pair-structure there are some who as they mature in this capacity develop a special characteristic. After they have developed the ability to click with one partner, this partnership does not remain a singular case, but similarly they develop the sense to click with other persons who like themselves have developed a similar *sense* for inter-personal choice. And thus chain-relations emerge and extend. This phenomenon appears hand in hand with the maturation and differentiation of social organization. It is a process of structural growth.



The occurrence of these chain structures cannot be explained solely as a reflection of sociodynamic effects. Outside of a particular chain formation not only isolated or little chosen individuals but also pair structures or even leaders may remain left out. Another dynamic process must therefore stimulate chain formation.

It had been seen that the individuals, who in the sociometric study of a whole community, form a social aggregate around one criterion form other social aggregates around other criteria and that the individuals who produce structures of chain-relations in one aggregate may produce them in other aggregates. If these chain-relations are traced as they cross through the boundaries of each particular aggregate, a new and larger configuration is seen developing,—a psychological network. The simple fact that individuals are more attracted to some individuals and not to others has many consequences. It leaves out those with whom reciprocal relations have not been established and even within the same group there may be formed different networks which do not cross or break through one another.

The dynamic meaning of chain-relations in social structure is better understood in view of a network hypothesis. The chain-relations in each aggregate are often not only contributing to network formation but are themselves a network effect. As chain-relations develop between different social aggregates, existing networks stimulate and increase the development of chain-relations in each single structure.

The relationship between sociodynamic effect and the development of networks appears to be complex. Sometimes its effect is simply negative. The greater the sociodynamic effect the larger the number of isolates and the larger the number and volume of most chosen, the less choices are free for chain-relations and network formation.

This analysis increases understanding of an obscure phenomenon, the beginnings of social organization. Marx has described the possible conditions under which the state withers. A minimum of both sociodynamic effects and networks is necessary for social organization to function with a reasonable degree of differentiation. Without them, not only the state but society[12] itself withers.

[12]We mean society as we find it at the present stage of evolution. But types of society, free of sociodynamic effect, can be constructed in which several individuals *share* in a choice, several individuals sharing a single individual. This is not paradoxical, at least not to some of our most characteristic feelings. In our chief religions, millions of people are sharing in the love of a single person, God.

Tele

The study of the cohesion of forces within a group can be made through an analysis of choices made and choices received, the choices going to individuals inside and to individuals outside of this constellation. A different study of cohesion is based upon the configurational aspect. It considers, instead of single elements, choices, the inter-personal structures and the degree of cohesion produced by them. Cohesion would be very low, for instance, if a large number of choices going to the individuals of a group were unreciprocated. There would be a surplus of choices within the constellation but a *loss* of tele.

Tele has been defined as "an inter-personal experience growing out of person-to-person and person-to-object contacts from the birth level on and gradually developing the *sense* for inter-personal relations," also as a sociometric structure: "that some real process in one person's life situation is sensitive and corresponds to some real process in another person's life situation and that there are numerous degrees, positive and negative, of these inter-personal sensitivities."[13] The tele process is "an objective system of inter-personal relations."

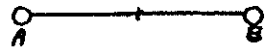
That the tele process represents an objective system can be deduced indirectly through quantitative calculations[14]. A study of the two sociograms on pages 357-8, shows that the number of clickings between the actual individuals forming Sociogram 2, is very much higher than the number of clickings between the individuals forming Sociogram 1. The factor responsible for the increased trend towards mutuality of choice far surpassing chance possibility is called tele. A close analysis of the two sociograms indicates still further the forms in which this factor, tele, operates. Not only that the number of pairs formed in actuality are higher than in chance, but in actuality the trend is stronger for a first choice to draw a first choice; for a second or third choice to draw a second or third choice. Whereas in chance, even where pair relations happen they are incongruous. These findings gain support from our studies of the evolution of children groups, from a simple level to a higher level of differentiation. In the kindergarten and early grades of a public

[13]See reference 11, p. 16; 12, p. 215; 11, p. 74.

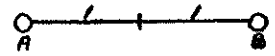
[14]It would be important as a contribution at the present time if derivatives of the tele process, as the sociodynamic effect and networks, were traced through other measurements than the sociometric methods used here. These phenomena must influence the findings of any kind of social phenomena studied, whether studied through public opinion polls, social distance tests, or attitude questionnaires, etc.

DIAGRAM V
Tele Chart I

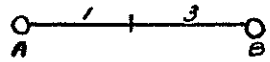
Simple Tele



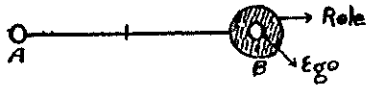
Simple Tele
(Congruous)



Simple Tele
(Incongruous)

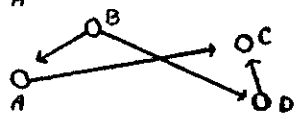


Symbolic Tele



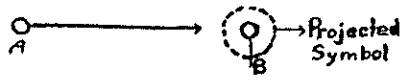
Object Tele

Infra Tele for persons
(Unreciprocated but positive attractions toward a real ego or a real role)

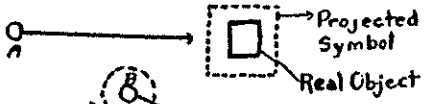


Infra Tele for
an object

Transference to
persons



Transference to
objects



Transference relations among
3 persons, belonging to a
group of insanes

The tele process may show many varieties of tele. Some of them are illustrated in the diagrams above. The attraction of A for B is responded to by an attraction of B for A in the same life situation. This is *simple tele.*

If the attraction between two persons occurs on the same level of preference, then the simple tele can be called *congruous.* A chooses B first; B chooses A first. If the attraction between two persons occurs on different levels of preference, then the simple tele can be called incongruous. A chooses B first; B chooses A third.

The attraction of A for B may not be for B's real ego, but for his alter ego, for some role or symbol which he represents—the role of the physician, the priest, the judge, etc. B, in turn, may not be attracted to A's real ego, but to a role he represents, for instance, the role of the scientist. This is *symbolic* tele.

A is attracted towards an object which, in turn, is useful to him, for instance, any food towards which A reaches spontaneously and which, in turn, satisfies his needs and benefits his health. This is *object* tele.

In all these three cases, the attraction is *positive* from both sides whether the sides are the two egos of two persons, two roles of these two persons, or a person and an object.

A form of attraction can take place which is *positive* for the one person but not shared by the other person. It is unreciprocated. A chooses B. B does not choose A. A chooses B in a certain role. B does not choose A either as an ego or in any role. This is *infra-tele* for persons. There can

DIAGRAM VI
Tele Chart II
The vertical spread of tele in a social structure

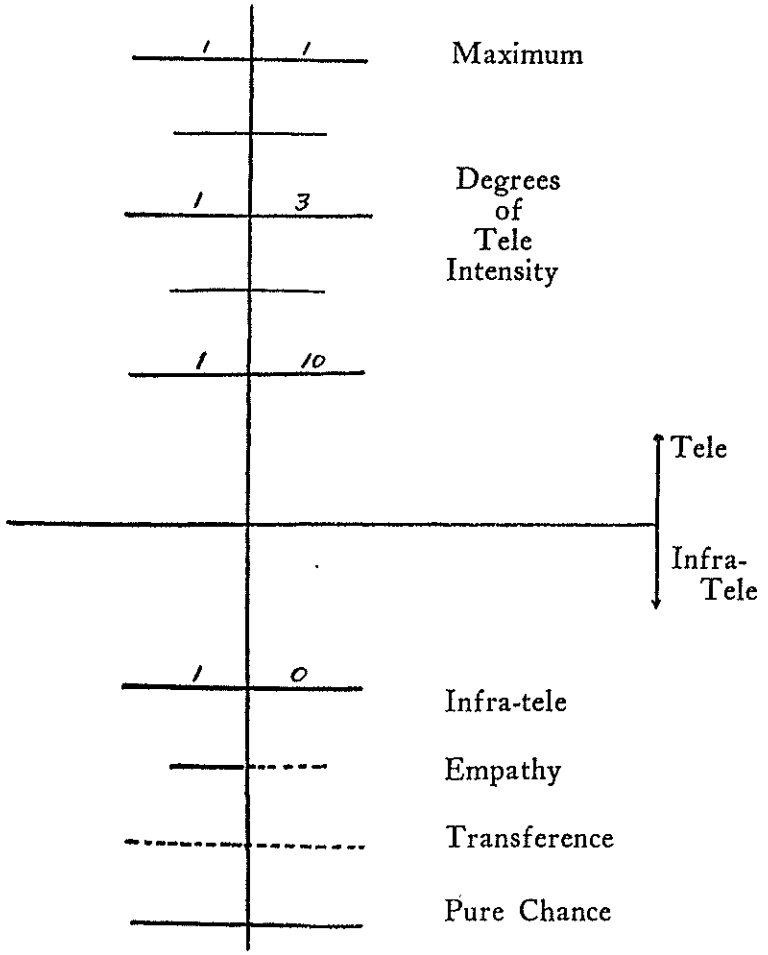


Diagram VI shows a scale ranging from maximum tele to pure chance.

also be an infra-tele for objects. Developments in the tele process which can be classified as aesthetic formations are, for instance, the *Einfuhlung* (empathy) of an actor into his part, the assimilation of an object, as a portrait. Empathy is positive but the process of reciprocation does not enter into its meaning.

There are developments in the tele process which can be classified as psycho-pathological formations, for instance, a person A, when in relation to a person B, sees B in a role which B does not actually experience, a role which A *projects* into B. It is a delusion of A, a projected symbol. This is *transference.*

A person A may be attracted to an object, for instance, a food, but not for what it actually is and not for what effect it may have upon his body, but as a symbol. He may attach to it a certain mystical significance which is entirely subjective, a delusion. It is a pathological attraction and may be definitely harmful to him. This is an *object transference.*

The quantitative study of transference effect upon social structure is possible through comparing a group of insane persons with a group of normal persons under the same conditions. Studies of groups of insanes reveal that the sociogram produced by them is neither all transference nor all tele. It is a mixture of both. The structure of an insane group will probably appear below the tele level but above the chance level. As far as it was above chance, it would account for the degree to which true tele processes are mixed in processes of transference and delusions.

school, the quantity of unreciprocated choices is higher than found in the 4th, 5th or 6th grade levels—but far closer to what is found in chance. Correspondingly the number of clickings or pair-relations is far smaller in these early grade levels than found later on and therefore far closer to chance probability. On the basis of the quantitative aspect of the tele factor discussed above, one may conclude that when the tele factor is very weak as in early infancy and childhood, the factor of chance is far more responsible for the inter-personal sociogram resulting. The stronger the tele factor becomes in later childhood and adolescence, the more it affects and shapes the structure and the weaker is in turn the influence which pure chance has upon it.

If the tele process were a *subjective* system, as transference, hit-or-miss guessing, or vague intuitions, the amount of clicking and of chain and network formation in the configurations studied would not develop beyond chance. The increasing number of pair and chain relations with increasing maturing of the participants and the age of the configuration in which they are, suggest that an objective social process is functioning, with transference as psychopathological outgrowth and empathy as aesthetic outgrowth. (See Diagrams V and VI.)

VIII. DISCUSSION OF SOCIOMETRIC SCALES

In the course of configurational statistics, the idea of comparing one social aggregate with another from the point of view of the degree of integration, the comparative strength of cohesion which holds individual members together, arose as soon as the first sociometric studies were made[15]. Rough rankings of different groups studied were made according to degree of integration.

(a) Scales on the Basis of Choice Analysis[16]

A sociometric scale can be worked out on the basis of the quantitative analysis of the choices made by the participating individuals. The general formula for the concentration of *inside* choices (Ratio of Interest) for any population[17] is

$$\frac{Y}{N \times X}$$

in which N equals size of population in the group; X, the number of choices per individual, and Y, the number of choices sent inside the group by its members. (See Diagram VII.)

The general formula for the concentration of *outside* choices upon a given group (Ratio of Attraction) within a larger population[18] is

$$\frac{Y'}{(N' - N) \times X}$$

in which N′ equals size of the total population and Y′ equals the

[15]See reference 13, pp. 98-103.

[16]We express our appreciation to Professor Henry E. Garrett for critical review of the following statistics.

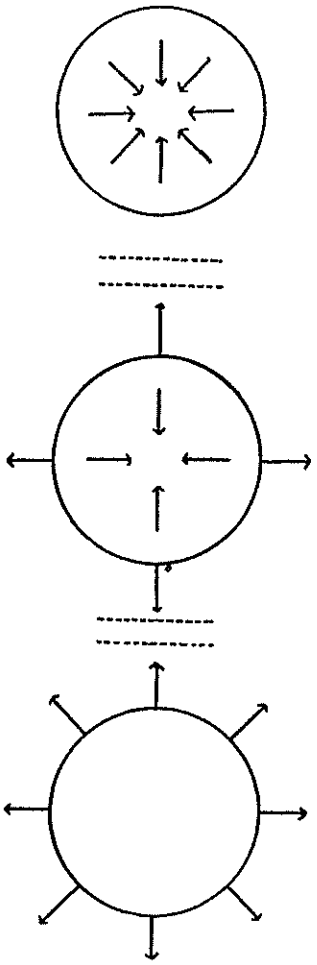
[17]This technique was first introduced in the study of the Hudson community. Every group in the community was in more or less degree the focus of choices coming from members *inside* a particular group or from members *outside* of that group. The degree of the concentration of the choices varied from group to group and a scale was worked out showing how the different groups rank. For a group, Cottage 8, with 26 members each having five choices, 100% concentration of the in-group members would have been 130 choices, but the actual concentration found as contributed by its members was 43 choices, i.e. 33%, the Ratio of their Interest. For Cottage 1, for instance, the concentration was but 29%, for Cottage 13, 66%, etc. (Ref. 13.)

[18]This group of 26 being placed in a large field of 435 individuals which was broken up into 16 specific constellations could have become the center of the focus of the choices of all these members from all these groups. The degree of concentration of choices relative to this larger field was calculated for Cottage 8 as follows. The total population of 435 minus Cottage 8's population of 26 was 409. The number of available outside choices was hence 409 times five, or 2,045 choices. If the 26 members of Cottage 8 were to receive 2,045 choices, the degree of concentration of incoming choices from outside members would be 100 per cent. The number of choices received by the members of Cottage 8 was 35. This figure can be used to calculate the Ratio of Attraction members of Cottage 8 have for outside members. (Ref. 13.)

DIAGRAM VII

A Sociometric Scale of a Closed Group
(criterion is limited to members of this group)

Direction and Concentration of Choices as Basis



Maximum Degree of Concentration

Intermediary degrees

Minimum Degree of Concentration

Between the top and bottom sociograms, numerous intermediary levels can be found for degree of choice concentration; as described on page 367 the various levels of the above scale can be readily determined. These can, of course, be compared with the degree of concentration found by chance.

number of choices sent inside the group by members of the outside population.

Next, the total concentration of choices in a group from its own members *and* outside population members can be expressed by the formula

$$\frac{Y + Y'}{(N' + N) \times X}$$

See Diagram VIII.

As a hypothetical norm for the concentration of choices within a group can be considered the sum of choices available to the members of a given group[19]. The formula for this norm reads

$$N \times X = Y + Y'$$

The direction taken by choices of outside members and the degree of concentration they show upon a certain group are inconclusive in regard to what effect it may have upon the members of that group. It opens up many potentialities but it cannot be inferred that because a higher number of choices enter a group the members of that group are more bound to one another. Concentration of choices upon members of a certain group and cohesion among these members are two *different* things. Statistical comparisons have shown "between the Ratio of Interest and the Index of Relative Popularity (Ratio of Attraction) . . . a negative correlation. This inverse relation is appreciable and indicates a considerable probability that any group which has a high Ratio of Interest for itself will have a comparatively low Index of Relative Popularity."[20] This indicates that the choices going from members of a group to individuals outside it, or the reverse, the number of choices coming to a group from members of other groups is an index for the *diffusion* of choices from the places where they originate in regard to the population as a whole. A different view can be taken in regard to the choices made by members of a group for members of that *same* group, especially drastic if the criterion upon which the choices rest is of a socially intimate nature. The number of choices the individuals who live in the same house have for one another can be more appropriately called an index of the existing cohesion among them than if individuals living in *other* houses are choos-

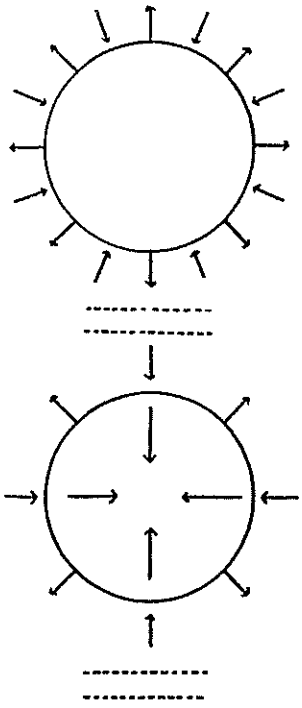
[19]Thus for the given group, Cottage 8, the number would be 26 times five, or 130 choices. To satisfy this norm it is required that if only 43 choices come from inside members, 87 choices should come from outside members.

[20]See reference 5, p. 424.

DIAGRAM VIII

A Sociometric Scale of an Open Group
(criterion allows the inclusion of other individuals than the members of this group)

Direction and Concentration of Choices as Basis



From inside, a minimum of concentration
From outside a maximum of attraction

An equilibrium in attraction and concentration

From inside, a maximum of concentration
From outside, a minimum of attraction

Between the top and bottom sociograms, numerous intermediary levels can be found for degrees of choice concentration and attraction.

ing them, as the latter choices operate at the time of the test outside of the house in which the persons are living together.

However, even these cohesive forces, the forces holding the individuals within the groupings in which they are have to be considered critically. They may not produce all *true* cohesion. It has been found, for example, that "a high Ratio of Interest was not in all instances correlated to a high standard of conduct if other factors existed in the organization of the group to counter-affect this. . . . In a certain case a high Ratio of Interest shown for its own group was a disadvantage. The members did not look for other outlets and at the same time there were numerous rejections among themselves."[21]

Quantitative analysis of choices is *one* aspect in the study of cohesiveness, but it gives a comparatively artificial picture of the actual events within a social configuration. Far more crucial than to say that so and so many choices come in to members of a certain group is how they respond to these choices, how they reciprocate, whether they meet them with mutuality or not. Just as we have found in regard to the statistical study of a closed group that structural analysis is more inclusive than quantitative analysis, also in statistical evaluation of an open group, i. e., a group within a larger population, structural analysis is superior to choice analysis. Sociometric scales of groups in a community based on choice frequency alone cannot stand by themselves. They need for adequate statistical interpretation, scales which are based on configurational calculations.

(b) Scales on the Basis of Configurational Analysis

A more precise and comprehensive scale is necessary as a basic reference for all possible types of configurations in regard to organization and degree of cohesion as they may be found in the community. It would make possible not only the comparison of one social aggregate with another, but the determination of its precise position in relation to other configurations of the same size population under the same conditions. Besides the value of such a scale for research, it would have a value also as a basic reference for operational and therapeutic experiments[22] based on sociometric techniques.

[21]See reference 13, pp. 99-100.

[22]In control studied presented elsewhere, there were compared structural developments as they happened when placements were made as indicated by the sociometric test as against chance placements. See reference 4. The reliability of the placements made could accordingly be studied with greater accuracy if not only position developments of individuals were compared but configurations as wholes.

If the deviations in a configuration which take place in chance were taken as the normal points on a scale, we have a reference base from which to measure the deviations which take place in actual configurations. Until norms can be established for actual populations, it would appear that such a chance reference base provides a useful measuring rod. It is understood that each chance level must be computed on the basis of the given conditions for that population.

If a population of a given size with a given number of choices were to produce a configuration in which every choice going out from a person is reciprocated by another person of that population, the sociodynamic effect would be zero. If that same population were to produce a configuration in which every choice going out from a person remains unreciprocated, the sociodynamic effect would likewise be zero. These two theoretical possibilities represent respectively the maximum degree of cohesion and the minimum degree of cohesion. For these two levels, chance probability in the distribution of choices does not provide. Nevertheless, it is within this wide range that actual configurations must fall in one or another intermediary stage. Although the mathematical working out of these intermediary stages is complex, it can be done with precision. A theoretical construct of a sociometric scale simplified for the purpose of illustration is given in Diagram IX.

A series of configurations, as indicated in the construct, differs in the essential respect from a series of single elements in that it is multi-dimensional. On one point of the scale there is not only one solution but many. Also on each level of the scale there can be many sociotropic[23] varieties (factorial n) all having the same level of integration.

In the example used for the construct on page 373, five persons can produce 120 sociotropic varieties by a shift of position. The scale opens the way of learning whether the maximum degree of integration is also the best therapeutic level of a social aggregate. It may well be that they vary considerably.

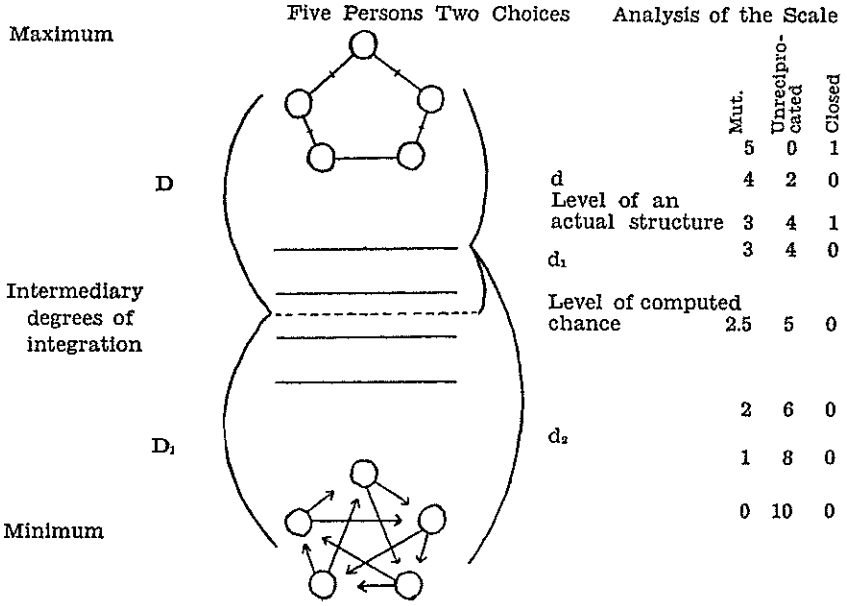
As in statistics of single elements, it appears possible that, after a sufficiently large number of different populations have been tested and their configurations determined, the field worker will be able to predict the position of a group on a sociometric

[23]Two sociograms are sociotropic if they are formed by the same persons and have the same sociometric properties, seen as total configurations. They may differ in the position one or the other individual may have within them.

scale when approaching a new community before testing it. He will become able to predict approximately the range within which the configuration of this community will fall. Yet, however large the sampling of configurations taken from a given population is, and however accurate the prediction of the possible configuration of the untested part of this population may become, the rest of the population has nevertheless to be actually

DIAGRAM IX

Theoretical Construct of a Sociometric Scale
(On Configurational Basis)



Analysis of the Scale

	Mut.	Unreciprocated	Closed
	5	0	1
d	4	2	0
Level of an actual structure	3	4	1
d_1	3	4	0
Level of computed chance	2.5	5	0
	2	6	0
d_2	1	8	0
	0	10	0

The Scale is illustrated by configurations produced by 5 persons with 2 choices each. Six main levels of integration are indicated in the diagram. Only the top or maximum level of integration and the bottom or minimum level of integration are drawn. The intermediary degrees are indicated by a straight line. The composition of each degree, however, is presented in the analysis to the right of the Scale.

Each of the six levels has, due to the possible shifting of the 5 persons and 2 choices, 120 sociotropic varieties. Sociotropic varieties are of the same level of integration although the position of the individual members may differ.

D —Deviation of maximum from chance.
D_1—Deviation of chance from minimum.
d —Deviation of maximum from average actual.
d_1—Deviation of average actual from chance.
d_2—Deviation of average actual from minimum.

tested if a transaction of useful treatment of this part should be contemplated. The slightest variation in the untested part of this population may concern a number of individuals, however few. Types of sampling can become useful for prediction purposes from a tested to an untested part, but it is not permissible to assume this automatically for treatment purposes.

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