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The Union of Opposites in Sociometry

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ABSTRACT. This article presents an empirical study that (a) introduces the sociodynamic test, which adds to the sociometric test (Moreno, 1934; Hale, 1981) a measure of coexisting opposite preferences underlying sociometric choice; (b) outlines how the sociodynamic method is used clinically; (c) demonstrates empirically that preferences are more predictable than choices, suggesting preference rather than choice data should be used when measuring interpersonal perceptual accuracy; and (d) illustrates nonlinear patterns of choosing and bonding by maintaining the integrity of coexisting opposites by plotting positive and negative preference with their corresponding sociometric choice. The study also illustrates how a new general theory of processes helps to identify a problem in clinical and experimental measurement; serves to design a method to overcome it; and directs us toward mathematical dynamics for the analysis of nonlinear patterns.

WHEREAS THEORETICAL AND CLINICAL PSYCHODYNAMICS stress the conflictual and contradictory nature of psychological and interactional processes, the sociometric assessment of choice (Moreno, 1935) does not allow the measurement of ambivalence (Hale, 1987). This omission renders choice a poor estimate of preference, limiting the usefulness of the sociometric test as a measure of interpersonal perceptual accuracy and compromising the informational value of sociograms that do not include ambivalent bonds. This article introduces a sociodynamic test that includes the sociometric measurement of choice and adds to it the independent measurement of the intensity of coexisting positive and negative preferences that underlie sociometric selections. The aim of this article is threefold: (a) clinically, to present a method useful to reveal contradictory preferences and their influence on group dynamics, which is being currently used in groups of psychiatric patients; (b) experimentally, to present a study demonstrating how the same method, as a paper-and-pencil test, enhances the sociometric instrument; (c) theoretically, to discuss how process theory, a new perspective in psychiatry (Carlson-Sabelli & Sabelli, 1984; Carlson-Sabelli, Sabelli, Hein, & Javaid, 1990; Sabelli, 1989; Sabelli & Carlson-Sabelli, 1989, 1991; Sabelli, Carlson-Sabelli, & Javaid, 1990 a & b), serves as a conceptual framework to identify a problem that limits the validity of commonly used methods of measurement in and beyond sociometry. It also suggests a solution that incorporates mathematical methods considered at the forefront of today's scientific research in a wide variety of areas (Babloyantz, 1986; Callahan & Sashin, 1987; Garfinkel, 1983; Guastello, 1987, 1988; Guastello & McGee, 1987; Prigogine & Stengers, 1984; Thom, 1975; Tsonis, P., & Tsonis, A. 1989; Yates, 1982; Zeeman, 1976).

The sociometric test introduced by Moreno (1934) consists of "an individual choosing his associates for any group of which he is or might become a member (cited by Bronfenbrenner, 1943, p. 365). On the standard sociometric test (Hale, 1981), subjects are asked to list choices and rejections in order of preference and to list the individuals each "chooses not to choose." Analyzing sociometric data provides information about the individuals and their position within a group. It can be used to identify leaders, isolates, rejectees, subgroupings, connectors, status, and expansiveness (Moreno, 1935; Proctor & Loomis, 1951; Roistacher, 1974). Sociograms provide visual configurations of the bonds among group members, reflecting the way the individuals organize themselves around various criteria (Moreno, 1935).

The sociometric test, congruent with the traditional logic prevalent at the time of its conception, is based on the assumption that sociometric choices and rejections are a direct reflection of the forces contributing to them. It considers choice/attraction and rejection/repulsion as the opposite poles of a single continuum. Although sociometric selection and rejection are dichotomous and mutually exclusive, attraction and repulsion are not. Furthermore, within this mechanistic view, it is expected that an increase at one pole (attraction) necessarily represents a decrease at its opposite (repulsion). When two opposites are equally powerful, the corresponding equilibrium would be equivalent to neutrality. This, of course, is not the case. Instead, when two strongly opposing forces are present, we observe processes of ambivalence. Many opposites grow together, such as love for and animosity against a family member. Attraction and repulsion may coexist as ambivalence or, more generally, as contradictory preferences.

Although ambiguities, contradictions, and ambivalence can be observed in the reasons individuals give for the sociometric selections they make (Moreno, 1934), the data have not been available for statistical or sociogram analysis. Thus, in spite of its clinical usefulness, the sociometric test has profound limitations that derive from its inability to consider contradictory situations, interpersonal ambivalence, and emotional ambiguities.

The impact of this problem is especially notable when the sociometric test is used as a measure of interpersonal perceptual accuracy (Moreno, 1942). Accuracy of interpersonal perception is measured as the congruence between sociometric selection (choice, rejection, neutrality) by a group member concerning the subject and the guess of the subject concerning each selection (Katz & Powell, 1953). A subject who is indifferent or ambivalent toward another cannot adequately describe the situation within the linear confines of the sociometric measure. Guesses are limited by the same constraints, doubling the impact of the problem. Our modification, measuring the tendency to choose separately from the tendency toward rejecting, is designed to address this problem—to provide a means of expressing contradictory preference—both wanting to choose and not wanting to choose another, at the same time and for the same reasons. The sociodynamic addition is based on the assumption that choice and rejection represent a bifurcation resulting from a complex interaction between mutually contradictory positive and negative preferences. This interaction includes thresholds and cannot be modeled by an algebraic sum (linear model). Correspondingly, the relation between the intensity of preferences and rank of choice seldom fits a straight line. This problem could not be solved within the conceptual framework of two-valued logic or linear metrics. To overcome these limitations, we developed a sociodynamic test that applies the geometric methods of mathematical dynamics and the underlying concept of the union of opposites.

Theoretical Analysis of the Problem

In traditional sociometry, both the data collection method and analysis are based on assumptions arising from the either-or separation of opposites of Aristotelian and mathematical logic and from the mechanistic tradition of Newtonian dynamics (numerical calculus). This linear mechanical model, in which opposing forces balance and neutralize each other, can deal only with simple processes that are determined, reversible, and near equilibrium; it cannot accommodate the coexistence of opposing feelings, drives, or preferences, which Freud (1923/1958), Adler (1954), Jung (1959), and others have described as characteristic of psychological processes. Evolutionary scientists such as Darwin, Marx, and Freud based their theories on another model of processes, a conflict view based on dialectics. The dialectic approach recognizes that processes are fueled by the contradiction of opposites. This model highlights the interpenetration of opposites but exaggerates their struggle, minimizing their harmonic interactions. Furthermore, dialectics lacks mathematical methods for the study of processes.

A third model of processes, process theory (Carlson-Sabelli & Sabelli, 1984; Sabelli, 1989; Sabelli & Carlson-Sabelli, 1989, 1991; Sabelli et al, 1990a, b), focuses on the coexistence of harmony and antagonism (Heraclitus's union of opposites) and uses the geometric methods of modern dynamics to study mathematically the nonlinear patterns of processes resulting from complex interactions (Abraham and Shaw, 1982, 1983). Going beyond calculus, this new mathematical science of processes has already revolutionized physics (Prigogine & Stengers, 1984) and biology (Thom, 1975; Garfinkel, 1983; Yates, 1982). Catastrophe and chaos theories are now beginning to enter the social and the psychological sciences (Woodcock & Davis, 1978; Callahan & Sashin, 1987; Guastello, 1987, 1988; Guastello & McGee, 1987; Zeeman, 1976). Dynamics uses geometrical models with two (phase plane) or three (phase space) dimensions (Abraham and Shaw, 1982) to analyze the pattern of processes that do not fit the unidimensional linear model. Characteristically, complex processes tend to converge to simple attractors describable in terms of a limited number of dimensions (Abraham & Shaw, 1982; Garfinkel, 1983). One can then study complex processes by examining plots in two or three dimensions. The choice of the variables taken as coordinates is a difficult and critical step for which dynamics itself can offer no suggestions. Process philosophy (Heraclitus, Lao-tzu, Hegel, Engels, Whitehead; see Sabelli, 1989) provides a theoretical basis for the choice of fundamental variables in its notion of the union of opposites, namely, that processes are energized and patterned by the intercourse of coexisting opposites. For instance, social processes are fueled by the interactions and contradictions between supply and demand, rich and poor; matter is constituted by positive protons and negative electrons; and life itself is energized and procreated by the intercourse of opposite sexes.

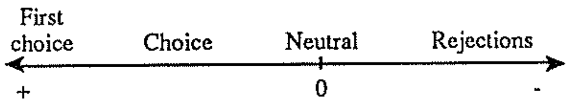
Thus, process theory suggests that choice-making should be studied as a function of the underlying positive and negative preferences that coexist, albeit in various degrees. Whereas the principle of the union of opposites occupies a central place in process philosophies and in quantum physics (Bohr's complementarity principle, see Capra, 1975; Kothari, 1985), it was not practical to apply it to empirical data until the birth of modern dynamics.

Applying these concepts to sociometry: Groups are organized by the recurrent interactions between their members, which are of two opposite signs—attraction and repulsion. Interpersonal harmonies and conflicts overlap; likewise, any social system produces both social communion and social alienation. Both attraction and repulsion are bonds, forms of

interaction and exchange. The balance of attractions and repulsions determines interpersonal distance, which is at once a bond and a separation. In a group, the attractions and repulsions among all members contribute to the interpersonal distance between each pair, as the attraction for one serves to separate from others. Each person is procreated, raised, and lives within an evolving population. Given the constant changes in intrapsychic motivations and social groupings, interpersonal distance is constantly changing. To measure choice, we need to know both interpersonal distance and the vector representing its change. At any one time, two persons can approach or separate or stay at the same distance; one distance and one vector of change results from the interaction of these multiple attractions and repulsions. This resultant is not always a linear vector product of the interacting forces, which can be represented in the same plane. Choice often is a nonlinear process including ambivalence, uncertainty, contradiction, and creativity. The topological approach of modern mathematical dynamics may be a useful way to study such complex processes. Kurt Lewin (1935) has already proposed topological methods to study the dynamics of social reality in interpersonal relations. The sociodynamic test introduced here measures coexisting opposite preferences and the resulting choices independently and plots them in a tridimensional phase space. This geometric approach avoids the linear simplifications imposed by the use of purely metric methods.

Under the influence of contradictory demands, people in crisis are highly influenceable by psychotherapy (Sifneos, 1980). In a similar manner, physical processes containing contradictory forces are creative and readily modifiable (Abraham & Shaw, 1983; Prigogine, 1980; Prigogine & Stengers, 1984; Thom, 1975). The coexistence of opposing forces produces fluctuations; intense oppositions produce qualitative changes in behavior ("bifurcation"), such as sudden switches from one extreme to the other (Thom, 1975; Zeeman, 1976), the occurrence of "chaos," or the creation of novel alternatives, progressive or pathological (creative bifurcations). Chaotic processes are drastically altered by minor influences ("butterfly effect"). Examples of these various possibilities are the ambivalence of a person in a stormy relation (chaos); the over-idealization or total rejection of a significant other by borderline patients, with sudden switches (catastrophe); and the creation of new alternatives, a creative bifurcation, whether useful—Moreno's true spontaneity (1966)—or neurotic behaviors, such as the abnormal behavior developed by animals when placed in contradictory approach-avoidance situations—Moreno's pathological spontaneity. The sociodynamic test, which applies the process theory concept of the union and bifurcation of opposites to the measurement of preference and choice, adds measures of the coexisting opposite preferences underlying choice to the standard sociometric test. Figures 1, 2, and 3 compare the unidimensional sociometric test (A) with the bidimensional phase plane of coexisting opposites (B) and illustrate through a tridimensional phase space (C), the relationship of coexisting opposites and choice. The intensity of positive preference (feelings and reasons for choosing a particular partner) is measured separately from the intensity of negative preference (feelings and reasons for rejecting). When both of the coexisting op-

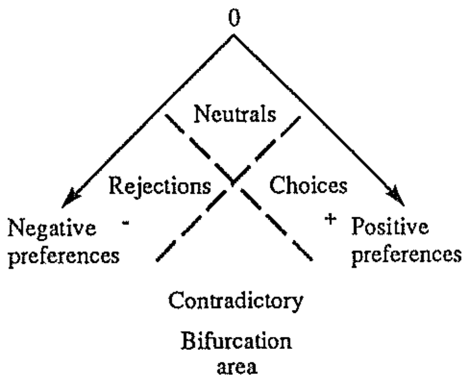
A. Sociodynamic continuum



A The sociometric test elicits choices in a linear manner from first choice to last. Choice and rejection are mutually exclusive opposite poles of a single dimension.

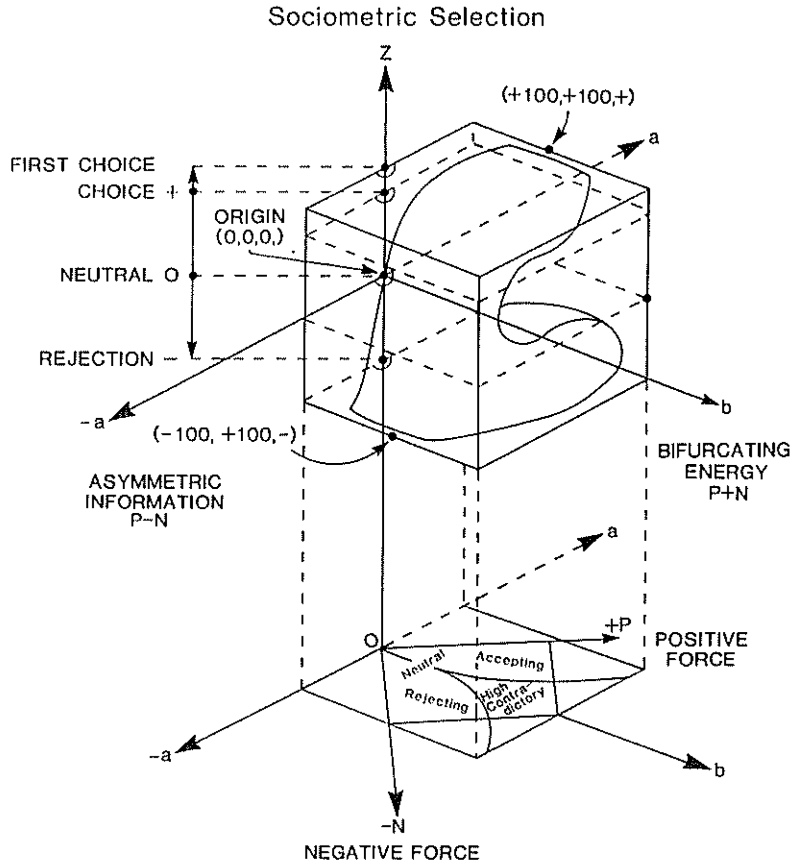
FIGURE 1. The Process of Choosing: A—Unidimensional Sociometry

B. Sociodynamic phase plane



B Bidimensional sociodynamic phase plane: the axes represent the intensity of coexisting positive and negative preferences. The cutting point to create categorical scores from the sociodynamic data was 50.

FIGURE 2. The Process of Choosing: B—Bidimensional Sociodynamic Phase Plane



Note that the x and y axes required a simple transformation to create from the positive and negative preference scores the asymmetric (p − n) and bifurcating (p + n) variables necessary for 3-dimensional analysis with catastrophe models. Conceptually, the asymmetric parameter (x axis) denotes the direction and intensity of the dominant preference force; the bifurcating parameter (y axis) represents the combined intensity contributed to the process by both forces.

FIGURE 3. The Process of Choosing: C—Tridimensional Phase Space

posites—intensity toward choosing and intensity toward rejecting—are high, conflictual preference may emerge as a separate category. The state of intense contradiction is unstable, chaotic, and often transient, rapidly bifurcating to one or the other opposite—to choosing or rejecting. Thus, it is expected that only a few of the coexisting contradictory preferences will be intense enough to fall into the contradictory category (bifurcation areas of Figure 1 and Figure 3). Nevertheless, by measuring preference as a bidimensional construct, the sociodynamic method provides an estimation of ambivalence behind each choice, making available for quantitative and dynamic analysis information found only in the reasons for choice on the sociometric test.

Clinical Observations

In recent years, we have introduced the process bidimensional framework as an action method with groups of psychiatric patients and students (Sabelli, 1989, p. 405). We ask group members to place themselves within a large *V* drawn in the center of the room (sociodynamic phase plane of Figure 2). The intensity of opposing preferences, emotions, attitudes, and feelings are represented by the two axes. The vertex of the *V* represents zero feelings (indifference or neutrality). For instance, in a psychodrama group, the left axis may represent the intensity of positive feelings toward choosing oneself to be the protagonist, and the right axis would represent the intensity of opposite feelings against becoming the protagonist. Group members are asked to stand within the *V* at the point determined by the intensity of both their negative and positive preferences. All group members make their choices simultaneously and thereby influence each other. This sociodynamic action test produces a moving scenario when opposites of high intensity exist together. Those with strong reasons for both choosing themselves and not choosing themselves place themselves high on both axes, high within the *V*, and almost always pace or rock. Indifferent individuals stand quietly, near the vertex. The individuals with strong, intensely contradictory feelings, pacing in the bifurcation area near the top of the *V*, are ready to change and, hence, to become the protagonists. The neutral individuals near the vertex are less motivated and less ready to be the group's protagonists.

These sociodynamic exercises are useful in encouraging the expression of feelings, as are other action methods. One can use the sociodynamic *V* to represent opposite emotions or perceptions instead of the often-used method of asking group members to place themselves on a linear continuum according to how angry or anxious they are, how they feel about some topic, or how masculine and feminine they consider themselves. The *V* representation provides insight into this coexistence of passivity and aggressivity, whereas the linear method forces the patient—and the therapist—to think in black-and-white dichotomies. For example, a continuum represents passivity as the opposite of aggressivity and assertiveness as a midway neutrality. In reality, high degrees of passivity can coexist with high degrees of aggressivity, as passive-aggressive personalities illustrate; in their treatment, passivity can be reduced if, and only if, aggressivity is also reduced. Relevant examples of the need to distinguish the neutral or indifferent from the contradictory include the following: a person with high masculine and feminine traits in contrast to another, who has low intensity in both directions; a person who loves and hates his parents compared with one who is indifferent to them; a person whose self-view encompasses both low self-esteem and grandiosity, as is often observed in depression and in self-disorders.

The two senior authors regularly use bidimensional sociodynamic methods in their clinical practice, finding that these methods bring out more of the complexity surrounding a variety of issues than the unidimensional action continuum and the standard sociometric test alone. There is, at present, no empirical study supporting these clinical observations.

Experimental Study

This study empirically examines the coexistence of contradictory preferences and considers why they are important in the process of making choices. For this purpose, we have expanded the standard written sociometric test to include a measure of the intensities of opposite preferences underlying choices. The predicted impact is that subjects will have a more complete domain in which to report interpersonal preferences and predictions. As ambivalent persons change their choices over and over, it is difficult to predict which choice they would make when filling out a questionnaire. Predictions of choices are therefore likely to be uncertain. On the other hand, the ambivalence can be accurately measured as the coexistence of contradictory preferences. Hence, when a criterion brings out contradictory preferences, it will be less likely that we can predict the interpersonal preferences of other for self with the sociometric test, which measures only choices, than with the sociodynamic test, which measures preferences. Conversely, the accuracy scores should be similar for both methods, with criteria eliciting little contradiction.

Methods

Subjects

The subjects were 12 university students in a psychodrama course who had known each other for at least 3 weeks. They were all white women; their ages ranged from 22 to 61 years. All tests were administered in the same session during the third week of class. The sociometric test was administered before the sociodynamic measurement of preferences. Students were informed that their choices would not be made known to the group members, but that one of the questions would be used as data for organizing a future activity. The students were also told that they would receive a personal profile indicating their individual patterns of choosing and their perceptual accuracy. These two conditions were made to enhance involvement and honesty.

Tests

The sociometric test used was that published by Hale (1981/1985, pp. 71–77). In brief, it asks subjects in a group to identify from among the other members in the group those with whom each would like to associate and not associate in a particular future situation or specific activity. The activities or situations are called "sociometric criteria," and group members are asked to list each other group member in one of three categories: choose to, choose not to, choose to be neutral toward. Both the positive and negative choices are listed in order of preference. There is no limit to the number of persons within each category. Subjects are then asked to predict in what category each of the other group members would place them. Finally, the reasons for intended choices and predictions are requested.

For the sociodynamic measurement of preference, we asked subjects to assign two separate numbers (from 0 to 100) to the intensity of their preferences for choosing and for rejecting each of the other group members as a partner for a specific activity. Fifty was explicitly stated to represent moderate preference. In the same manner, we requested each subject to predict the positive and negative intensity scores each other group member would assign to the subject.

Sociometric criteria

The same three different criteria were used for both measures. To highlight differences in precision between the sociometric and sociodynamic measures, we selected criteria likely to engender different thresholds of choice and rejection. Based on the work of Jennings (1947a, 1947b) and Hale (1981/1985), we expected highly threatening personal criteria to elicit a sharp dichotomy of choices versus rejections; in contrast, with low-threat social criteria, we expected greater degree of ambiguity and tolerance.

1. Work criterion. "With whom in the group do I choose to work on a project assigned by the leader of this group?" We designed this social criterion to allow for the highest degree of contradictory preference.

2. Pleasure criterion. "With whom in the group do I choose to spend a few hours, doing something pleasurable of our own choosing?" This low-threat personal criterion was designed to elicit a moderate amount of contradiction in the preferences.

3. Intimacy criterion. "With whom in the group do I choose to exchange and discuss in some detail an intimate secret—a secret that no one in this group already knows?" This high-threat personal criterion was designed to engender the least amount of ambiguity, hence the lowest degree of contradiction in the preference data.

Scoring

The choice and prediction data were entered on 12×12 sociomatrices, broken down by criteria. The metric data were coded into three categories—choice, rejection, or neutrality. The positive and negative preferences were analyzed as raw intensity scores and also converted to categories—choice, rejection, neutrality, and contradiction—for comparison with the metric data. To create these categories, the intensity score of 50, designated as the moderate value on the sociodynamic test, which gives equal extension to the four domains of neutral, positive, negative, and contradictory preference, was used as the cutting point. These categorical scores were used when comparing the number of accurate perceptual predictions individuals were able to achieve with the two methods (Table 4): Choice = positive preference > 50 paired with a negative preference of 50 or less. Rejection = positive preference of 50 or less paired with a negative preference > 50. Neutrality = both positive and negative preference of 50 or less. Contradictory choice = both positive and negative preference > 50. The subject's prediction of others' choices and preferences toward self were compared with the actual choices and preferences stated by the others.

Statistical and Mathematical Analysis

Data analysis included regression analysis, dynamic geometry—phase plane and phase space portraits—and computation of indices of conformity to measure interpersonal perceptual accuracy. All of the above data were analyzed statistically, using the standard parametric and nonparametric tests described below.

Regression analysis of intensity scores for positive and negative preference was performed with a BMDP 1R computer program (Dixon, Brown, Engelman, Hill, and Jennrich, 1984/1988) to investigate whether or not interpersonal preference is really linear or whether it is forced into an inverse linear model by the sociometric method. If preference is linear, then an inverse relationship between negative and positive preferences will be evident, even when they are measured separately; the correlation coefficient should approximate −1. If, however, positive and negative preferences are two separate dimensions, rather than opposite ends of a single dimension, then positive and negative preferences will not be inversely related when measured separately; the degree of departure from −1 serves as an estimate of the amount of contradictory preference present. Two null hypotheses were tested for the preference data: (a) that positive and negative preferences are inversely related (correlation coefficient = −1); (b) that there is no correlation between positive and negative preferences (correlation coefficient = 0). Inverse linearity requires that rho be not significantly different from −1 and that it be significantly different from 0. Three dimensional regression lines and the corresponding multiple correlation coefficients were also calculated to study linear trends in the relation between sociodynamic preferences (independent variables) and sociometric outcomes (dependent variable); the squared multiple correlation coefficients indicate how well the independent variables predict the dependent variable.

The relation between positive and negative preferences and the corresponding sociometric choice (dynamic geometry) was investigated by plotting the point determined by these three coordinates in the phase space (Figure 1). Positive preferences were plotted on the x axis and negative preferences on the y axis of the bidimensional phase plane (see Figure 2). The corresponding sociometric choice was plotted on the z axis, which is represented geometrically in Figure 3 and by means of symbols in Figure 4. The data obtained for each of the three criteria were plotted in this fashion for each individual subject as well as for the population as a whole. Specific types of nonlinear patterns were identified in the data by visual inspection.

Indices of accuracy of conformity of predictions of interpersonal preference were computed using the method described by Katz and Powell (1953) for binary data, as modified by Hubert and Baker (1978) to permit varying strengths of choice or levels of preference. The index of accuracy is the harmonic mean of the regression coefficients of prediction scores (the guesses each subject makes concerning how each other subject will choose her), and the actual choice made, using first one variable, then the other, as dependent. Because the prediction of each subject is matched with the actual preferences and choices of each other subject, the unit of analysis is the dyad. To detect and compare the amount of perceptual accuracy subjects were able to achieve regarding sociometric choice and sociodynamic preferences, we categorized the preference data in the four classes described above. When either a choice or a prediction was missing, the data were omitted from the analysis. To determine whether the observed proportion of accurate predictions was significantly different from chance, we applied the chi-square test. The proportion of expected accuracy by chance was one third for the sociometric method, which includes three categories, and one fourth for the four categories of sociodynamic preference. We compared the precision of the sociodynamic and the sociometric measurements of interpersonal perceptual accuracy, using Pearson's chi-square with Yates's correction, contrasting two related hypotheses: (a) that preferences would be more predictable than choices, because when preferences are indifferent or contradictory, choices become unpredictable; (b) that the difference between the metric and dynamic measurements would be greatest for criteria eliciting indifference, and contradictory preference (shown by nonlinearity in the preference plane).

Results

The number of positive, neutral, and negative responses differed for both choices and preferences in a manner consistent with our prediction that the work criterion is least threatening and the intimacy the most threatening (see Table 1). The work and pleasure criteria elicited more positive responses, whereas the intimacy criterion elicited more negative responses. The intimacy criterion produced a bimodal distribution, indicating a bifurcation between choices and rejections, both of which outnumbered neutral cases for this criterion only. The work criterion allowed the coexistence of high negative and high positive preferences.

Regression Analysis of Opposing Preferences and Choice

Positive and negative preferences were negatively correlated for all three criteria, but only the intimacy criterion met the two conditions required for an inverse linear relationship (see Table 2). The correlation coefficient of −.8579 both approached −1 and was significantly different from 0. In contrast, the hypothesis that the negative and positive preferences were linearly and inversely related was rejected for both the work and the pleasure criteria. Calculation of the correlation coefficients between positive and negative preferences for each subject and each criterion (see Table 3) showed linear relations for 28 cases and nonlinear relations for 8 cases.

Three dimensional correlations between positive preferences, negative preferences, and sociometric outcomes were .59 for the work criterion, .70 for the pleasure criterion, and .69 for the intimacy criterion. These correlation coefficients indicate that the underlying preferences account-

TABLE 1
Comparisons of Sociodynamic Choice and Sociodynamic Preference Patterns

Categories of response	Number of choices made	Number of sociodynamic preferences made
Work totals	127	132
Choice	85	56
Rejection	2	27
Neutral	40	53
Contradictory	NA	3
Missing	5	0
Pleasure totals	129	132
Choice	78	54
Rejection	8	29
Neutral	43	49
Contradictory	NA	0
Missing	3	0
Intimacy total	126	132
Choice	39	35
Rejection	56	58
Neutral	31	38
Contradictory	NA	0
Missing	6	0

Note: To make comparisons of categorical sociometric data with interval level sociodynamic data, sociodynamic intensity scores were converted to categories.

TABLE 2
Regression Analysis of Positive and Negative Preferences in the Sociodynamic Test

Criteria	Correlation coefficient	Rho = −1		Rho = 0	
		Z score	p	Z score	p
Work	−.3139	7.78	< .001	3.57	< .001
Pleasure	−.7379	2.98	< .010	8.38	< .001
Intimacy	−.8579	1.61	—	9.75	< .001

Note: N = 132 dyads. The null hypotheses tested were (a) that the correlation coefficient for sociodynamic positive and negative preferences (rho) would equal −1 (one-tailed z test), and (b) that rho would equal 0 (two-tailed z test). An inverse linear relationship was defined by a correlation coefficient not significantly different from −1 and significantly different from 0 ($p < .05$).

TABLE 3
Differential Occurrence of Linear and Nonlinear Patterns for Each of the Three Criteria

Criteria	Tridimensional linear trend*	Nonlinear patterns			
		Nonlinear trend in preference plane*	Overlap of choices and rejections for the same preference coordinates	All choices or all rejections regardless of preference coordinates	Total with nonlinear trend
Work	5	3	3	3	7
Pleasure	5	3	4	3	7
Intimacy	7	2	2	2	5
Total	17	8	9	8	19

Note: The data derive from the phase space portraits for each subject (illustrated by the example presented in Figure 2); N = 36 (12 subjects, 3 criteria).
*Linearity was defined by a correlation coefficient not significantly different from −1 (one-tailed t test) and significantly different from 0 (two-tailed t test) at $p < .05$.

ed for only a moderate percentage of the sociometric choices: 35% for work, 50% for pleasure, and 47% for intimacy. Three-dimensional linear inverse correlations were obtained in only 7 subjects for the work criterion, 6 subjects for the pleasure criterion, and 8 subjects for the intimacy criterion. In order to analyze the data, we must therefore turn to methods that do not presuppose linearity.

Dynamic Geometry

Phase space plots of positive preferences, negative preferences, and sociometric outcome provided a visual comparison of linear versus bifurcation models. Presuming that choices and rejections are a linear function of the underlying preferences, one would expect a tridimensional linear regression line extending from first choice, resulting from strong positive and weak negative preferences, to rejections, resulting from weak positive and strong negative preferences, and including neutrality in the middle of the linear continuum.

In Figure 4, the three distinct phase space portraits obtained from one subject for each of the three sociometric criteria appear; intensities in the z axis are represented by symbols (defined in Figure 3) rather than as a third geometrical dimension. The data clearly did not satisfy the linear model re-

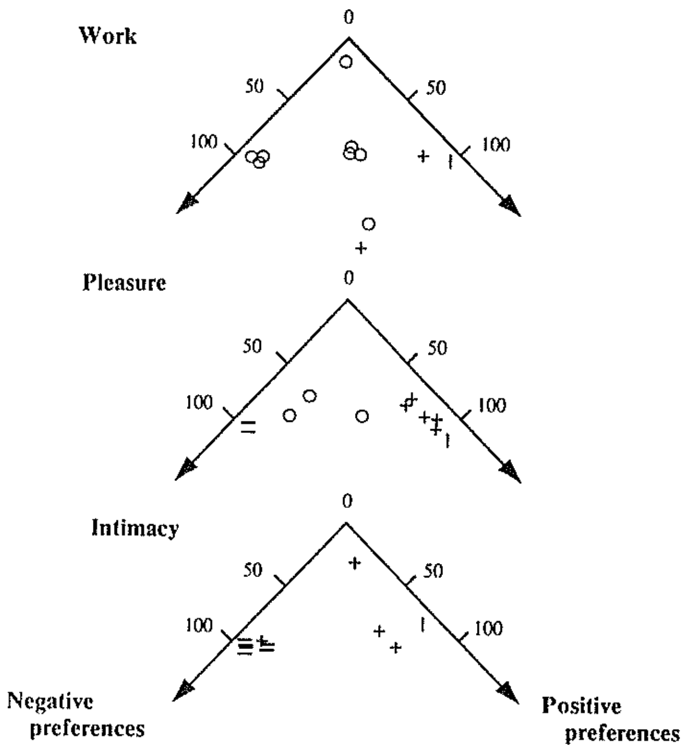


FIGURE 4. Sociodynamic Phase Space Portraits Obtained From One Subject for Each of the Three Sociometric Criteria

Positive and negative preference scores are plotted on the horizontal phase plane. The corresponding sociometric choice, instead of being plotted on the vertical axis, is represented by symbols, as in Figures 1–3.
Top: The Work criterion data present a nonlinear pattern, indicating the coexistence of positive and negative preferences. For instance, one positive and one neutral sociometric choice correspond to preference scores that are high in both the negative and positive axes (contradictory area). This subject rejected no one, even though indicating a strong negative preference, showing a high degree of tolerance, probably accounted for by the non-threatening character of the work activity.
Middle: The Pleasure criterion data indicate a linear pattern in the phase plane as well as in the tridimensional phase space. This suggests that this subject does not experience a contradiction between positive and negative preferences. For this criterion, this subject also has a high tolerance because she indicated neutrality, even when her positive preference intensity score was low (20) and the negative preference score was high (75).
Bottom: The Intimacy criterion data appear to be largely linear except for the coexistence of one choice among rejections. This could be an example of a catastrophe resulting from a contradiction.

quired for the use of metric analysis in the case of the work criterion (Figure 4, top); the underlying preferences accounted for only 57% of sociometric outcomes (squared multiple correlation coefficient).

Only 17 of the 36 phase space portraits were linear. The data points were linear for all three criteria in only 2 of the subjects. For all but one subject, nevertheless, at least one criterion provided linear data. Three distinct types of nonlinearity were observed in our population: (a) In 8 cases, phase plane portraits of the positive and negative preferences showed that the data did not fit a straight line (as in Figure 4, middle) but rather the points scattered over the plane in a manner grossly nonlinear to the naked eye (Figure 4, top). (b) In 9 instances, subjects chose, rejected, or remained neutral toward others while assigning to them the same preference coordinates (as illustrated for one choice and multiple rejections in Figure 4, bottom). This pattern of overlap of opposing choices with the same underlying preferences is represented by the fold of Figure 3. (c) In 8 cases, the subjects accepted all other group members, even though they had a great deal of variance in the intensities of positive and negative preference

TABLE 4
Comparison Between the Measurements of Choice and Preference Regarding Accuracy of Predictions

Criteria by test	n	Number of accurate predictions	Accuracy conformity measuring accuracy	Accuracy text vs. chance (chi-square)	Index choice vs. preference (chi-square)
Work					
Choice	112	47	.0228	3.76*	
Preference	132	62	.3143	33.99***	36.22***
Pleasure					
Choice	101	46	.1118	6.81**	
Preference	132	68	.3137	49.42***	54.37***
Intimacy					
Choice	105	44	.2179	3.50*	
Preference	132	55	.3250	19.54***	21.80***

Note: The subject's prediction of others' choices and preferences toward self are compared with the actual choices and preferences stated by the other. To make comparisons with categorical choices, the preference data were converted to categories. Accuracy, by chance alone, would be expected to be 33.3% on predictions of choices and 25% on predictions of preferences; n is the number of cases (dyads) in which predictions were made regarding available choices and preferences.
*Significant at $p < .050$; **significant at $p < .010$; ***significant at $p < .001$.

scores; 2 subjects made no choices for the intimacy criteria but considered all subjects as neutral or rejected—a nonlinear pattern.

Marked differences appeared in the phase space portraits between criteria in the relative intensity of positive and negative differences leading to choice or rejection for most of the subjects (see Figure 4). In most cases, a small degree of negative preference led to rejection in the case of intimacy and a high degree of negative preference was tolerated regarding the work criterion, so the choice was weakly positive or neutral. On all three criteria, sociometric choices, rejections, and neutrality arose from a wide variety of underlying preferences. Few responses included low intensity of positive and negative preferences. Neutral choices often arose from predominance of negative preferences. In other words, what was reported in the sociometric test as neutral often had high-intensity negative preference scores. These data are at variance with the linear assumption that sociometric neutrality would be observed whenever roughly matched positive and negative preferences neutralize each other, regardless of their absolute intensity.

Negative preferences were more frequent than rejections for the work and the pleasure criteria (Table 1). Strongly negative preferences paired with weakly positive ones often accompanied neutrality in the sociometric test (see Figure 4, middle). The two tests also differed significantly in the number of omissions. Subjects failed to make 14 sociometric choices and 78 sociometric predictions. There were no omissions in the sociodynamic data. These observations suggest that negative preferences were more easily expressed than outright rejections. Phase space portraits did not reveal a significant pattern regarding the 14 omitted sociometric choices, which were observed with high or low positive and negative preferences.

Prediction of Choices by Others

The experimental subjects were more accurate in predicting the preferences and choices made by others regarding themselves than could be expected by chance. The index of conformity was greater for the sociodynamic measurement than for the sociometric test for every criteria. The differences between metric and dynamic measurements were statistically significant (Table 4). Accuracy indices for the sociometric test were low and decreased from 0.22 to 0.02 as the criterion's threat increased. In contrast, the sociodynamic measure engendered equal accuracy regarding all three criteria (accuracy indices between 0.31 to 0.33), presumably reflecting the greater precision added by consideration of contradictory cases.

Discussion

These empirical observations highlight the importance of contradictory preferences that may underlie choice. When given the opportunity to express separately their positive and negative feelings and emotions regarding a particular choice, the subjects were able to do so in spite of the pervasive tendency to think of opposites as mutually exclusive polarities. Such widespread attitudes must have biased our data against the process hypothesis.

The clinical observations suggest that the measurement of opposing preferences is meaningful and practical. The experimental study indicates shortcomings of the linear assumptions imposed by the metric method. Regression analysis indicates that opposing preferences can coexist rather than neutralize each other. Positive and negative preferences are inversely related for some criteria for some of the subjects, but often they are not linearly related, and one therefore needs to collect data in a way that allows for differentiation between these cases. The data show that to consider the choice-making process as a continuum along a linear dimension is an error in measurement. In the context of both clinical psychodynamics and process theory, it is a crucial distortion of the data because it obscures the coexistence of opposing feelings and drives.

The coexistence of contradictory preferences appears to be relevant because measuring the intensity of each opposite pole separately rather than eliciting choices enhances the subjects' accuracy in predicting others' choices. The work criterion, which includes more contradictory preferences, also has the greatest differential between the indices of accuracy for the two tests. In contrast, when contradiction is not apparent, and when individuals know clearly whom they will choose and not choose, then subjects should have approximately the same accuracy on both test forms. The response to the intimacy question provides such a picture. Taken together, these findings suggest that the heightened prediction of the sociodynamic measurement may be related to its unique ability to reveal the contradictory preferences underlying choices, even in cases that are not overtly ambivalent. The perceptual accuracy scores of individuals taking the standard sociometric test, on the other hand, are lowered by the inability of the test to measure contradictory preference. The importance of this is twofold. By bringing conflictual preference into the domain of observables, the sociodynamic measurement (a) encourages group members to express their choices and predictions with more clarity and (b) makes information not previously accessible available for statistical and dynamic analysis. This indicates the validity of the preference scores.

Further deviations from the linear model were observed in tridimensional phase portraits (Table 3), indicating that the dichotomy of choice or rejection is a complex process with thresholds that vary from subject to subject and from criterion to criterion, rather than an additive (linear) function of the underlying reasons and feelings. Rejecting the linear model leads one to search for alternatives. Choice is, by definition, a dichotomous situation for which the concepts of bifurcation and catastrophe may offer a suitable model. When a subject experiences opposite drives simultaneously, these opposites do not cancel each other. One or the other predominates, or they may alternate and intertwine. The alternative predominance of the two opposites was most clearly observed in action as subjects with strong positive and negative preferences toward another actually walked their ambivalence, back and forth, between the poles of the *V*—the horns of their dilemma. Or the subject chose or rejected the all-or-none fashion of a catastrophe. The highly threatening intimacy criterion appears to evoke such a pattern. Nevertheless, the patterns observed were very complex and did not readily fit simple catastrophe models. Callahan and Sashin (1987) have developed more complex models, such as a double catastrophe, to describe the fight-or-flight bifurcation. Our data clearly indicated that in many subjects, different criteria elicit different patterns of choosing and that different subjects differ in their response to any one criterion. This type of uniqueness is characteristic of nonlinear processes and indicates that phase space portraits are more likely to provide meaningful insights than statistical methods that tend to obscure unique patterns by grouping the data. Regardless of the particular model that applies to each criterion and subject, we understand bifurcation theory to provide two fundamental guidelines. First, it demonstrates that the model must be tridimensional because lower dimensional processes are always deterministic, either linear (unidimensional) or cyclic (bidimensional). Only in three-dimensional processes are bifurcations, and hence choices, possible. Second, the concept of bifurcation indicates that even the catastrophic separation of opposing behaviors represents the surface appearance of a deeper coexistence of opposing drives (the union of opposites). The bidimensional phase plane provides a practical manner in which to apply this principle in empirical research, and empirical psychological studies indicate that the union of opposites is a pattern of psychological processes demonstrable by statistical data. The tridimensional feature of processes is reflected in the complex of opposing preferences and unique choices in sociometry, portrayed by the tridimensional phase space of dynamics, and postulated by process theory as universal law: All processes are material, that is to say, spatial and hence tridimensional (Sabelli, 1989). These dyadic and triadic constructs illustrate how process theory combines empirical human science, dynamic geometry, and process philosophy into a single method (Figure 5), which we have named psychogeometry (Carlson-Sabelli, Sabelli, Hein, & Javaid, 1990). The term *geometry*, referring to the measurement of material bodies, seems appropriate because process theory adds a third law of tridimensionality to already known laws regarding the unidimensional tendency of energy toward equilibrium and the coexistence of opposing forces in all processes. With this approach, we have obtained evidence to support the conflict theory of depression (Carlson-Sabelli, Sabelli, Hein, & Javaid, 1990; Sabelli & Carlson-Sabelli, 1991).

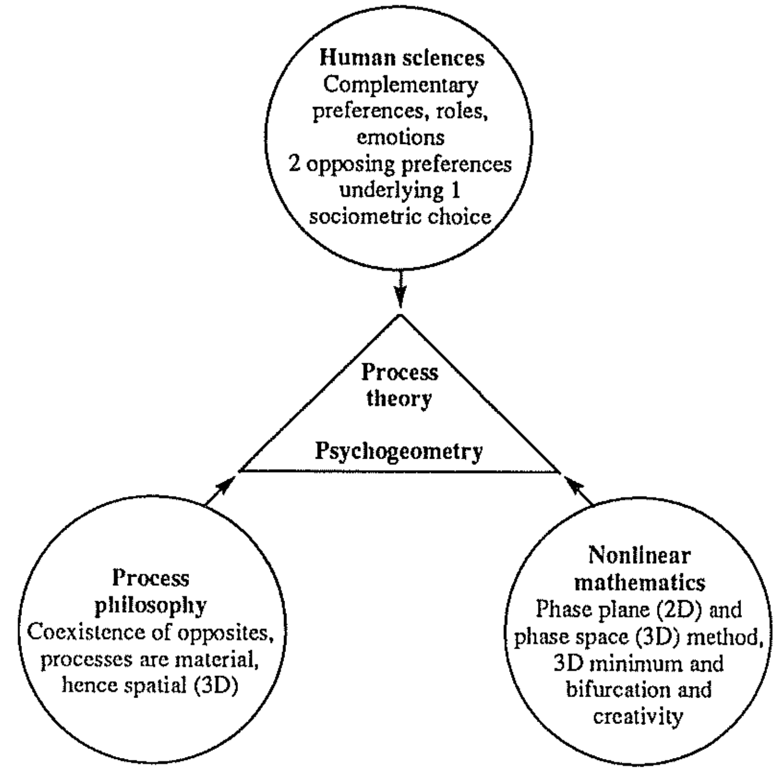


FIGURE 5. Psychogeometry

Process theory integrates empirical human sciences, mathematical dynamics, and the philosophical theory of processes into the psychogeometric method for data analysis.

Successful here, the method of measuring both opposites may also be applied to the other instruments that measure oppositions in an either-or-manner or as a continuum along a linear dimension. The Rotter Internal/External Locus of Control Scale, for example, has been improved in just this way (Wallston, Wallston, Smith, & Dobbins, 1987). Similarly, Bem (1974) developed the Bem Sex-Role Inventory (BSRI) to overcome the built-in bias of other commonly used scales, such as the masculinity-femininity scale of the California Psychological Inventory (Gough, 1957), that assume an inverse relationship between masculinity and femininity. By measuring masculinity separately from femininity, rather than as the two poles of a single continuum, the BSRI is able to identify the extent to which all individuals are androgynous, having both feminine and masculine traits, as proposed by Weininger in 1903, and later by Freud and Jung (Sulloway, 1979, pp. 183–184). Although the process theory concept of the union of opposites was not the impetus for these particular cases, it could be for others. Applying the concept of the union of opposites to the Myers-Briggs test, for example, one would measure each opposite separately, thereby distinguishing personalities who are high in the capacity to "sense and to think," to "judge and to perceive," etc., from those personalities low in both or high in one or the other.

In our clinical experience, the bidimensional framework is practical and illuminating; the present experiments validate its use. Our goal has been to consider that processes of choice actually evolve through the interaction of coexisting and opposing preferences. This coexistence of opposites is obscured by sociometric scales that force the data into an inverse linear relationship.

The concept of the union of opposites from process theory, a new perspective in psychiatry, serves as a conceptual framework to identify a problem that limits the validity of commonly used methods of measurement. It also suggests a solution that provides a new nonlinear method for data collection and analysis that makes it possible to reveal the union of opposites in empirical data and incorporates mathematical methods considered at the forefront of modern scientific research in a wide variety of areas. It can thus be useful in sociometry, psychological testing, and, more generally, in psychodynamics.

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Note Added at Proof: The research described above has been continued by the authors (Carlson-Sabelli et al., 1991 a, b; Carlson-Sabelli, 1992). It was found that indeed the distribution of choices and rejections is best described by one or another of Thom's elementary catastrophes. The simpler catastrophes are described by two parameters called asymmetric and bifurcating because of their properties. It was discovered that the asymmetric and bifurcating parameters of the sociodynamic catastrophes could be formulated in terms of opposites (P = positive force or attraction; N = negative force of repulsion). The asymmetric parameter is the difference between these opposite forces, $f(P - N)$, while the bifurcating parameter is their sum $f(P + N)$. Conceptually, the asymmetric parameter denotes the direction and intensity of the dominant force while the bifurcating parameter represents the combined intensity contributed to the process by both forces. This is illustrated in figure 3 of this article. This discovery provides a conceptual link between the concepts of mathematical dynamics and those of process theory. Modern mathematical dynamics offers methods for studying patterns in complex processes through plotting trajectories of change in a few variables, but does not offer guidance on which variables to select. Process theory prescribes that the variables of interest are the opposite forces co-existing in the process.

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