A Model For Single System Evaluation Of Treatments

John Crane
School of Social Work, University Of British Columbia

ABSTRACT

Les méthodes appropriées à l'analyse de données pour l'étude des systèmes simples varient selon le nombre d'indicateurs requis pour chaque concept, la fréquence de mesures et la possibilité de reproduire les traitements. Cette étude examine le cas le moins développé, en ce qui concerne l'analyse, mais dont l'usage est probablement le plus répandu, et dans lequel on retrouve beaucoup d'indicateurs, peu de données dans le temps, et des traitements qui ne peuvent être reproduits qu'en partie. L'analyse temporelle ne s'applique pas dans ce cas. Une méthode d'analyse de données comportant des transformations qui répondent aux critères des analyses d'ANOVA et de Régression, complétée par l'infographie, est développée et illustrée. Elle s'applique particulièrement aux formes d'exercice telles que la thérapie familiale de Bowen ou aux études des groupes intacts, pour lesquelles n'existe aucune méthode d'analyse satisfaisante.

Existing textbooks on single systems research in social work (e.g. Bloom and Fischer, 1982) are aimed at the practitioner whose only resources for data analysis are a pencil, ruler, graphing paper and pocket calculator. With such limited tools, the capacity for processing data and carrying out the analysis is so restricted that not much more can be expected than a few quick graphs. This is particularly true for single systems studies in "everyday" practice. Even if the study is conducted in a setting in which time has been set aside for research, the need to make use of the data in treatment planning means that the turnaround time for data processing, graphics and analysis is extremely short. The net result of a small data base and scarcity of time for analysis is that estimates of change are likely to be imprecise and inconsistent. These estimates are crucial to both experimental and quasi-experimental single systems designs.

An even more serious problem is that for most forms of social work practice today, there are no well-established powerful methods of analysis applicable to single systems studies. As shown below, this results from conflicting assumptions between practice models and conventional methods of data analysis.

In recent years the microcomputer has become more accessible to the practitioner; currently, this process is rapidly accelerating, as the cost of the microcomputer relative to its data processing power declines. This development makes possible some fresh approaches to problems of data processing and analysis in single systems studies.

Given on the one hand the problems in data analysis and on the other the exponentially increasing data processing capabilities of the computer, this paper describes how the latter might be brought to bear on the former. It attempts to establish three main points:
1. The need for single system studies, in view of the inability of traditional group comparison designs to fulfill the great expectations of them that were held three decades ago, and the promise of single system designs in providing a tool that practitioners can use by themselves to enhance cumulative learning from practice.

2. The need for a highly differentiated approach to data analysis in such studies, taking account of variations in the number of indicators required, the number of points in time at which measurements are needed, and the replicability of treatments. This permits the application of single systems designs not only in clinical studies but in a variety of program and policy oriented studies as well.

3. The potential of the microcomputer as an aid in data analysis, particularly in the graphical representation of abstract concepts.

**Terminology**

The term “single systems research” is widely used in social work to replace earlier terms such a “N-1 research”, and “quantitative case study”. Its advantage over these terms is that “system” designates a wide variety of fields of social intervention, such as persons, families, small groups and organizations, to which a common set of research designs may be applied. (Bloom and Fischer, 1982: 473-486)

**Content Overview**

This paper is limited to single system studies in which quantitative analysis is used and is mainly concerned with methods of analysis that could be employed by practitioners such as clinicians or program managers and consultants. The first section relates single system studies to the more familiar group-comparison designs. The factors that shape data analysis requirements of single system studies are then discussed. This is followed by an example, and possible extensions to the problem of aggregating over a series of single system studies are briefly suggested.

**Need For Single System Studies**

Single system studies in social work emerged out of awareness of the limitations of group-comparative studies. Some of the background of this development is set forth in detail in a recent monograph on research utilization in social work (Crane, Colling et al, 1983). This paper attempts only to suggest some of the main outcomes of these developments, in order to show that there is a strong case for investment of research resources in the development of single systems research.

The necessity of comparison groups was an article of faith in social science research methods textbooks of the 1950’s. Use of controlled comparisons in the form of the classical experimental design was held to be essential both for generalization of findings and for estimating net causal effects of treatments. It was thought that in due course the use of these methods would lead to a body of firmly based empirical generalizations. These great
expectations have fauntered on three decades of experience. The evidence for this is overwhelming, and of diverse origins. A few of the key points are:

1. Experimentation provides no basis for generalization unless replications hold up. But replication in comparison group experiments in social work and related fields has been largely a failure. As Lee Cronbach, not known as soft on methodology put it: "replication is only a figure of speech" (Cronbach et al, 1980: 7)

2. A second major weakness of the comparative-experimental method has been the low power of the findings. A paper published on power of social work experiments in 1976 showed that 25 main findings were so statistically weak as to be useless for policy making (Crane, 1976; see also Crane, 1982) As a result of these and other weaknesses of this method, a number of its most vocal proponents in social work reversed themselves in the late 1970's and called for a moratorium on field experiments.

3. It has become clear that single systems and group-comparative studies are complementary. The power of studies of the latter type can be increased by the collateral use of single system studies designed to sharpen knowledge of treatments and related variables that are presently inadequately controlled in group experiments. These will also gain in power by taking single systems studies rather than cases as sampling units.

4. At the same time, single systems research in social work needs to be extended beyond the clinical realm in which it is now mainly applied. Potentially, it has much to offer to the longitudinal study of organizations, social movements and communities.

**Differentiated Data Analysis**

Data analysis requirements of single system studies depend on three main factors: the number of indicators of problems and or changes that are needed, the spacing of the measurements over time, and the degree of replicability of the treatments to be applied. The possible patterns of these factors, illustrated by some research problem areas are shown in Table 1.
Table 1

Types Of Single System Studies
With Examples Of Research Problem Areas

<table>
<thead>
<tr>
<th>No. of Indicators {1}</th>
<th>Replicability of Treatments {2}</th>
<th>Frequency of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Few</td>
<td>High</td>
<td>[a] Behavioural Treatment of Habits e.g. Smoking</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>[c] Time Series Studies of Effects of Change in Law Enforcement e.g. of Impaired Driving Laws</td>
</tr>
<tr>
<td>Many</td>
<td>High</td>
<td>[e] Behavioural Family Therapy</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>[g] Effects on Crime Rates of Gun Control Laws</td>
</tr>
</tbody>
</table>
Number of Indicators: Column [1] of the table shows the number of indicators of problems or change variables that are required; these are classified, for simplicity of presentation, as "few" or "many". This classification depends mainly on the degree of abstraction of the problem or change variables. Variables of a low degree of abstraction can often be represented adequately by a single indicator. Thus a variable such as "homework" may be measured by the number of hours of study outside of school, and reduction in smoking by the number of cigarettes smoked per day.

Most practice models in social work today employ variables that are sufficiently abstract as to require a multiple indicators approach to their measurement. As Sullivan and Feldman (1979) point out, we cannot directly test abstract concepts, and must recognize that there is a gap between the concepts and their empirical indicators. The most common strategy for dealing with the gap is to employ several classes of indicators, measured as independently as possible. If all of these conform to a predicted pattern of change with treatment, this is taken as support for the theory underlying the treatment. To maximize the independence of the measurements, different data sources (e.g., different observers and/or different settings of measurement) are used.

As Blalock has pointed out (1969: 5) the use of multiple indicators requires both a main theory and an auxiliary theory. The former refers to a substantive area and the latter to the relationships between concepts and indicators. In Blalock's terms (pp 23-24): the main theory is the "language in which we do our thinking" and the auxiliary theory is "an operational language involving explicit instructions for classifying or measuring". In practice research in social work (not the field Blalock was writing about) the main theory consists of propositions about problems, interventions and change, and the auxiliary theory consists of instructions about how these are to be measured. According to Blalock (p 25) "the two languages cannot be linked by any strictly logical argument". Rather, correspondences between the two languages must be established by common agreement and a priori assumption. Apart from behaviour modification, Fischer's (1978) work on operationalizing the core conditions and the Task Centered System (Reid and Epstein 1977) efforts to find and evaluate empirical indicators of practice concepts in social work have so far been rare. An example is explored below. In any such effort, it is clear that for the abstract concepts that predominate in social work practice models, multiple indicators will be needed.

Replicability of Treatments: Column [2] of the table shows the replicability of treatments, similarly dichotomized into "high" and "low". The bearing of this on data analysis is that highly replicable treatments can be clearly phased in advance, permitting greater control over the interpretation of the meaning of phases. This permits the use of more complex designs such as multiple baselines.

Spacing of Measurements Over Time: Columns [3] and [4] of the table show this factor. Column [3] studies have many measurements, at equally spaced and (usually) short intervals. If as many as 50 time points are available, the relatively powerful methods of ARIMA time series may be employed (McCleary and Hay, 1980). In contrast, column [4] studies involve
the application at relatively infrequent intervals of batteries of indicators — too many, in general, to permit very frequent administration. Even if it were practical, frequent administration would not likely be called for in these studies, since they generally deal with variables such as self esteem, nonclinical depression and perceived relationships with peers, for which hourly fluctuations are of secondary interest.

Brief Illustrations

Location [a] studies (see Table 1) are illustrated by the experimental treatment of autism developed by Hamblin et al (1971). In this work, few problem or change indicators were needed, measurements could be taken frequently, at evenly spaced intervals over the period of treatment, and treatments were highly replicable, permitting a sharp distinction to be made between treatment phases. It was possible therefore to use relatively straightforward time series analysis to arrive at estimates of change in slope and level across different treatment phases. Because methods of analysis are well established for this case and since for other reasons it is still not much used in social work, it is not further dealt with in this paper; instead the paper focusses on the much more representative social work case illustrated by Saunders’ (1984) study that could be classified into section [h] of table 1.

Saunders attempted to find empirical indicators of Bowen’s concept of triangulation, and to use the resulting data to assess changes in three family therapy cases. Treatments were only partly standardized, many indicators were needed, and measures were taken in batteries repeated at intervals that were in part determined by progress with intitial problems and the emergence of new problems. In this variety of single systems study the effects of different treatment phases are assumed to be cumulative, and hence neither independent nor reversible. Saunders’ data are used below to illustrate a possible computerized analysis of data with this design.

At first blush it may seem masochistic to focus on this most difficult case. Research is supposed to advance by picking tractable problems; finding workable solutions to these may make it possible to begin to deal with more difficult problems. But recall another principle that we researchers are constantly urging on practitioners: be empirical! learn from experience! Experience to date can be described in terms of a distinction between service controlled and research controlled single systems studies. In the research controlled mode, interventions are made according to the pattern required to draw causal inferences. This determines, for example, the length of treatment phases and the number of observations to be taken within each phase. (see Crane et al 1983 and Thomas, 1978). As Thomas (1978) has shown, there are many difficulties in applying the research controlled model; these seem to be especially severe when nonbehavioral treatment models are applied in community settings. The subsequent record suggests on the other hand that single case experimental designs work quite well with behavioral models, have begun to yield some impressive generalizations concerning the treatment of phobias, and show similar promise as a family treatment modality (Thomlison, forthcoming). For less standardized treatments, it is probably much too early to aim at estimating net effects — this applies with
even more force to group comparison designs, where the findings can
seldom be trusted to replicate.

Objectives of type [h] Studies

In view of the complexity of the measurement problems, the use of treat-
ments that are only partly standardized and the need for more powerful
methods of data analysis, studies of this type are developmental or forma-
tive rather than summative. Their major objectives at present should proba-
bly include the following:

1. specification of concepts by multiple indicators.
2. identification of patterns of change: do the indicators behave in accor-
dance with theoretical expectations?
3. specification of treatments, particularly the phasing of treatment objec-
tives and activities. This will make possible the application of designs
that permit stronger inferences, such as the multiple baseline design.
4. Testing of data analysis models and data transformations that make
possible the use of existing well established methods of analysis and
inference.

A More Detailed Illustration

The recent quantitative case study by Saunders, referred to above, illustrates
strategy of data analysis, and some uses of the microcomputer in type [h]
studies.

Problems treated: treatment was concerned with problems of “adolescent
acting out” in three families who sought counselling at a Family Service
agency. Saunders provided the service and conducted the research. The
problems as initially presented by the parents were focussed on the behav-
iour of the adolescent children, involving in each case, poor school attend-
ance and achievement, conflict with one of the parents and acting out
behaviour in school or community (for example arrests for shoplifting).

Treatment: the approach was based on the family therapy theories of M.
Bowen (1978) and S. Minuchin (1974) who interpret the problem of adoles-
cent acting out as a blocking of the normal process of adolescent develop-
ment towards autonomy and an identity distinct from that of the family.
This blocking occurs as a result of the adolescent’s entanglement in the
problems of the parents, who are concurrently dealing with the “mid-life
crisis” that involves conflicts around separation, loss, and the “reality of
changing relationships” (Saunders, 1984: 3-4). The major concept em-
ployed by Saunders was that of “triangulation” of the adolescent into the
marital relationship. According to the theory, this is a process of joining
with the child against the other parent; it serves the parents as a method of
disguising and taking the focus off the problems they themselves are expe-
riencing. They are unaware of the extent to which they are employing this
tactic. In Saunders’s terms

The therapeutic task is then to reestablish the parental boundary and
emphasize the marital issues. This will allow the adolescent to move
towards emancipation
**Indicators:** these were selected according to the following reasoning. The adolescent’s search for autonomy involves some conflict with both parents, accompanied by a mutual sense of strain and of relationship problems. There is assumed to be an optimum level of such problems. The following pattern is taken to be evidence of triangulation of the adolescent into the marital relationship in the sense referred to above: a mutual sense of serious problems between the adolescent and one of the parents; a marked absence, on both sides, of a sense of serious problems between the parents; a pattern of mutual blaming between the parents for the problems of the adolescent and the ways in which theses are being dealt with.

**Measures:** in the light of this reasoning about indicators of the concepts, comprehensive measurement would be concerned with problems in the three pairs of relationships involved, with the mutual attributions of blame by the parents, and with the acting out behaviour of the adolescent. Ideally, a mix of different types of measures should be employed (e.g. self reports and behavioural ratings, standardized and idiosyncratic scales, quantitative and narrative data) in order to maximize the independence of the observations and to compare information taken from different perspectives. In practice, it was found to be feasible to employ a mix of self reports using standardized scales, three self-anchored (idiosyncratic) scales, a set of critical-incident records and narrative data on behavioural changes. To illustrate quantitative analysis, only the standardized and idiosyncratic self report data are made use of in the present paper; further details on these and the other kinds of data employed are provided in Saunders’s report.

**Standardized Self Reports:** As problem indices in the parent/adolescent and marital relationships, four of the nine CMP scales developed by Hudson and associates (Hudson, 1982) were employed. Each scale is a paper-pencil 25-item self report questionnaire designed to measure the severity of a problem in personal or social functioning. The complete battery includes one or more measures of self esteem, nonclinical depression, peer relationships, parental attitudes to children, children’s attitudes to parents, marital satisfaction, sexual satisfaction.

Saunders’ use of the scales was as follows: *The Index of Parental Attitudes* was used to tap the parents’ perceptions of problems in the relationship of each parent with the adolescent. The *Child’s Attitude Towards the Mother* and the *Child’s Attitude Towards the Father* were used to tap the adolescent’s sense of problems in these relationships. The Index of Marital Satisfaction was employed as a measure of problems in the marital relationship.

**Abbreviations:** Abbreviations employed in this paper for these measures are, respectively: for the parental attitude measures, IPA(m) and IPA(f); for the measures of adolescent’s attitudes towards the parents, CAF and CAM; for the Index of Marital Satisfaction, IMS(m) and IMS(f). Self anchored (SA) Scales: there were three nine-point scales of this type, one for each parent and the adolescent; these were used separately by the members of each family triad to designate and rate the major presenting problem of the family from their own perspectives. The SA scales were designed, in Saunders’s phrase:
to allow family members to label their problems according to their own perspective and to assess change during treatment (Saunders, 1984: 14).

Scoring: As noted, the Hudson scales are designed to register the severity of problems in an area of personal or social functioning. This is placed on a scale of from 0 to 100, with a score of 30 or above considered to represent a definite problem. In accordance with the assumption that some sense of problems between parents and adolescent is essential to continued family development, Hudson's measures of perceived problems between each parent and the adolescent (IPA's) were rescaled so that a raw score of 30 was considered optimum. The score of 30 was selected for this purpose on the basis of Hudson's extensive data showing that this score differentiates persons who report having a serious problem from those who feel they have no serious problem in this area. Departing from Hudson, however, Saunders scored deviations in either direction from 30 on the IPA measures as indicative of problems in the three-way relationships he was concerned with. His scores on these variables were arrived at by the formula: 100-percentage departure from the norm of 30. This places these scores on a continuum ranging from 0 to 100, with the latter score representing an optimum state. The Index of Marital satisfaction was scored by Hudson's method, with scores above 30 viewed as evidence of a problem.

Direction of Scoring: the greater the score, by Saunders' method, the less the triangulation. A score of 100 represents the maximum possible freedom from triangulation, as measured by the Hudson scales. In table 2, all variables are so scaled that 100 represents this optimum state, and progress towards it is shown by an increase in score. This makes the table easier to read. Table 2 shows the scores on the nine measures, taken four times over a five week period for each of the three families.

Table 2

Data on Changes in 9 Scores Over 4 Time Points

<table>
<thead>
<tr>
<th></th>
<th>Family #1</th>
<th>Family #2</th>
<th>Family #3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T₁</td>
<td>T₂</td>
<td>T₃</td>
</tr>
<tr>
<td>IPA .(f)</td>
<td>19</td>
<td>23</td>
<td>70</td>
</tr>
<tr>
<td>C.A. F</td>
<td>23</td>
<td>83</td>
<td>97</td>
</tr>
<tr>
<td>IPA .(m)</td>
<td>47</td>
<td>51</td>
<td>60</td>
</tr>
<tr>
<td>C.A. M.</td>
<td>47</td>
<td>50</td>
<td>69</td>
</tr>
<tr>
<td>IM.S.(f)</td>
<td>50</td>
<td>57</td>
<td>63</td>
</tr>
<tr>
<td>IM.S.(m)</td>
<td>45</td>
<td>48</td>
<td>58</td>
</tr>
<tr>
<td>S.A. 1</td>
<td>11</td>
<td>44</td>
<td>67</td>
</tr>
<tr>
<td>S.A. 2</td>
<td>11</td>
<td>22</td>
<td>56</td>
</tr>
<tr>
<td>S.A. 3</td>
<td>53</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Saunders (see note 12)
Graphical representation of "Triangulation": Using data, that have been scaled in this way concept of "triangulation" amongst three persons can be represented graphically by a triangle in which the length of each side corresponds to the optimality (appropriate degree of closeness) of one of the three relationships. A relationship in which one parent’s relationship with an adolescent child is "too close" implies a triangle with one parent-child side being much shorter than the other two sides. Progress in treatment can be represented by a change in shape of the triangle towards one with sides of equal length.

Direction of Changes: Graphs 1-4 display these changes for family #1 over the course of treatment; as the graphs for other combinations of variables and for the other two families in Saunders’ sample proved to be very similar, they are not reproduced here. The predicted trend over the four points in time is toward more "optimum" relationships or freedom from triangulation. As can be seen from the graphs, the data conform closely to this prediction, lending some general support to the Bowenian treatment approach and to further testing of the Hudson scales as indicators of triangulation and related concepts.

Family Triangle At Time 1, Family #1

Base   Fa's IPA Sides   Mo's IMS & IPA

Triangle has been centered on x-axis
Family Triangle At Time 2, Family #1

Base   Fa's IPA, Sides   Mo's IMS & IPA

Triangle has been centered on x-axis

Family Triangle At Time 3
**Construction of Triangles:** The relative lengths of the three sides should be proportional to the corresponding scores showing freedom from triangulation. Given this, the lines may be drawn to any convenient scale. To begin, select any convenient point for the lower left hand corner. The base of the triangle should be horizontal. Then, knowing the lengths of the sides, one may easily use elementary trigonometry to solve the triangle and find the locations of the other two points (Brink, 1940: 158-162). Any graphics program for a microcomputer will draw lines connecting points on a grid (Lotus Development Corporation, 1983: 223-248).

**Data Analysis:** Except for one catch, the data matrix shown in Table 2 invite a straightforward repeated-measures ANOVA. The catch is that to use this method one has to assume that the observations within each column of the table are independent — hardly a safe assumption for data collected from different members of the same family and from three families under concurrent treatment by the same therapist. Counting degrees of freedom based on the number of observations does however make sense within the multiple indicators’ framework previously adopted. Therefore the ANOVA model of analysis seems worth pursuing, especially in view of its easy extension to more sophisticated regression methods involving several independent variables.
To deal with the risk of violating the assumption of independence of observations one can use the autocorrelation function, easily programmed into today's microcomputers, to test for any desired number of autocorrelation lags in the data (McCleary and Hay, 1980: 243). The number of lags to be checked depends on the number of observations, but can be selected by following the rule of thumb: number of lags=n-20 where n is the number of observations. This will ensure that the autocorrelations are computed on samples of at least 20. If autocorrelations significant at, say, the .20 level are discovered, the data may be prewhitened, again using standard methods of analysis. This should be done separately in each column. The residuals left from this process will be the portions of the observations that are statistically independent of the other observations. One then has a stochastic series to which it makes sense to apply methods of analysis based on ANOVA to test for changes in one or more parameters of the series, such as the mean or the median.

An additional decision must be made at this point whether to use parametric or nonparametric ANOVA. The parametric form involves the further assumptions of normality of distribution of the data and the equality of the column variances (Iverson and Norpoth, 1976). A useful nonparametric form of ANOVA for practitioners' use is that of Friedman's two-way analysis of ranks. This is about 95% efficient for small samples, compared to the nonparametric form, and avoids both of the foregoing assumptions and also the assumption of interval measurement of the dependent variable that is generally held to be necessary for parametric ANOVA. This test can also be usefully coupled with Kendall's W, to measure the consistency of the patterns of change displayed by the multiple indicators. A final advantage of this method is that the needed ranks as well as the Chi-square and W can easily be obtained using simple microcomputer routines. (Siegel, 1956: 166-172).

To illustrate this 'workhorse' method of analysis, Saunders' data, converted to ranks, are shown in table 3.

Table 3

Ranks

<table>
<thead>
<tr>
<th>Family #1</th>
<th>Family #2</th>
<th>Family #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>T₂</td>
<td>T₃</td>
</tr>
<tr>
<td>Father/Adolescent</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Mother/Adolescent</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Father/Mother</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>S. A. T.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Rank Sum</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>
Kendall’s W for these data is 1.0, showing that 100% of the variance in the ranks is accounted for by the changes over time. Furthermore, inspection of the graphs shows that the direction of change in all variables is towards improvement (recalling that the data are scaled so that a larger score represents progress towards treatment goals). This pattern was shown as well in the data for the other two families.

Possible Extensions.

All of the usual extensions of simple ANOVA may be applied as larger data matrices are developed by combining the analyses from, for example, 40 or 50 case studies. The simple model of analysis presented above has only one independent variable — the number of time intervals at which the measurements are taken. With the additional data, one could add cases, therapists and types of measures as independent variables. Straightforward regression methods could be employed, and beyond these the methods of linear causal modelling (Asher, 1976).

Summary: A Basic Data Analysis Strategy

In outline, the strategy of data analysis developed in this paper is as follows:

1. Derive testable predictions from practice models.
2. Find multiple indicators of the concepts guiding the predictions. In order to satisfy requirements of change measurement, these indicators should be of high reliability and be backed by evidence of criterion validity.
3. Attempt to maximize the experimental independence of the indicators by making use of such strategies as employment of independent observers and self-reporters, as well as different data collection instruments.
4. The quantitative data should also be backed by qualitative data, such as narratives based on semi-structured interviews, that represent an independent line of evidence on changes.
5. Test for serial dependencies among the indicators by using the autocorrelation function [24]. If necessary, statistically remove any significant dependencies by applying prewhitening methods to each column of the data matrix.
6. Replicate the study over a minimum of three cases, and test the data for all cases taken together for chance effects and the percentage of variation in the data that is accounted for by changes over time. The latter test will include a test of the concordance of the patterns of change displayed by the different indicators and cases.
7. Graph the changes in the indicators and inspect for trends consistent with the initial predictions. The graphing may involve linear trends or variations on these such as the changing shape of triangles used in the present paper.
References


Minuchin, S. Families And Family Therapy. 1974; Cambridge: Harvard University Press.


