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Effects of compound messages on global characteristics of Galileo spaces

JOSEPH WOELFEL, [1] BARBARA NEWTON, [2] RICHARD HOLMES, [1]
D. LAWRENCE KINCAID [1] & JONG-YOUNG LEE [1]
[1] *Department of Communication, State University of New York, Albany, New York 12222, USA;*
[2] *EWCI*

Abstract. The present article investigates the effect of messages compounded of many assertions on the overall size of a Galileo space. A Galileo space is a space within which objects and attributes are arrayed in such a way that the differences in meaning between any two objects in the space is given by the distances between those objects. Thus attributes that seem to be similar are located close to each other, and objects which are seen to embody a given attribute are located close to that attribute. Similarly, objects thought to be similar to each other are located close to each other. Results show that, following approximately a ten hour latency period, the space shows a substantial increase in size, followed by a return to its original dimensions. There is some indication that the expansion of the space may be periodic, which gives rise to the possibility that human beliefs and attitudes may be modelled as a damped oscillating system. Should this be the case, human cognitive processes, such as attitude and belief changes, might be modelled by the equations for dampled oscillations.

1. Introduction

The effects of messages on aspects of the beliefs and attitudes of groups, audiences, publics and cultures have always been of interest to a wide diversity of communication researchers. In the classical period of communication theory, Greeks and Romans such as Plato, Aristotle, Cicero, Quintillian and ohters considered the principles of message strategies within the context of public discourse from a rhetorical and philosophical perspective. More recently, communication theorists have investigated these same questions within a mathematical framework. One approach to the analysis of the effects of messages on beliefs and attitudes of aggregates of people has defined messages as assertions about the relations among objects in a domain or "neighborhood," (Woelfel & Fink, 1980). Any concept or "object" in a culture is assumed to be defined by its pattern of dissimilarity relations with the elements of a set of reference objects judged by the culture to be "close to" that concept or object. Beliefs are defined as relations among any subset of these concepts. Following Mead, (1934), the self is represented as an object whose definition is likewise given by its pattern of dissimilarity relations within the domain. (This definition of the self applies only within the domain, and thus such a measure is consistent with Mead's contention that the self is situationally variable).

Attitudes are then defined conveniently as beliefs about the self (Woelfel and Fink, 1980).

Within this system, messages are defined as assertions about the interrelations among the objects in some domain or neighborhood. Similarly, the effects of messages are defined as the changes in the dissimilarities patterns among the concepts which can be attributed to those messages.

Several sets of findings relative to this model have been reported in the literature. Barnett, et. al., (1977) and Serota, et. al, (1977) showed results from a field study of a congressional election which provided data suggesting the utility of this model. In a similar study, Wallace showed similarly suggestive results from a nearly two-year longitudinal study of dairy farmers. Craig (1977) reported mixed results from an experimental study, showing stability of relations where predicted by the theory, but changes predicted by Craig were not observed. This study, unfortunately, contains a very serious mistake. Craig's predicted outcome is not the outcome predicted by the theory, nor has he included enough information in the study to determine what the predicted outcome is.

Woelfel, et. al (1979) have presented less ambiguous data from a four-wave panel design experiment which showed that messages about a fictitious activity allegedly sent by public figures produced motions in a domain within the ranges predicted by the model.

Cody (1980) has most recently presented the results of a series of laboratory experiments which are generally favorable to the model.

Cody's results, unfortunately, are subject to misinterpretation because of an erroneous statistical inference. Cody correctly notes that the theory's prediction of a trajectory for the concept which was manipulated in the experiments is equivalent to predicting the coordinates of the manipulated concepts in the treatment condition. He thus correctly computes the correlation between the predicted coordinates and the observed coordinates on each dimension. These correlations (computed for the first six dimensions) all exceed 0.7. Unfortunately, however, Cody performs statistical significance tests for each dimension rather than for all dimensions at once. Cody is thus mislead into believing that each correlation is not significant when in fact the overall pattern is as predicted by the theory and highly significant.

One factor common to each of the studies cited is the fact that each deals with local message effects, that is, with the effects of messages on the interrelations among specific concepts addressed in the messages. None of the studies focuses specifically mw any global characteristics of the domain itself, although all make reference to at least one global measure, the Trace.

A global factor refers to some characteristic of the domain or neighborhood taken as a whole. The Trace, for example, is equal to the total variance in the domain. More graphically, this can be considered the total squared distances of each of the objects from the center of the domain. Roughly speaking, the Trace can be taken as a measure of the overall "size" of the domain or neighborhood.

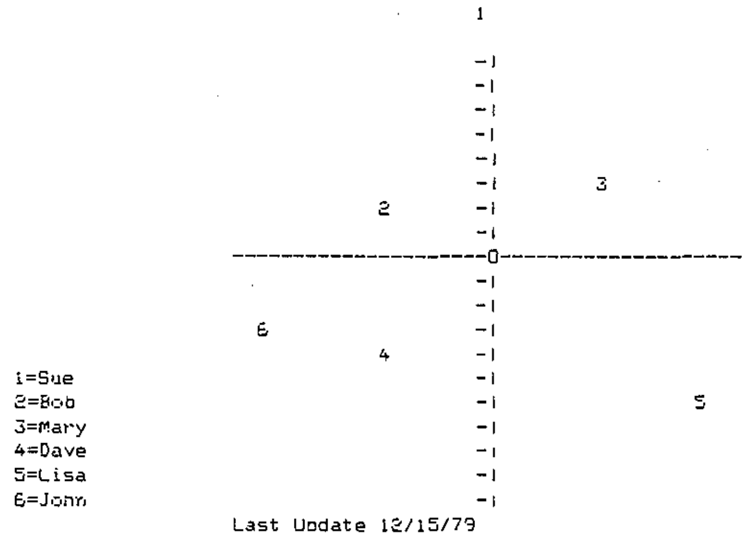

Fig. 1. First principal plane of six common first names ($N = 20$).

Another useful global measure relating to domains of meaning is the eigenvalue. Each neighborhood or domain is represented in the model as a spatial array whose dimensions are orthogonal reference vectors within which the concepts or objects are located as points. With each such dimension or "eigenvector" there is associated an "eigenvalue", which is given by the sum of the squared coordinates on that dimension. The eigenvalue, then, may be seen as the squared length of its associated dimension in the space.

The horizontal axis in Fig. 1 represents the first eigenvector of such a domain, while the vertical axis represents the second eigenvector. Since these eigenvectors represent respectively the width and height of the domain, changes in their associated eigenvalues represent changes in the width and height of the domain, while changes in the Trace (which is the sum of the eigenvalues) clearly represents changes in the overall size of the domain.

While most of the theorists and researchers cited above would agree that global effects are important and worthy of study, no work specifically related to such global characteristics has been reported. The purpose of this article is to report the results of a study devoted specifically to the measurement of such global effects in an experimental setting.

2. Theory

As noted earlier, concepts or objects are assumed to be defined by their dissimilarity relations with the members of a set of "nearby" objects. Together, these objects comprise a "domain" or "neighborhood". Within each domain or neighborhood there is also a special object, the self. "Beliefs" refer to the relations among the concepts, and "attitudes" refer to relations between the self and the remaning concepts. Among the most obvious global characteristic of a meaning domain when defined in this way are its size and shape.

Although theoretical work concerning the size and shape of meaning domains is scarce, some plausible hypotheses have been suggested (Woelfel and Fink, 1980). Barnett, et. al, suggested that the neighborhood of a political campaign ought to grow smaller as the election approached, but observed mixed results, once confirming and once rejecting their hypothesis. Others (Woelfel and Fink, 1980) have suggested that learning ought to increase the size and perhaps the dimensionality of the space, due to the increasing dissimilarities to be expected if learning is thought to entail increasing discrimination among objects of experience. This notion is consistent with Woelfel and Fink's thermodynamic analogy, since the receiot of energy in the form of information contained ought to lead to an increase in the size of the domain if it behaves like other thermodynamic systems when they absorb energy. Still others (Woelfel & Barnett, 1982) report on several studies which report a tendency of newly-formed spaces to tend toward increasingly euclidian structure under some circumstances. In all cases, these reports represent considerable speculation based on secondary analyses of data taken for different purposes. Barnett and Woelfel (1979) for example, have written specifically about the dimensionality of psychological processes, dealing specifically with changes of eigenvalues and hence shape over time, but their investigation in concerned principally with the number of significant eigenvectors underlying meaning domains. Their analysis, moreover, is based entirely on secondary data collected for other purposes.

In no case does any researcher report results of a study specifically designed to investigate such factors.

However tentative, this early wrok may serve as an organizing point for research into the effect of messages on global factors which can serve as the basis for sounder hypotheses later.

2.1. Compound messages

Woelfel and Fink (1980) distinguish simple messages (those which involve only one relation) from compound messages (those which involve more than one relation). While messages may be compounded of many assertions, all the studies already cited focused attention on messages compounded of a small number (between one and four) of assertions. In this study, however, we investigate the effects of a message compounded of many assertions.

2.2. Delayed effects

Many studies of local message effects (Saltiel and Woelfel, 1975), have observed delayed effects of messages, including returns to an original position after an initial shift away (boomerang effect), and its opposite, sleeper effect, under which the effects of the message continue after a period of time has passed. Since virtually all the studies which report these effects consist of two or at most four periods of measurement, it is easy to account for the discrepant findings in terms of the lag between receipt of the message and measurement of the effect. Conceiveably, a change which represented a gradual movement away from a position, followed by a gradual movement back could be recorded as either or both effects depending on the point in time at which measurements were taken.

Similarly, just as Woelfel and Fink's notion of increasing discrimination leads to expectations of increasing size, forgetting, which can be thought of as a blurring of distinctions, ought to yield a shrinking effect.

This movement away from a position followed by a gradual return is a highly plausible function, since it represents the curve predicted of a massive object deflected from a stable equilibrium position. As such, it is one of the most commonly observed functions in nature. Since many theorists in several fields have described culture as an equilibrating system, such a functional form should not be unexpected here.

Combining this information, we are led to hypothesize as follows:

H(1) Upon receipt of a compound message, a cultural domain will expand and then contract.

3. Method

In order to test this hypothesis, a random lagged experiment was designed. First a compound message was constructed. This consisted of 30 assertions about six names (five assertions per name). The six names were arbitrarily chosen common American first names. Assertions consisted of simple declarative sentences assigning random values of 5 attributes to each name. The attributes were chosen as grammatical opposites: intelligent-unintelligent, friendly-unfriendly, neat dresser-sloppy dresser, tall-short and liberal-conservative. On the basis of a coin toss, one pole of the attributes (e.g., intelligent or unintelligent) was assigned to a name. On the basis of a second coin-toss, the adverb "somewhat" or "very" was included in the assertion. The actual message resulting from this process was:

- Sue is somewhat short. She is somewhat liberal politically. She is a very sloppy dresser. She is very unfriendly. She is very intelligent.
- Bob is somewhat tall. He is somewhat liberal politically. He is a very sloppy dresser. He is somewhat unfriendly. He is very unintelligent.
- Mary is very short. She is very liberal politically. She is a somewhat sloppy dresser. She is very unfriendly. She is very unintelligent.
- Dave is very tall. He is very liberal politically. He is a very sloppy dresser. He is somewhat unfriendly. He is very unintelligent.

– Lisa is very short. She is somewhat conservative politically.

75 undergraduate students at SUNY at Albany read this message, and, after a randomly selected waiting period ranging from zero to 178 hours, filled out a GalileoTM-type pair comparison questionnaire. This instrument asked the respondents to estimate the difference or "distance" between all non-redundant pairs of the original first names on a numerical scale. The Galileo(TM) instrument is ideally suited to this experiment, since its metric properties are important to allowing meaningful comparisons of global attributes of the resulting solutions. Since we are interested in measuring changes in the size of the space over time, use of analytic procedures which renormalize measurements within each analysis (such as factor analysis or non-metric scaling) are inappropriate, since distances and hence sizes and shapes are not conserved across repeated analyses.

In a pretest, the length of the delay between reading the message and filling out the form was randomly varied among zero, one hour, one day (24 hours) and one week (178 hours).

Data from these measurements were entered into the Galileo(TM) version 5.2 computer program at SUNY at Albany for analysis. Galileo(TM) is a metric multidimensional scaling program that computees the Trace of the scaler products of the (centered) distances among the objects (in this case names), the eigenvectors of that centroid scalar products matrix and their

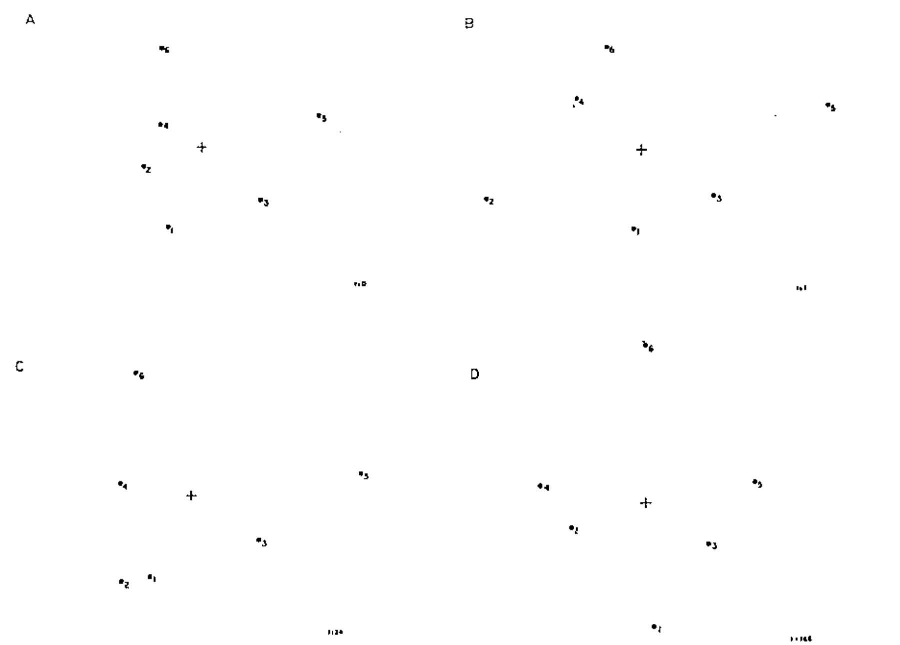

Fig. 2. Plots of the rotated configuration. 1 = Sue, 2 = Bob, 3 = Mary, 4 = Dave, 5 = Lisa, 6 = John.

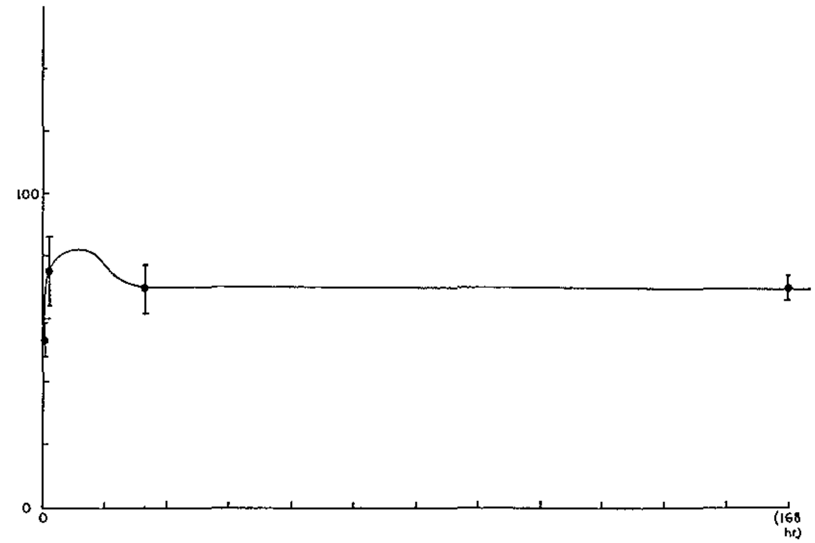

Fig. 3. Size of trace by length of delay.

associated eigenvalues. The Galileo(TM) program also provides automatic rotations and translations of the resulting spaces to best fit on one another over a time series of measures to eliminate spurious and artifactual differences in orientation. This facilitates comparisons of the spaces over time. Plots of the rotated configurations are provided in Fig. 2. As Fig. 2 shows, the first

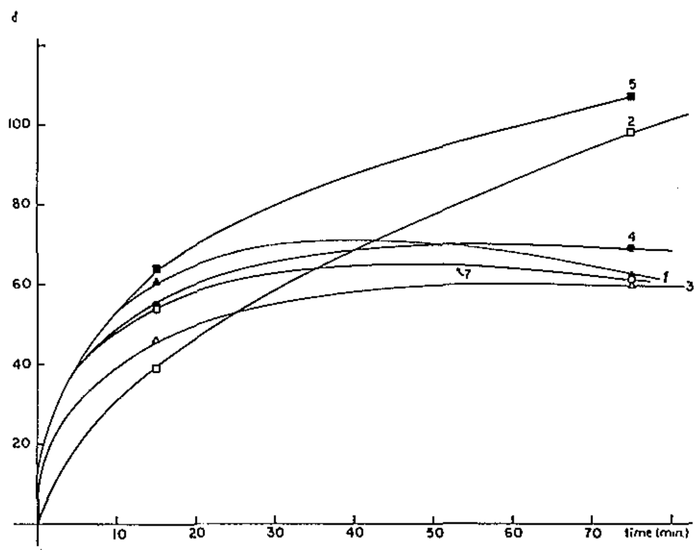

Fig. 4. Distance of concepts from the center of the space.

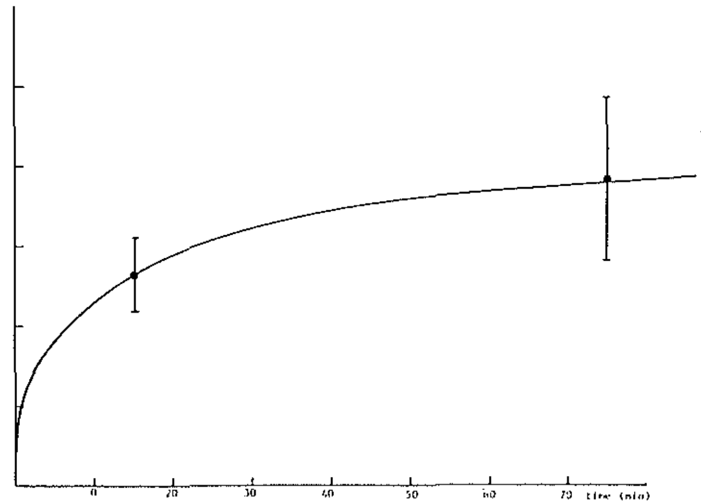

Fig. 5. Trace x time (minutes).

principal plane of these spaces remains roughly similar in shape, but at first grows then remains stable over the measurement period.

Fig. 3 presents here the traces of these spaces across the four intervals.

These figures show a clear growth of he space between the first measure (immediate measurement) and the second (one hour delay) followed by a decrease between the second and third period (24 hours), and no change over the subsequent week.

Fig. 4 reports the curves of each of the concepts' distance from the center of the space across the first day. These curves also show a clear expansion of the space which is not complete after one hour. The same effect is revealed in Fig. 5, which gives the curves of the trace over time.

While these data themselves support the general hypothesis noted above, they also make clear the need for finer discrimination of time intervals to gain more detailed information about the changes in size and shape over time, particularly during the early period when most of the action seems to be taking place. Consequently, a second experiment was designed, using the same message and instrument, but this time randomly varying the delay time at one hour intervals beginning one half-hour after the reading of the message. 471 students participated in this second phase. Data were analyzed as before, with coordinates, eigenvalues, Trace and other relevant variables provided by Galileo Version 5.2.

4. Results

Visual scrutiny of the plots of the first three principal planes of the configuration showed the names arrayed in essentially the same pattern in the second

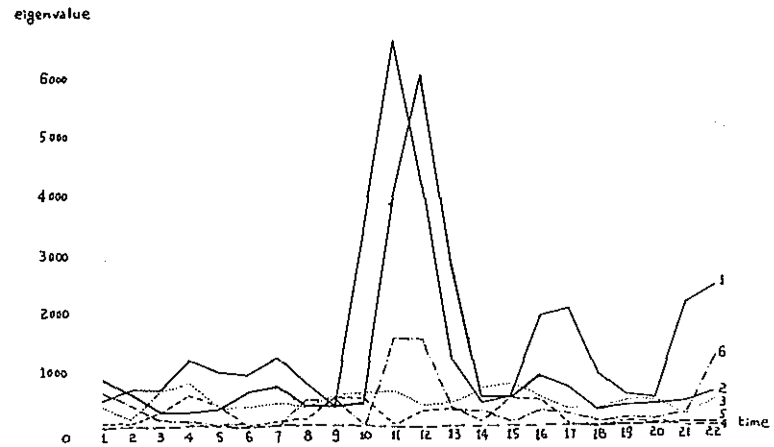

Fig. 6. Eigenvalues by time - 2nd order ($N = 471$).

experimentas in the first. (Copies of these plots, which are not provided here, can be obtained from the authors.)

The data from the second experiment allow more precise timing of the effects of the message, but samples within each of the time periods range between 4 and 5. These small samples within each time period are subject to wide uncertainties, however. Consequently, the eigenvalues of the configurations obtained from the Galileo(tm) analyses were transformed into moving averages of the first several orders. This procedure takes the first m values of each eigenroots at each time point and averages them to produce the average eigenroot at time $(t1 + t2 + \ldots + tm)/m$. It then calculates this value for tim $t2$ through $tm + 1$. The variable m is referred to as the window. Widening the window, that is increasing m, provides increasing smoothing of the distribution at the expense of high frequency information. In this analysis, windows of

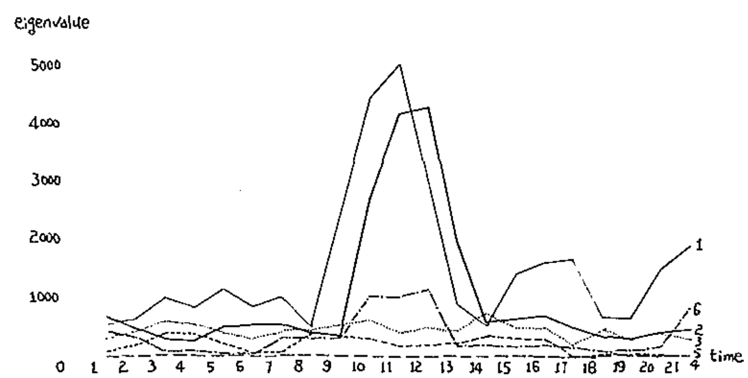

Fig. 7. Eigenvalues by time - 3rd order ($N = 471$).

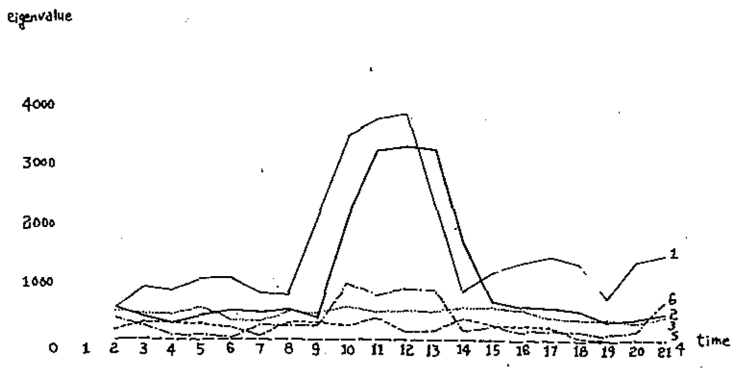

Fig. 8. Eigenvalues by time - 4th order ($N = 471$).

$m = 1$, 2, 3, and 4 were used. Plots of these smoothed eigenfunctions are shown in Fig. 6 through 8. While minor differences may be noted, in general the shape of each of the eigenfunctions remains essentially the same across all levels of filtering (i.e., across window sizes).

Each eigenfunction shows a rise after 9 hours which falls back to near initial values after 14 hours. Although the exact timing varies from eigenfunction to eigenfunction, (an of course different window sizes artifactually change the apparent onset and ending of events) nonetheless the form of each of the eigenfunctions is consistent with the form of the curve predicted for a mechanical system displaced from an initial equilibrium position.

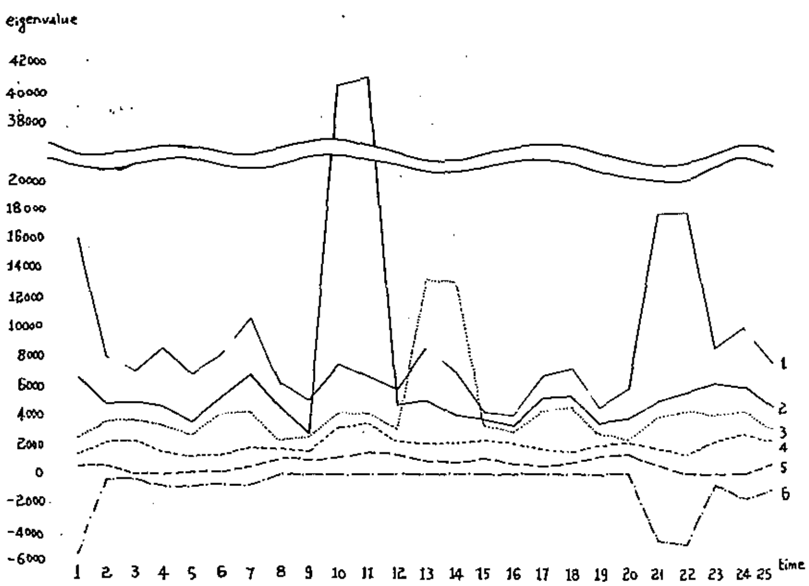

Fig. 9. Eigenvalues by time - 2nd order ($N = 557$).

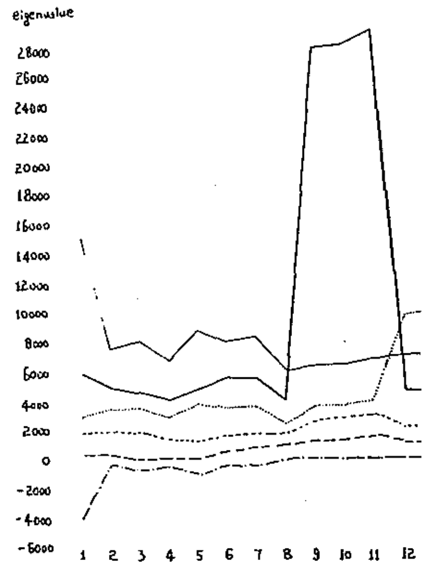

Fig. 10. Eigenvalues by time - 3rd order (N

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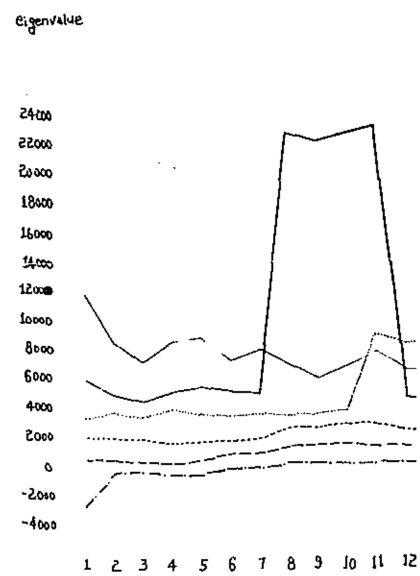

Fig. 11. Eigenvalues by time - 4th order (N

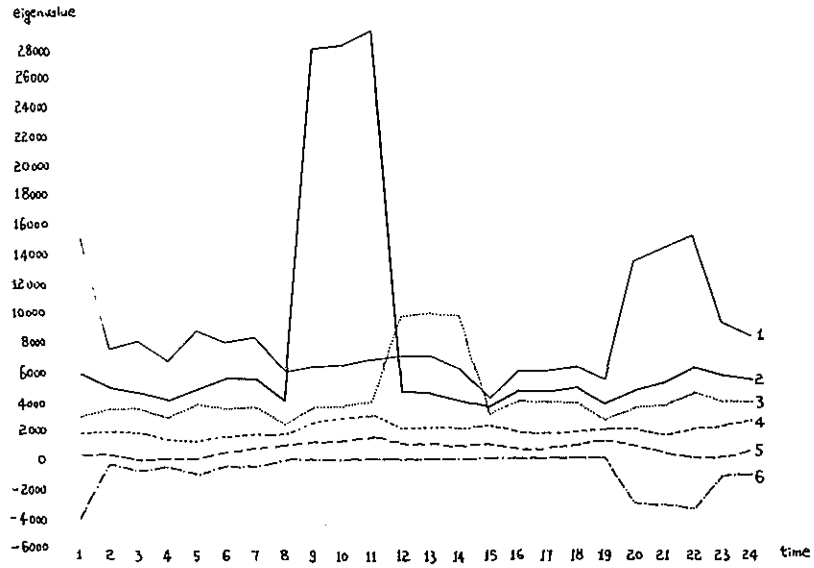

Fig. 10. Eigenvalues by time - 3rd order ($N = 557$).

Although the theory presented above indeed predicts an expansion followed by a shrinkage of the space, the long period of latency followed by the very large rise and quick fall is unaticipated. Consequently, the experiment was repeated exactly the following year by an independent research group. 550

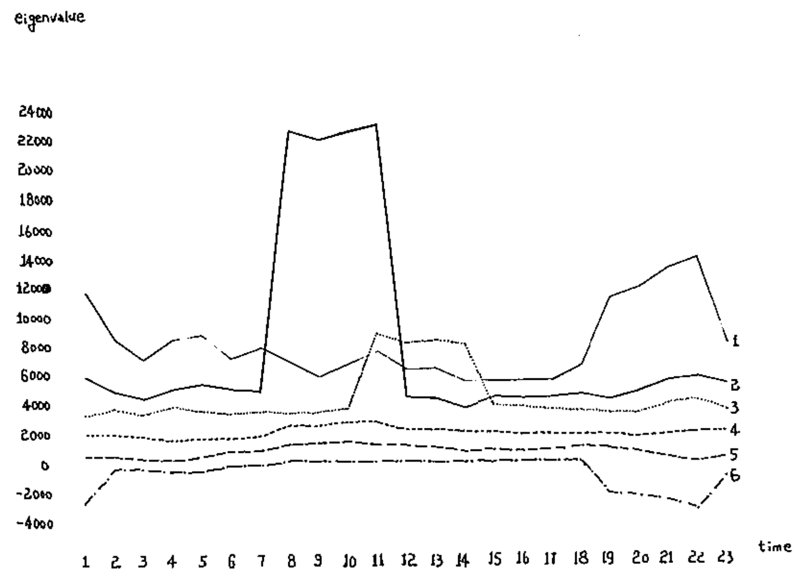

Fig. 11. Eigenvalues by time - 4th order ($N = 557$).

additional students at SUNY at Albany participated in this third phase of the study. Results from this third phase are presented in Figs. 9–11. Although the actual numerical values of the eigenvalues are somewhat higher in the third phase than the second, the overall pattern is very similar, showing a 9 hour period of latency, followed by a steep rise and a return to original values after 14 hours.

5. Discussion

Although initial theoretical guesses suggested that a belief/attitude space ought to grow with the receipt of information and shrink thereafter, the pattern of data actually observed exhibits some unanticipated departures from this pattern. First, in the initial study, the similarity of the pattern to the initial configuration after 168 hours had passed is surprising. Considering that the actual compound message the respondents read is a fairly lengthy and random list of assertions about a set of fictious persons, it is very unlikely that any single individual subject could be expected to remember much of the message after a week's time. Yet the average of all responses to the paired comparison task shows excellent recovery of the underlying pattern after this much time has passed. This may well be explained by a random forgetting on he part of subjects. If each subject forgets parts of the message at random, then the random losses may be cancelled by the averaging process. In this sense it may well be the case that the group of respondents "remembers" a pattern that has been forgotten by each of its members. This pattern would be consistent with the "superordinate" character some writers ascribe to culture.

A second unanticipated finding is the long (9 hour) latency period observed before the very quick expansion and contraction of the domain. One possibility that must be considered is that of an artifact of design. Although the time of day at which subjects were initially exposed to the stimulus was varied, nonetheless there is a greater statistical likelihood that subjects assigned to long waiting periods would have slept between initial exposure and measurement. What effect this might have had on the results is unknown.

Should the effect prove real rather than artifactual, explanations might be found within the physiology of memory. Perhaps a transfer from short to long term memory might be considered. In any event, periods of latency in biological systems are the rule rather than the exception in physiological and chemical experiments.

In general, the pattern observed is consistent with the curve to be expected by the perturbation of an equilibrium system with an initial period of latency. Further research might well utilize different messages in different meaning domains to establish potential variability in the timing of the latency period – or whether it occurs at all – for different content areas. Similarly, should the pattern be repeated in other domains, some investigation of the behavioral implications of the bump might well be investigated.

One methodological note might be of importance. Most recent multidimensional scaling work conducted by psychometricians has dealt primarily with the discovery of ordinal patterning in data. The use of ordinal scaling models, particularly those that renormalize data within analysis, has necessarily directed attention away from the relative magnitudes of patterns. Increased scrutiny of the sizes of meaning domains as a function of time might well warrant increased use of magnitude estimation procedures and metric scaling algorithms to preserve distances across analyses. Sufficient interest in these matters might argue for initial tentative standards of units of length to make comparisons across experiments possible.

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