

HOW TO DO A GALILEO STUDY

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# Chapter 1

## Purpose of the Book

This book is designed for the first-time Galileo user. It is meant to provide a working guide to the design and execution of a simple but complete Galileo study from initial conception of the problem to write-up of a final report of findings. It is intended primarily for the user who has a practical or applied problem to solve, rather than for the theoretical worker whose primary aim is the advancement of theory. It assumes no special technical or mathematical skill beyond elementary geometry and some high school algebra, and it does not require computer programming skill. Even so, it may prove quite useful to the expert theorist or methodologist who is unacquainted with the Galileo technique.

## Chapter 2

### What is a Galileo?

Galileo(TM) is a term used to describe a complete system of research methods, including interview methods, questionnaires, and a computer program. It is designed to measure beliefs, attitudes, and thought patterns—particularly changes in thought processes of groups and cultures over time, and to provide a means of designing effective messages for communicating desired changes to groups of people and measuring the effects of these messages. Typical Galileos have been used to measure public opinion in election campaigns, changes in perceptions of women, perceptions of children about occupations, to design public service messages about conservation, and by commercial companies to promote products and services, in addition to basic scientific and theoretical studies.

It was designed in part to answer a long-felt need for a standard procedure for making precise measures of complex public opinions which could reflect the complex, multidimensional nature of these processes while avoiding as much as possible the biases of the researcher. Moreover, although Galileo studies of very great complexity are frequently designed by theoretical researchers, the basic procedures are meant to be used intelligently by non-technical researchers and to present results in a form which is useful to and easily understood by the non-scientist.

Since prehistory, students of human behavior have believed that people's thoughts influence their actions. Persuasion, from the Rhetoric of Aristotle to modern advertising, is based on the assumptions that changing people's thoughts and beliefs will lead to desired changes in their actions. Any persuasive message, in fact, may be thought of as an attempt to change the attitudes

and beliefs of some person or persons in order to change their behavior in some way.

While simple in concept, persuasive efforts very frequently go awry. When they do, it is usually because the communicator has not fully understood in advance exactly how the persuasive message would be understood by the audience to whom it was directed. For this reason it is a decisive advantage to know in advance, as precisely as possible, the mental picture of the audience.

The Galileo system is a series of procedures for making a “mental map” of the audience for a persuasive campaign on any topic. It identifies the main concepts any group of people use to understand and define a topic, and it measures the beliefs and attitudes they hold about those concepts. Once these measurements have been made it is relatively easy to design the most effective persuasive messages possible for the audience about that topic.

The first step in constructing a Galileo measure of the way people think about a topic is to find out which concepts a group uses to understand and define the topic in their own minds. This is done very simply by asking a systematically chosen sample of the group to talk about the topic in some depth. The concepts they mention most frequently are the concepts by means of which they understand the topic. The very simple assumption underlying this strategy is that the concepts people use to define a topic are the concepts that come to mind when they are asked to discuss the topic. Thus, if we want to know what concepts people use to define a topic like soccer, for example, we could ask a series of people to talk at some length about soccer and record the concepts they use to describe it—like “a game,” “fun,” “a team sport,” “the natural pastime,” “boring,” “dramatic,” etc. At first, many such concepts emerge from the interviews, but somewhat surprisingly, after a short while, people begin to repeat the same concepts. After five or ten interviews very few new concepts crop up. In fact, while as many as forty or fifty such concepts may sometimes be discovered in a series of 25 or 50 interviews, those that are used repeatedly by most people interviewed only very seldom number more than a dozen.

Once the concepts used by a group to define a topic have been discovered, the next step in the Galileo procedure is to construct a “map” of the way people perceive the concepts. This map consists quite literally of a picture of the relationships people see among the concepts. The map is constructed by a) measuring as precisely as possible how much difference in meaning the people see between each concept and all the others, and b) placing those concepts which are viewed as similar in meaning far from each other in the



map.

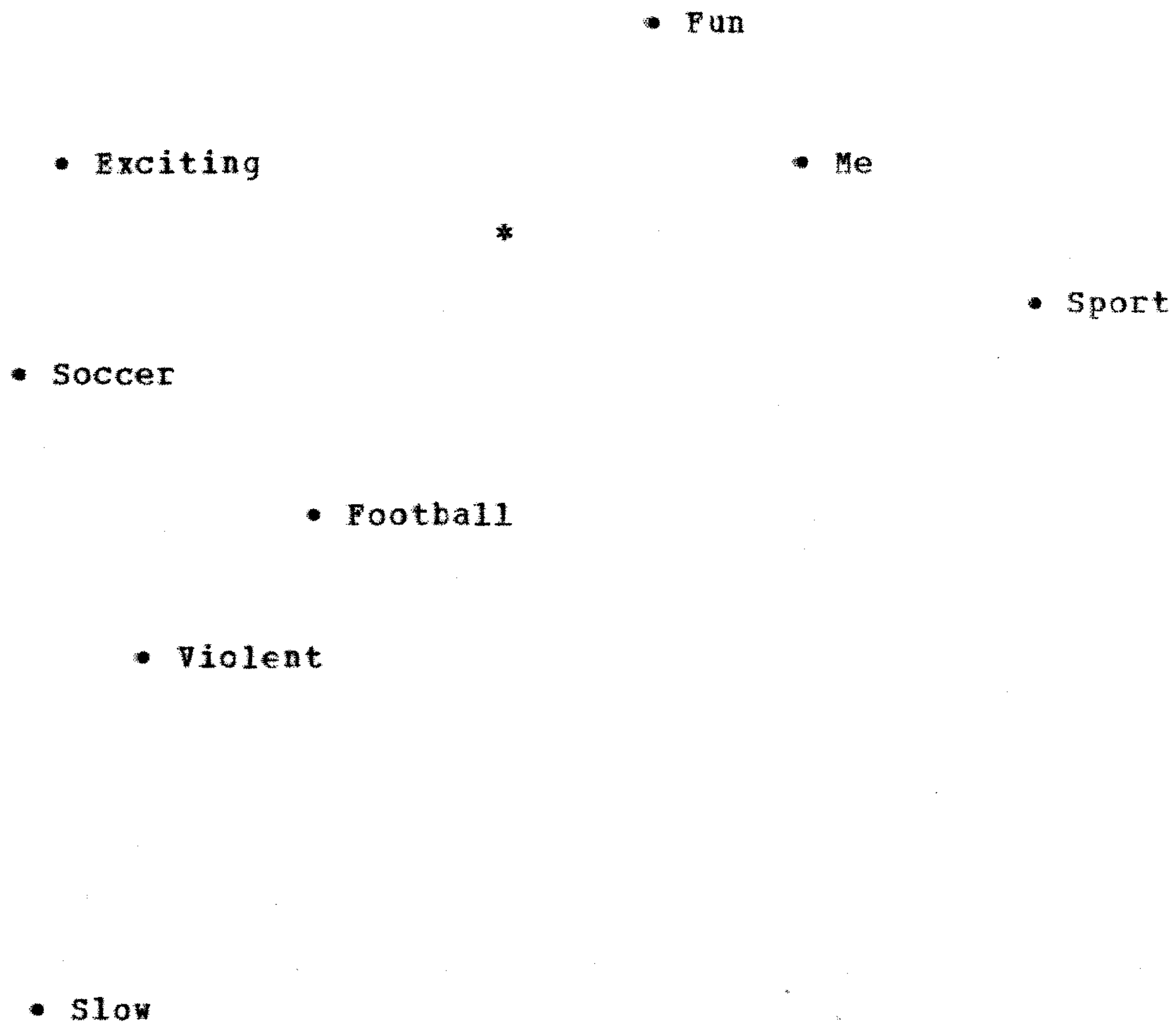
A simplified example of such a map is given in Figure 1 (insert Fig. 1 here). If this example had been drawn from real people (this is a fictitious example) it would show that those people viewed soccer as slower, less exciting and violent than football, but equally a sport (both football and soccer are equally close to “sport” in the example) and roughly equally “fun.” The real utility of the Galileo system is made clear by the concept “me” which can be found near the center of the map. Careful and extensive research has shown that the distance of any concept from the “me” in the map is strongly associated with the amount of time and energy people invest in that concept. Political candidates closest to the “me” receive the most votes in elections. Products closest to the “me” are bought most frequently; activities in general which are closest to the “me” are performed more frequently than those far from the “me.” And most important of all, moving a concept closer to the “me” results in greater favorability toward that concept and increased behavior toward that concept. Thus, if we could *move* the concept “soccer” closer to the concept “me” for a sample of people, we would expect them to exhibit a greater interest in soccer, talk about it more frequently, and even (on the average) to listen to, read about, and attend more soccer matches.

The Galileo system has shown itself to be an invaluable tool for designing persuasive messages, because it provides clear cut message strategies for moving concepts closer to the “me.” Extensive research has shown that, when two concepts are equated in a persuasive message, they move closer to each other in the Galileo map. Thus, if we say to the sample in question “soccer and football are quite similar,” subsequent measurements will show soccer and football moving closer together in the map. We also know that the less people already know about the concepts, the more they will move as a result of the message. If we say “soccer is fun,” then “soccer” and “fun” will move closer together. A moment’s reflection will show that, if we say both of these things together, *soccer will move between football and fun (toward the star in Figure 1) and close to the “me.”*

The logic underlying the Galileo system is not new. Earlier techniques resembling Galileo in some respects have been known to psychometricians since 1938 as variations of *multidimensional scaling* and have been even been marketed commercially under different names (such as “brand mapping”). Galileo differs from these procedures in several important ways.

First, in Galileo, concepts defining the domain of meaning (i.e., the concepts which define the topic) are obtained directly from the audience by

FIGURE 1  
A HYPOTHETICAL GALILEO MAP



means of a variation of the WISCONSIN SIGNIFICANT OTHER BATTERY, a proven technique developed at the University of Wisconsin to provide the most precise available measures of persuasive influence.

Secondly, Galileo is the only scaling system designed specifically for analysis of groups rather than individuals. This makes it especially useful for analyses of public opinion, commercial market segments, diffusion of innovations, changes in cultural beliefs and values, and other situations involving groups of people.

Third, the interrelations among these concepts are measured by the method of complete pair comparisons on ratio level scales of well-tested accuracy and precision. These measurements are the most precise measures known to psychometricians.

Fourth, the precision of measure made available by these procedures allows the use of a “fully metric” multidimensional scaling algorithm to generate the Galileo map. In practice this means that the map corresponds *exactly* to the actual measurements made rather than only approximately as is typical in the more common non-metric techniques.

Fifth, because the system is metric, it is not subject to “degenerate” solutions. (In many cases, other scaling programs produce completely distorted maps while giving an erroneous estimate of how distorted they are.)

Sixth, the ratio scaled completely metric Galileo program is specifically designed for over time analysis. Galileo solutions are automatically linked together to produce moving pictures rather than snapshots.

Seventh, only Galileo has the “Automatic Message Generator.” Because of its ratio-scaled metric, the Galileo computer program is precise enough to compute the projected effects of every possible combinations of messages that might be sent about a topic to determine which combination will produce the maximally desired outcome.

# Chapter 3

## Getting Started

### 3.1 The Preliminary Interviews

The first step in any Galileo study is to determine the words the people you want to study use of describe the topic you want to study. If you intend to study an election campaign, you must first determine the issues the voters in the election believe are important. If you are studying the market's attitudes toward a product, you need to find out what words potential buyers use to describe it and similar products. If you are studying the conceptions of villagers toward television, you will first need to learn the words those villagers use themselves when they talk about television. Although this may seem difficult, it is actually very simple once you get started. Since you want to know the words people *use* when they talk about the topic, you need only ask them to talk about the topic and listen carefully to what they say.

### 3.2 Who to Ask

The first decision you must take is *who* to ask. Only you can answer this question, since the study will obviously describe only those people studied and other people like them, and only you can determine who you want to study. If you are studying an election, you will want to study potential voters; if a product, potential buyers. But once you have decided, a simple rule should be followed: once you have decided on the population of interest, *for these preliminary interviews* you should draw *the most widely varied sample*

*you can find from that population.* Try to get people of the widest possible range of opinion, and interview them. If an important group of opinions are left out at this stage, you may still be alright later, but it's better to be safe if you can afford it.

### 3.3 What to Ask

Remember, you want to learn the words people use when they describe the topic or product or service you are studying. The best way to learn these words is to ask the people to describe the topic or product or service to you. Write down (or tape record) their answers, or at least the main phrases they use. Try to exact in copying the words and phrases they use. Probe by asking them to go on, or describe it several ways, or to explain their answers more fully. DO NOT SUGGEST ANSWERS OR WORDS TO THEM. Remember, it is their view you want—not yours. Ask them what they like and dislike about the topic. Ask them why they feel or think the way they do. Ask them to repeat what they have said in different words.

### 3.4 When to Stop

The interview should be just like a normal conversation, and it should be terminated when you are not able to get any new words, or when the respondent is only repeating words used already. Usually this takes from 15 minutes to an hour, with 30-45 minutes the average. In the same way, you stop the *series* of interviews when additional interviews yield no new words or very few new words not mentioned in the earlier interviews. Usually this takes about 30 interviews. You should probably try to have at least 20, and very rarely, a large and varied population in a well-funded study may use as many as 100.

### 3.5 Coding the Data

By now you should have a very long list of words (or a large amount of tapes). As you look at the list, however, you will notice that many of them are very similar in meaning. You should now begin to group similar words and phrases into categories. (if you have had previous research experience, you

will recognize this as an ordinary content analysis of the interviews.) Each of the words should be counted, so you know how many times each word was mentioned, as well as how many times each category was mentioned. It is best if several (two or three) people do this independently, i.e., without conferring with each other. Afterwards, they should meet and compare their results to work out their differences and prepare one master list. You will almost always find that as few as 10-15 categories will account for 75%–95% of all the words mentioned. Each of these 10-15 categories should be named with a word or short phrase. Usually one of the words—preferably the most frequently mentioned word in the category—can be used as the name for the category. If you have trouble naming the categories, you should ask several more people drawn from the population you wish to study to help name them. Remember, it is *their* opinion you want to measure, and using a word or phrase they are not familiar with will work against you.

Now you have finished the preliminary work. In your first study, this may have taken several weeks. Once you have gained practice (and if you have the resources) you will be able to accomplish all this work in a few days. Professional Galileo researchers can do the preliminary work in a few hours under good conditions with special facilities.

### 3.6 An Example

Recently scientists at Michigan State University conducted a Galileo study for the Dairy Herd Improvement Association of Michigan to help promote a testing program for Dairy Herds in the State of Michigan. The program (which we will call “the test”) involves certain tests made of the milk produced by dairy herds which are used to provide useful information to dairy farmers which they can use to improve their production of good quality milk. Although the evidence showed the test to be quite effective in improving dairy farmers’ production and profits, farmers were not adopting it at a very fast rate, and so the Galileo study was designed to find out what farmers thought of the test and what the DHIA might say to the farmers to convince more of them to adopt it.

Although the dairy scientists knew very well what the test was, the first step was to find out what the dairy farmers thought of it. After consulting with dairy scientists with a good knowledge of dairy farming in Michigan, a sample of 36 widely different farmers was drawn, and 28 of them were

interviewed in person and asked the kind of questions just described. Because of the difficulty of taking notes on the farm, small cassette tape recorders were used to record the interviews and later students listened to the tapes and counted the words and phrases the farmers used to describe the test. Each tape was listened to by at least two people independently so the results could be compared and errors eliminated. Then two more people collapsed the separate lists into categories and compared their results. Finally, they agreed that the following twelve words or phrases gave a good and fairly complete picture of the categories dairy farmers used when they described the test:

01	Accurate Information	07	Measuring Production
02	Good	08	Necessary
03	Convenient	09	Profit
04	Keeping Records	10	Computers
05	Culling	11	Useful
06	Breeding	12	Inexpensive

Naturally, it is always wise to include the name of the idea or product or service that is being investigated (and necessary if messages are to be designed from the output). It is also useful to measure the relationship of each of these concepts to the person filling out the Galileo questionnaire, and so the concept “you” was also included in the list. Other ways to describe the person besides the word “you” are often used, such as “me,” “myself,” and so on. In this study, the word used to describe the test and the word “you” were also included, and so we have

- 13 DHIA Production Testing Service
- 14 You

Once these concepts have been chosen, the next step is to prepare the main questionnaire.

## Chapter 4

# The Galileo Questionnaire

Constructing the Galileo Questionnaire is the easiest part of the study, since the format is completely standardized, and meant to fit perfectly with the computer program in Part Three. With a little practice you can learn to write a Galileo Questionnaire: the Cover Letter, the Instructions, the Pair Comparisons, and the Demographics.

## 4.1 The Cover Letter

The cover letter is, very simply, a letter included with the questionnaire that explains to the respondent what it is you want him or her to do for you, and why he or she might want to cooperate with you by filling out the questionnaire. There are no special rules for writing such a letter, except that you should try to use the correct standards of politeness and kindness that people in your culture expect. An example of the cover letter used in the Dairy Science project is shown in Figure 2.



COOPERATIVE EXTENSION SERVICE  
MICHIGAN STATE UNIVERSITY and  
U.S. DEPARTMENT OF AGRICULTURE COOPERATION  
Department of Dairy Science  
East Lansing, Michigan 48824

March 25, 1977

Dear Sir:

The Department of Dairy Science at Michigan State University spends most of its research time investigating methods of improving profit on the dairy farm. When useful information is found it must be brought to you for application.

A major problem for us has been to communicate with you. To improve our system of communication we have enlisted the help of other departments on the campus. The enclosed questionnaire is part of the effort.

We would appreciate very much if you would complete the enclosed questionnaire. The information will assist us in doing a better job for you.

Sincerely,

Clinton E. Meadows Extension Specialist

CEM/lb  
Enc.

## 4.2 The Instructions

While all the concepts discovered in the preliminary interviews are used to describe the topic of your research, they are all somewhat different in meaning from each other. The purpose of the Galileo Questionnaire is to find out *how different* is the meaning of each from the meaning of each of the others. Moreover, it is essential that the degree to which each concept is different

from each other be represented by a number. Teaching respondents how to express the difference in meaning between ideas in numbers is the purpose of the Instructions.

Basically the process involves choosing any two of the concepts from the list of concepts found in the preliminary interviews to use as a standard of comparison. This pair of concepts is called the Criterion Pair, and the Criterion Pair is used as a ruler to measure the differences between all the other pairs. While at first this may seem very difficult and abstract, it is in fact the most elementary form of measurement known, and is used in virtually all cultures even by uneducated people. It is exactly the same principle as using one's foot or thumb or arm to measure the length of objects, and the average person can learn to do it in only a few minutes with surprising accuracy. The only requirement for use of this rule is that the people be able to use numbers at least up to 100. If the people you are studying do not use numbers in everyday life, you can still do a Galileo, but you will need help. Some of the places you can go for help will be listed at the back of this book.

The instructions actually used in the Dairy Science project are listed in Figure 3. They are in a form which has been developed after years of research on thousands of people in several nations, and can be used just as they are (changing the words in the Criterion Pair, of course) in most cases. If you feel that the people in your culture could be better instructed in a different way, by all means feel free to modify the instructions. Be sure, however, that you explain exactly how you have modified the instructions in any articles or reports you might submit to scientific journals, so that other researchers may compare their results with yours. You will note, also, that the number assigned to the Criterion Pair in these instructions is 100. This is because, in the State of Michigan, the U.S. dollar is the base currency, and it has 100 pennies in it, so that people are familiar with the base of 100. You might want to use the base of currency in your country instead so that people will be familiar with it. If the people are not used to using large numbers, you might want to use 10 instead of 100. Changing this number will change the size of the map resulting, but not its shape. It is the same as measuring in meters or kilometers or centimeters: the result is the same but the numbers are different.

## Sample Instructions

We would like you to give us *your opinion* about some ideas related to dairy farming. You can help by *comparing* these ideas to each other to tell *how different* or *far apart* they are. For example, we might ask, “How different are *dairy farming* and *crop farming*?” You could answer with a number. If the two ideas are *very different*, you would write a *large number*. If they are *very similar*, you would write a *small number*. If they are *identical*, you would write *zero* (no difference).

To help you judge *how large* the differences are, we’ll say that the *amount of difference* between *dairy farming* and *crop farming* is *100 units*. Try to keep this difference in mind when comparing the other pairs of words. If two words are *further apart* than crop farming and dairy farming, write a number *larger* than 100. If they are *twice* as far apart, write *200*, and so on. **YOU MAY WRITE ANY NUMBER YOU WANT.** Remember, there are no wrong answers, only your opinion.

### 4.3 The Pair Comparisons

Once the respondents have learned how to make the comparison between pairs of ideas and to report the differences in meaning between them as numbers, it is necessary to present each possible pair to them for comparison. This is done in a standardized way to make the outcome suitable for input to the Galileo Computer Program. Figure 4 presents a sample page from the Dairy Science Galileo Questionnaire. Since there are fourteen concepts the Dairy Science Study, then  $14 * 13/2 = 91$  comparisons are necessary. (In general, for  $n$  concepts  $n(n - 1)/2$  pair comparisons will be required. It is worthwhile to compute this equation for a few values of  $n$  to get an idea of how long various Galileos might become.)

## Sample Page of Galileo Questionnaire

ID # 1-6

CARD 01 7-8

HOW FAR APART ARE

0102	09-01	Accurate information	and	Good	—
0103	18-26	Accurate information	and	Convenient	—
0104	27-35	Accurate information	and	Keeping Records	—
0105	36-44	Accurate information	and	Culling	—
0106	45-53	Accurate information	and	Breeding	—
0107	54-62	Accurate information	and	Measuring Production	—
0108	63-71	Accurate information	and	Necessary	—
0109	72-80	Accurate information	and	Profit	—

HOW FAR APART ARE

0110	09-17	Accurate information	and	Computers	—
0111	18-26	Accurate information	and	Useful	—
0112	27-35	Accurate information	and	Inexpensive	—
0113	36-44	Accurate information	and	DHLA Test	—
0114	45-53	Accurate information	and	You	—
0203	54-62	Good	and	Convenient	—
0204	63-71	Good	and	Keeping Records	—
0205	72-80	Good	and	Culling	—

Notice first of all that there are three pair comparisons alone at the top of the page. These are practice comparisons and are not used in the analysis. You may use any comparisons you want for these practice items; they are only meant to familiarize the respondents with the process.

Next you will notice that the remaining pair comparisons are presented in blocks of eight. Each of these will fit one computer card when the data are keypunched later. The numbers in the first column (i.e., 1–8, 9–17, 18–26, etc.) are precoding instructions to the keypuncher. The next column of numbers (0102, 0103, 0104, etc.) are called the matrix dimensions and tell which pair of concepts are being compared. Notice that the numbers in these pairs correspond to the numbers of the concepts on pp. 11–12. Thus *accurate information* is 01 and *good* is 02, so naturally 0102 refers to the pair *accurate information* and *good*. On the far right of the questionnaire is

the answer blank, and this is where the respondent (or the interviewer, if the questionnaire is administered by telephone or in person) places the answer.

All this may seem somewhat cumbersome, but it actually saves time, money, and much more importantly prevents many clerical errors later. Taken together, all this information provides the following rules for the keypunchers:

## 4.4 Rules for the Keypuncher

Rule 1. The first 6 columns of *every card* are identical. They contain identification information from the Demographic sheet, which will be described in the next section, and are always duplicated from the first 6 columns of the Demographic Card(s).

Rule 2. The matrix dimensions (0102, 0103, etc.) in the second column of the questionnaire are keypunched *left-justified* in their appropriate fields, while the *answer* is punched *right-justified* in its appropriate field. Thus the answer circled in the questionnaire is punched on the card as

COLUMN	36	37	38	39	40	41	42	43	44
PUNCH	0	1	0	5	b	b	b	7	5

meaning that this respondent said that concepts 01 and 05 were 75 units apart. Note: *If the number is greater than 5 digits, punch 99999.*

Rule 3. All cards must be punched and verified. No errors whatsoever are tolerable. This has nothing whatever to do with the Galileo system—it is just good advice, and the frequently-heard notion that a 1% or lower error rate is acceptable is *completely* false. MOST of the actual time our programmer spends analyzing data collected outside our own research group is spent correcting coding and keypunching errors.

## 4.5 Demographics

The term “demographics” refers to variables that describe characteristics of the people in the sample, such as their age, their sex, their education, and so on. Galileo has no special requirements for demographic information, and what kinds of demographic variables you measure—or whether you measure any at all—is a matter of your interests. Space is left for the most important demographic information. If you have more demographic information than

will fit in the space on the Galileo cards, by all means use as many cards as are needed. In any event, you will want to punch an identification number somewhere in the first six columns of each card so that you can tell what goes with what questionnaire. You will also need the identification number to connect the individual's Galileo cards with his or her demographic cards if, indeed, you have demographic cards in addition to the Galileo cards. The identification number ought to be written somewhere on the actual questionnaire itself as well, so that errors found on the cards can be referred back to the actual questionnaire for the correct data.

If your Galileo study intends to compare differences among several groups, then the group to which each individual belongs (for example, male or female) ought to be coded somewhere in the first six columns of the card so that the *select* option of the Galileo program may be used later to break the sample (See Appendix 1). Needless to say, if your study is meant to show changes over time, the time at which each questionnaire was filled out should also be coded in the first six spaces. An example of the demographic information collected for the Dairy Science project is shown in Figure 5.

Figure 5  
Sample Demographic Sheet

- |   |                        |
|---|------------------------|
| 1. What is your age?                                  | _____                  |
| 2. Are you married?                                   | _____                  |
| 3. What was the last year of school you finished?     | _____                  |
| 4. How many years have <i>you</i> been farming?       | _____                  |
| 5. How many years have <i>you</i> been dairy farming? | _____                  |
| 6. Did you grow up on a dairy farm?                   | _____                  |
| 7. Have you always farmed in Michigan?                | _____                  |
| 8. What is the total number of acres you operate?     | _____                  |
| 9. How do you market your milk?                       | Grade "A"    Grade "B" |
| 10. What percent of your labor is hired?              | _____                  |

11. How would you describe your dairy operation?

Circle those which suit your operation.

1. Stanchion barn
2. Stanchion & free stalls
3. Stanchion & loose housing
4. Stanchion & parlor
5. Parlor & free stalls
6. Parlor & loose housing

12. What was the approximate average production  
per cow last year in pounds or milk? \_\_\_\_\_

13. How many cows do you milk? \_\_\_\_\_

14. Has your herd ever been on test? \_\_\_\_\_

15. Is your herd on a milk test program now? \_\_\_\_\_

16. Which testing program are you now enrolled in?  
Circle one.

1. DHIA
2. DHIR
3. Owner sampler
4. Tri-monthly testing
5. Private test

17. How long has your herd been on test? \_\_\_\_\_

18. Have you always been on the present form of testing? \_\_\_\_\_

# Chapter 5

## Administering the Questionnaire

There are two questions that need to be answered: to whom should the questionnaire be administered, and how should the questionnaire be administered.

### 5.1 Who to Sample

Ultimately, only you can decide who to administer the questionnaire to, since the answer depends on who you want to know about. Once you have decided the population you want to measure, the rules for sampling from that population are no different for Galileo questionnaires than for any other questionnaire. In general, for the main waves of data, you will want a sample that is representative of the population of interest. You can help to guarantee representativeness in the standard ways, such as random sampling, stratifying, clustering, etc. How many need to be sampled again is no different for Galileo than any other questionnaire, although the Galileo is a bit more robust than typical questionnaires, and will give good results even with relatively small samples. In commercial work, it is usual to keep the sample at about 200-500 cases, but larger samples are always good. In general, the precision of the results goes up as the square root of the sample size.

Whenever you are measuring a process—like an election campaign or the change in perceptions of women—the following rule is useful. First, make an estimate of about how long it will take for the process to show meaningful changes. Will the process show change in a month, a year, five years?



Once you have decided how long of a time will be needed to see substantial change, or to prove that substantial change is not taking place, decide how many questionnaires you can realistically afford to administer. Divide the number of questionnaires you can afford by the number of days you think the process will take to unfold, and administer that many questionnaires every day. Needless to say, you will not always be able to follow this rule to the letter, but it will give you a good idea of how to proceed, and will emphasize for you how important it is to measure many points of time between the beginning and end of the process, rather than bunching up your questionnaires into “waves.” In general, ten questionnaires per day for a month is much better (and often less expensive) than 300 questionnaires sent all at once, since a) you can see how things are changing day by day, and b) if you want to, you can always average all the questionnaires together to get the same outcome you would have had if you had mailed them all at once. And remember, precision goes up very rapidly at first, then more slowly, so that going from 50 to 100 cases gives a substantial increase in precision, while going from 500 to 550 does not add very much.

## 5.2 How to Administer the Questionnaire

The rules for administering a Galileo questionnaire are essentially the same as the rules for administering any questionnaire. Galileos may be administered by mail, over the telephone, or in person, individually or in groups, and even by computer. (There is even a computer-based Galileo called **Intergal** which writes questions on a computer screen while respondents answer by typing on the computer console.) Which of these methods is appropriate for your study depends entirely on the type of population you are studying. Obviously, if the population is very young or illiterate, you will not be able to mail the questionnaire to them, nor will you be able to telephone rural villagers in societies where telephones are rare. You will also need to use the standards of politeness appropriate to the group you are sampling.

A typical Galileo questionnaire is not a difficult questionnaire to fill out, and many people report that it is an interesting and enjoyable experience. A fifteen-concept Galileo takes an average of 25 minutes to be filled out in a random U.S. population, and if you allow an hour, that will usually be ample. But you should remember that you are asking the respondents to do work for you, and on some concepts the work may be quite hard, as is

the case for any questionnaire, since people are searching their memories and making judgments about important ideas. Mental work is work too, and it is completely appropriate to reward the people for helping you. They are in a real sense your employees, and you have hired them to report to you about their culture or their own feelings. In commercial work, payment for this work is very common. In deciding how much to pay, you should consider how much the time you are using would be worth to these people in their own lives. Sometimes with wealthy people, such as doctors or lawyers or government officials, you will not be able to pay enough, and in those cases you might offer to donate a nominal amount to their favorite charity. It is not only just to pay for these services, but the results in improved accuracy and the savings in decline in refusal rates are more than worth the money.

### 5.3 A Word about “Failures”

Sometime (about as often with Galileo as with other types of questionnaires) some people will report that they cannot do the Galileo. In these cases it is worthwhile to interview them briefly to find out why not. Often a few words of explanation—or even encouragement—are enough to help them along. In any event, you will learn valuable lessons from these interviews about how to write your instructions (or how to deliver oral instructions) that will help you later. Remember teaching people how to fill out a Galileo form is a communication process, and communication processes are bound to fail if we only talk and do not listen. Whenever anyone has trouble with a Galileo, you should not be discouraged, but rather look at it as a valuable opportunity to learn more about how people think and how the Galileo works. In general, after you have finished designing a Galileo questionnaire, you should consider the first 20 or so that you administer a test of the final result on the basis of which you revise the questionnaire if you find difficulties. Even after all this work, however, you will find people who cannot or will not fill out the Galileo, just as there are people who cannot or will not fill out any questionnaire. Remember, no task is so easy that everyone can do it, and a measurement system so simple that anyone could use it would not yield much useful information. When you find such people, thank them politely for their time and move on.



# Chapter 6

## Analyzing the Data

Once the questionnaires have been filled out, the largest part of the work is completed and there remains only the analysis and report writing. There are only two phases left before the results are available for scrutiny: keypunching and running the cards through the Galileo program.

### 6.1 Keypunching

Years of painful experience with data of all types—including Galileo data—suggest one simple rule for keypunching: find a reliable, professional keypunching firm in your area and have them keypunch your data. It is possible to have untrained students punch the cards, but 1) Galileo produces a lot of cards, 2) mistakes are inevitable, and 3) the expense in time and money of correcting mistakes always exceeds the costs of professional keypunching. And even though the Galileo computer program has a built-in cleaning package to find errors in the data, it is by no means foolproof (it can only find mistakes that represent impossible or very unlikely values) and it costs more for the Galileo program to find and purge errors than it costs to avoid them in the first place. If you have no experience with keypunching at all and don't understand these sections, then make a photocopy of pp. 20 to 22 of this book and take them, with your questionnaires, to the keypuncher. Ask the keypunching service how much they charge per 1000 cards, PUNCHED AND VERIFIED. Then calculate the number of pair-comparisons you have where,

$$\text{Pair Comparisons} = \frac{\text{Number of concepts} * (\text{number of concepts} - 1)}{2}$$

and divide this number by 8 (since there are 8 pair-comparisons per card in the Galileo coding system). This is the number of cards you will have, *not* including the demographic items, which usually need much fewer cards. Make no mistake about it, this is a lot of cards, which is one of the key reasons Galileos are so precise—they generate great deal of information per respondent/minute.

## 6.2 Writing the Galileo Program

Once your data deck returns from the keypuncher, you are ready to analyze it with the Galileo computer program. Complete instructions for the Galileo Version 4.0 computer program can be found in Appendix 1 of this book. The Galileo Procedures are a System, and each part is made of fit perfectly with each other part. The Galileo questionnaire yields punched cards that are already formatted to the Galileo input requirements, so the next steps are very nearly automatic. You need only answer two questions to complete the few simple cards needed to get the Galileo Computer Program to analyze your data: 1) what to ask for, and 2) how to ask. The second of these questions is answered in detail in Appendix 1. Once you know what to ask for, Appendix 1 will make sense and usually becomes very easy.

## 6.3 What to Ask For

The Galileo System is a complete multidimensional measurement and analysis system that has developed over many years to provide enough flexibility to allow the user to perform virtually every important multidimensional scaling procedure in general use. Which of these operations are required in any study depends on the goals of the particular study, and since this book is meant only as an elementary introduction to the system, only a few of the basic options will be dealt with here. Many of the options you will find listed in the Galileo Documentation in Appendix 1, such as DELPCT, XCOR, REGEN, and so on, are meant primarily for the theorist or advanced methodologist

for purposes beyond the scope of a typical applied study. The operations described here will suffice to handle almost all the requirements of the first-time user.

## 6.4 Calling Galileo: The System Control Cards

Your computer system has many computer programs in it, and your first task is to get on the system and call the Galileo program. This is done by means of a few (usually 3 or 4) *system control cards*. You will need help from your own system consultants—every computer center has these—to learn how to access the Galileo. This will take only a few minutes. (If a Galileo program is not mounted on your system—and if you are a bonafide scientific or educational institution, you can get a Galileo computer program for a nominal cost by contracting the nearest Galileo Owners Group representative—see Help, Appendix 2.)

Once you have gotten on the system and accessed GALILEO, you should write RUN NAME, N CONCEPTS, N DATASETS, CRITERION PAIR, and CONLABEL CARDS. The program requires N CONCEPTS and N DATASETS cards, which tell GALILEO how many concepts to expect and how many sets of data you mean to compare. If you have only one sample, you still must tell GALILEO there will be one dataset. If you wish to compare, say, MALES to FEMALES in your sample, you have two datasets. Although the program will run without CRITERION PAIR and CONLABELS cards, you will find that it is foolish and very time-consuming later to omit these, since the output will be much harder to read, and you will forget what the output refers to after a short while.

After these cards, you will need to tell GALILEO which of the major operations it can perform you will require. For elementary work, only four such operations need to be considered: Coordinates of Galileo Spaces, Comparison of Spaces, AMG (Automatic Message Generator) and Plots.

## 6.5 Coordinates of Galileo Spaces

The coordinates of Galileo Spaces refer to the reference axes against which the concepts are plotted. Strange as it may seem, these coordinates are of very little direct interest to the researcher, since they are completely

arbitrary—there is an infinite number of alternative coordinate systems which would be satisfactory as well. The coordinates are constructed solely as a convenience—a mathematical device to be used in later calculations.

The coordinates chosen by the Galileo computer program are chosen so as to make the later mathematical calculations as easy as possible, and this is their sole justification. You may think of them as numbered and lettered grids on the Honolulu street map in Figure 6. You'll notice that the East-West Center lies at H-16 and Diamond Head is located at K-17. You can easily see that any other set of coordinates could serve, yet the distance from the East-West Center to Diamond Head remains the same. Another way to deal with the coordinates is to disregard them entirely. The Galileo program will make good use of them automatically, and unless your computer has no Calcomp plotter, the maps will be made automatically.

When you call for coordinates of Galileo Spaces, however, you get several other outputs which are very important. These are 1) the cleaning package, 2) the means matrix, 3) the sample size matrix, and 4) the trace.\*

The cleaning package examines the data deck to determine whether any “impossible” numbers are punched in any card. If you have, say, 15 concepts, then no matrix dimension less than one or greater than 15 is possible. Moreover, the smaller matrix dimension *always* should come first, e.g., 0102, 0613, never 1104. (What's more, there should be nothing but numbers on the card. Any letters or symbols other than numbers will cause the program to stop.) If the cleaning package finds any of these errors, it will point them out to you, as in Figure 7. Notice that on the first line, Galileo has found an illegal matrix dimension, and it points out that this was on card #14, ID number 11512014. Galileo will ignore this card from now on, and it will not use it in its calculating. The best advice, however, is to get this card, find the error by rechecking the questionnaire, and re-run the job. Remember, accuracy is the watchword of science.

Needless to say, the Galileo program cannot tell in advance whether the *data* it reads (rather than the matrix dimensions) are correct, since every respondent is free to write any number at all between 0 and 99999. While Galileo cannot tell that an answer is wrong, it is possible to say that a number is very improbably or unlikely. Thus, if most people think the difference between A and B is 43 units, it is very unlikely that an answer of 3150 is correct—perhaps it should be 150 and the 3 is a coding error. To help check

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\*In some versions of the Galileo Program, the trace is called the *sum of roots*.







FIGURE 7

A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	14	ID IS 11512014	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	28	ID IS 11506114	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	42	ID IS 11506014	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	56	ID IS 11506614	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	70	ID IS 11503314	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	84	ID IS 11509514	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	98	ID IS 11511614	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	112	ID IS 11501014	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	126	ID IS 11502114	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	140	ID IS 11502814	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	490	ID IS 11500814	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	504	ID IS 11501314	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	518	ID IS 11504314	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	532	ID IS 11510714	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	546	ID IS 11506814	ROW IS	21	COL IS	20
THE EXTREME VALUE 1500. WAS READ INTO THE MATRIX LOCATION 15 4 FROM CARD NUMBER 593								
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	560	ID IS 11507414	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	742	ID IS 11510814	ROW IS	21	COL IS	20
THE EXTREME VALUE 2000. WAS READ INTO THE MATRIX LOCATION 11 1 FROM CARD NUMBER 744								
A METRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	756	ID IS 11503414	ROW IS	21	COL IS	20
A MATRIX DIMENSION LE ZERO OR GT	15	WAS ENCOUNTERED ON CARD NUMBER	770	ID IS 11504614	ROW IS	21	COL IS	20

this, Galileo has an EXTREME VALUE option, which flags all answers above a given number which you may set at any value you wish. If you do not set a value, the default value of 1000 is used. The Galileo program will list every number it finds greater than the number you set (or greater than 1000, if you set none). In Figure 7 the program has flagged two such values.

Unlike errors in matrix dimensions, however, Galileo does not ignore numbers higher than the extreme value—it simply lists them for you, but uses them anyway. You *can* filter out all values higher than a certain value, however, by setting the MAXVAL option. MAXVAL *deletes* all numbers above the value you set. There is no default value for MAXVAL—if you don't choose it, it will not operate. MAXVAL is a useful filter, particularly if the sample size is small, since even one or two large errors can distort the result fairly badly. You will have to use your own good judgment on how to set this value, because only you will be able to estimate how large is too large for the data you have.

## 6.6 The Galileo Means Matrix

In many ways, this is the simplest, yet the most important output from Galileo, since it contains the basic information out of which the rest of the calculations come. You should spend *most* of your time examining this matrix, and you will learn a great deal from it. Remember, large distances between concepts mean the sample sees the concepts to be different, small values mean they are similar. (Zero means they are identical.) Figure 8 shows the means matrix from the Dairy Science project. Notice the farmers see themselves as very far from *computers*, but quite close to *necessary* and *useful*. They see computers as very far from *convenient*, which means they see them to be quite inconvenient for them. They see *breeding* as very close to *necessary*, which means pretty much what it says—breeding is very necessary. Notice especially that the farmers see the DHIA Test as 97.5 units from themselves—which is a very high number compared to the others. This is enough to explain why they are reluctant to adopt it, and lets us know we will have to move it closer to them to improve the adoption rate. In any event, you can see that the means matrix is very useful—and also very easy to read with a little practice. After a short while you will begin to appreciate what a wealth of useful information lies in the means matrix.

UNCLASSIFIED															UNCLASSIFIED MEANS MATRIX															SET NO. 1														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30															
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000																
270.147	245.465	426.357	272.525	200.840	230.079	265.440	125.010	151.931	147.330	201.296	229.552	130.809	225.616	267.152	251.687	243.916	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556																
231.165	229.216	201.296	229.552	130.809	225.616	267.152	251.687	243.916	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900																
151.931	147.330	201.296	229.552	130.809	225.616	267.152	251.687	243.916	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900																
195.802	183.636	375.404	242.677	130.809	225.616	267.152	251.687	243.916	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900																
162.590	133.263	194.635	265.051	225.616	267.152	251.687	243.916	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762																
243.337	236.300	256.776	265.051	225.616	267.152	251.687	243.916	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762																
320.602	246.500	270.350	306.030	267.152	251.687	243.916	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556																
250.394	243.599	257.929	317.760	251.687	243.916	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	221.762																
270.602	156.235	140.694	304.126	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900																
292.016	265.000	254.663	330.960	263.931	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900																
232.573	202.798	222.727	69.051	204.416	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762																
127.255	164.470	272.046	224.046	165.950	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556																
207.429	165.245	256.465	70.870	294.740	377.427	211.160	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	146.910	92.311	251.900	221.762	264.556	264.556																

DATASET 1						--GALILEO MEANS MATRIX						SET NO. 1	
9	10	11	12	13	14	15							
9	0.000												
10	171.674	0.000											
11	229.505	233.262	0.000										
12	147.596	114.559	318.317	0.000									
13	207.510	253.200	235.314	302.671	0.000								
14	250.767	223.750	234.207	226.032	241.942	0.000							
15	234.505	234.330	236.861	266.369	210.892	203.475	0.000						

FIGURE 8

UNPUBLISHED										--UNPUBLISHED MEANS MATRIX										SET NO. 1									

DATASET 1				--GALILEO MEANS MATRIX				SET NO.
	9	10	11	12	13	14	15	
9	0.000							
10	171.074	0.000						
11	229.505	233.202	0.000					
12	147.596	114.559	310.317	0.000				
13	207.510	253.200	235.314	302.071	0.000			
14	250.767	223.750	234.207	226.032	241.942	0.000		
15	234.505	234.330	230.061	266.369	210.692	203.475	0.000	

FIGURE 8

## 6.7 The Sample Size Matrix

While a certain number of respondents may have participated in your study—say 300—not all of them may have filled out every pair comparison. And some values may have been deleted by the cleaning package or the MAXVAL option. And if you’ve broken the sample, say into males and females, or rural and urban, you will want to know how many of each group you have. This information is conveyed in the sample size matrix (see Figure 9). It is rather self-explanatory, but if one or two cells show a much smaller or higher sample than the others, you might want to find out why.

## 6.8 The Trace

The trace (or sum of roots) is just a single number, but a useful one. Its square root tells the total distance in the map. If this number goes up over time, it means the people see the concepts growing more different—if it goes down, less different. By consulting the means matrix, you can tell which concepts are getting close to which—or further apart. Figure 10 shows where the trace (sum of roots) appears on the output with other information related to coordinates.

## 6.9 Statistics

A very useful option which may be called regardless of the operation specified (as long as the raw data are input) is Statistics. This option gives a set of basic and standard statistics for the pair comparisons. In addition to the means and sample sizes, statistics give also standard deviations, standard error of measure, indices of skewness and kurtosis, and percent relative error, along with a mean of all non-zero cells, that is, the grand mean of the means matrix. These statistics are not in any way unusual, and serve the purpose of making statistical inference about the sample possible. They are shown in Figure 11.

FIGURE 9

TWI AND TWIT COMPARED-1980

-- SAMPLE SIZE FOR EACH PAIR

SET NO. 1

	1	2	3	4	5	6	7	8
1	0.							
2	36.	0.						
3	36.	36.	0.					
4	35.	36.	36.	0.				
5	36.	36.	36.	36.	0.			
6	35.	35.	35.	36.	36.	0.		
7	36.	36.	36.	36.	36.	36.	0.	
8	36.	36.	36.	36.	36.	35.	35.	0.
9	35.	36.	37.	36.	36.	34.	35.	35.
10	36.	36.	35.	36.	36.	35.	35.	35.
11	36.	36.	36.	36.	36.	35.	35.	35.
12	36.	36.	36.	36.	36.	35.	35.	35.
13	36.	36.	36.	36.	36.	35.	35.	35.
14	36.	36.	36.	36.	36.	35.	35.	35.
15	35.	36.	36.	36.	36.	35.	35.	35.

	9	10	11	12	13	14	15
9	0.						
10	35.	0.					
11	35.	35.	0.				
12	34.	35.	35.	0.			
13	34.	35.	36.	36.	0.		
14	35.	35.	36.	36.	36.	0.	
15	35.	35.	36.	36.	36.	30.	0.

CELL WITH MAXIMUM DISTANCE IS 14 4 DISTANCE IS 19.6667

CELL WITH MINIMUM DISTANCE IS 12 11 DISTANCE IS 3.5429

FIGURE 10

## GALILEO COORDINATES

	1	2	3	4	5	6	7	8	9	10
Discussion	-21.31	-11.61	-9.90	-9.71	2.95	4.45	0.02	5.13	-3.70	7.15
Oral Presentation	-3.00	-22.14	9.13	3.67	-8.70	-3.81	0.01	1.15	8.53	4.93
Interesting	5.52	-4.96	-16.03	7.10	8.97	-8.88	-0.00	0.63	1.55	-0.30
Instructor	4.34	-7.25	18.64	-3.75	10.10	3.71	-0.01	-4.85	4.41	-3.80
Useful	0.44	0.19	-4.57	10.25	-1.67	9.00	-0.03	4.87	0.68	-12.04
Demanding	12.57	12.72	8.25	-9.12	-1.94	-5.82	-0.02	8.03	-1.00	-7.05
Science & Engineering Courses	29.51	-1.81	0.65	2.20	-1.85	3.27	0.03	-1.43	-10.07	10.84
Writing	-11.41	28.15	3.00	4.17	0.37	1.28	0.03	-0.22	6.90	11.06
Communication Courses	-22.58	2.79	7.38	3.46	-2.65	-4.29	-0.01	-5.09	-12.35	-5.18
Me	5.81	3.93	-16.55	-8.26	-5.57	1.08	-0.01	-8.22	5.05	-5.61

### Eigenvalues (Roots) of Eigenvector Matrix--

2220.00	1682.41	1212.31	462.75	314.92	273.79	-0.00	-235.31	-436.68	-582.76
---------	---------	---------	--------	--------	--------	-------	---------	---------	---------

Percentage of variance accounted for by individual factors--

45.21 34.25 24.68 9.42 6.41 5.57 0.00 4.79 8.89 11.86

Sum of Roots 4912.209\*\*\*\*\*

Warp Factor = 1.2554 \*\*\*\*\*

Number of Dimensions in Real Space 6

Number of Dimensions in Imaginary Space 4



## STATISTICS FOR TW1 AND TWIT COMPARED-1980

SET NUMBER

ROW	COL	MEAN	STAN. DEV.	STD ERR	SKEWNESS	KURTOSIS	COUNT	MIN. VAL	MAX. VAL	ERROR
1	2	12.333	9.826	1.661	1.856	4.133	36	0.0	50.0	13.5
1	3	14.500	17.953	3.035	3.384	12.513	36	0.0	100.0	20.9
1	4	8.771	7.243	1.242	0.805	0.273	35	0.0	30.0	14.2
1	5	7.000	8.734	1.476	3.296	13.590	36	0.0	50.0	21.1
1	6	11.914	10.745	1.843	1.455	2.531	35	0.0	50.0	15.5
1	7	15.000	12.944	2.188	2.485	7.777	36	0.0	70.0	14.6
1	8	5.556	5.241	0.806	1.107	0.944	36	0.0	20.0	15.0
1	9	8.771	6.415	1.100	0.466	-0.779	35	0.0	20.0	12.5
1	10	10.500	8.852	1.496	2.359	8.520	36	0.0	50.0	14.3
1	11	10.500	6.882	1.163	0.600	0.072	36	0.0	30.0	11.1
1	12	10.556	10.694	1.808	2.830	10.206	36	0.0	60.0	17.1
1	13	9.583	9.785	1.654	2.299	6.354	36	0.0	50.0	17.3
1	14	6.778	5.583	0.944	0.725	0.177	36	0.0	20.0	13.9
1	15	12.200	11.311	1.940	1.983	4.430	35	0.0	50.0	15.9
2	3	9.667	18.781	3.175	3.588	13.337	36	0.0	100.0	32.8
2	4	4.833	4.805	0.812	1.016	0.897	36	0.0	20.0	16.8
2	5	15.361	15.969	2.699	3.100	11.134	36	0.0	90.0	17.6
2	6	7.600	7.499	1.286	1.024	0.484	35	0.0	30.0	16.9
2	7	5.528	5.620	0.950	0.925	0.121	36	0.0	20.0	17.2
2	8	13.278	10.994	1.858	1.512	2.132	36	0.0	50.0	14.0
2	9	12.500	17.863	3.019	3.499	13.504	36	0.0	100.0	24.2
2	10	7.139	5.355	0.905	0.750	0.366	36	0.0	20.0	12.7
2	11	6.722	4.457	0.753	0.508	0.388	36	0.0	20.0	11.2
2	12	6.722	5.368	0.907	1.069	0.690	36	0.0	20.0	13.5
2	13	17.333	16.834	2.845	2.510	7.599	36	0.0	90.0	16.4
2	14	18.944	16.708	2.824	2.315	6.991	36	0.0	90.0	14.9
2	15	6.111	5.195	0.878	0.953	0.544	36	0.0	20.0	14.4
3	4	14.667	18.553	3.136	2.973	10.244	36	0.0	100.0	21.4
3	5	14.500	18.249	3.085	3.023	10.896	36	0.0	100.0	21.3
3	6	12.571	17.243	2.957	3.764	16.130	35	0.0	100.0	23.5
3	7	8.194	16.832	2.845	4.511	21.645	36	0.0	100.0	34.7
3	8	17.167	20.791	3.514	2.310	5.617	36	0.0	100.0	20.5
3	9	10.811	16.722	2.787	4.195	19.169	37	0.0	100.0	25.8
3	10	8.686	16.585	2.844	4.747	23.288	35	0.0	100.0	32.7
3	11	8.083	16.559	2.799	4.758	23.430	36	0.0	100.0	34.6
3	12	7.806	16.549	2.797	4.791	23.791	36	0.0	100.0	35.8
3	13	11.833	16.254	2.747	4.421	21.137	36	0.0	100.0	23.2
3	14	16.333	22.376	3.782	2.926	8.058	36	0.0	100.0	23.2
3	15	7.000	16.637	2.812	4.840	24.154	36	0.0	100.0	40.2
4	5	10.889	11.950	2.021	3.381	13.918	36	0.0	70.0	18.6
4	6	6.972	5.403	0.913	0.528	-0.226	36	0.0	20.0	13.1
4	7	10.500	7.418	1.254	0.520	-0.496	36	0.0	30.0	11.9
4	8	11.639	9.184	1.552	2.079	6.303	36	0.0	50.0	13.3
4	9	6.889	7.807	1.333	2.174	6.293	36	0.0	40.0	19.4
4	10	8.889	11.980	2.026	2.207	4.892	36	0.0	50.0	22.8
4	11	13.028	12.913	2.183	1.930	4.140	36	0.0	60.0	16.8
4	12	15.139	17.441	2.948	3.328	13.130	36	0.0	100.0	19.5
				1.995	1.417	1.926	36	0.0	50.0	13.3



## 6.10 Automatic Message Generator (AMG)

If you are using the Galileo system to help you in selling a product or in the diffusion of an innovation, the Automatic Message Generator will be an invaluable tool. To operate the Automatic Message Generator, you will have to include both the name of the product or innovation (or some word describing it) and a concept of self “me” or other “ideal point” like “the car I would buy” in the original pair comparison list. When you write the AMG program, you need only specify the start concept (the name of the innovation) and the target concept (the self-concept or ideal point) and the number of concepts you are willing to include in the final message. (“Family planning is good” is a one-pair message: “family planning is good and helpful” is a two-pair message, etc.) You may specify one, two, three, and four-pair message. Galileo is not programmed to search beyond four pair messages, since the computations rapidly become uneconomical after this number, and such complicated messages are very seldom effective anyway. Once you have done this, the Galileo Program will search through every possible combination of messages that can be made out of the words in the pair-comparison list, and list for you those that can move the start concept toward the target. Many such messages can usually be made, and some will be more effective than others. Although there are many calculations provided for those whose main interests are theoretical, the last column of the AMG output is all you need to determine which one, in practice, will turn out best for you in most cases. Notice at the top of Figure 12 the program lists the “start to target distance.” This is how far you are now from your goal. The fourth column of Figure 12 (marked TG-R) tells you how close each message can bring you to your goal under optimal conditions, and the last column tells what percent of the starting distance will remain. Zero is perfect. While in real life it is impossible to achieve this ideal point, nonetheless the message combination with the lowest number in the last column will be the most effective possible message, and how much change it will bring about depends on how much confidence they place in those who are spreading the message. These factors cannot be controlled by the Galileo, of course, but nevertheless, no other combination of messages you can make out of these words will be more effective than this one no matter who delivers it or how often. (Occasionally, some of these numbers will be negative, i.e., be preceded by minus signs. They should be ignored.)

The concepts that make up the messages can be read by their numbers

## A. M. G. 4-PAIR MESSAGE SOLUTIONS

	THETA	CORR.	ST-R	TARGET IS 3 TG-R	ST-TG TG-CAP	8.66 ST-CAP	PCT
06-09-10-13	61.8	0.472	4.25	7.64	7.63	4.09	88.19
06-09-10-15	13.0	0.974	4.55	4.35	1.95	8.44	50.18
06-09-12-13	72.0	0.309	3.02	8.24	8.24	2.68	95.19
06-09-12-15	22.1	0.926	3.63	5.47	3.26	8.02	63.14
06-09-13-15	41.4	0.751	3.62	6.40	5.72	6.50	73.95
06-10-12-13	51.8	0.619	4.32	6.88	6.80	5.36	79.46
06-10-12-15	18.4	0.949	5.38	3.94	2.73	8.22	45.48
06-10-13-15	34.3	0.826	5.40	5.19	4.88	7.15	59.91
06-10-14-15	63.7	0.443	4.57	7.80	7.76	3.84	90.04
06-12-13-15	43.9	0.721	4.70	6.19	6.00	6.24	71.54
06-12-14-15	75.5	0.250	3.82	8.55	8.38	2.17	98.70
07-08-09-15	108.9	-0.324	-2.33	7.52	8.19	-2.81	86.81
07-08-10-12	72.0	0.309	2.29	8.24	8.24	2.68	95.21
07-08-10-15	50.5	0.637	3.92	6.87	6.68	5.51	79.29
07-08-13-15	66.0	0.407	1.91	8.07	7.91	3.53	93.22
07-09-10-12	35.4	0.815	3.13	6.37	5.01	7.06	73.60
07-09-10-13	56.2	0.557	3.42	7.33	7.19	4.82	84.64
07-09-10-15	6.6	0.993	4.36	4.35	0.99	8.60	50.27
07-09-12-13	39.0	0.778	1.07	7.86	5.45	6.73	90.73
07-09-14-15	79.7	0.180	1.03	8.53	8.52	1.55	98.56
07-10-12-13	45.4	0.702	3.67	6.62	6.17	6.08	76.50
07-10-12-15	20.1	0.939	5.33	4.09	2.98	8.13	47.21
07-10-13-15	26.3	0.896	4.86	4.81	3.84	7.76	55.56
07-10-14-15	62.4	0.464	4.15	7.67	7.67	4.02	88.61
07-12-13-15	31.8	0.850	3.87	5.74	4.56	7.36	66.34
07-12-14-15	73.7	0.280	3.05	8.34	8.31	2.42	96.28
09-10-12-15	51.7	0.619	4.03	6.93	6.80	5.36	80.02
09-10-13-15	67.7	0.380	4.86	8.16	8.01	3.29	94.28
10-12-13-15	58.9	0.517	4.87	7.43	7.41	4.47	85.75

\* THE BEST MESSAGE IS UNDERLINED

FIGURE 12

in column one of Figure 12. Thus, the most effective message on this page says that the product is a conservative, reliable innovation.

Although the terminology of the AMG makes one think of messages, this need not be the case. One should not think of the AMG as a device to help you bombard your population with messages: it is a device to help you population bombard *you* with messages so that you can understand what they think of your innovation. If the ideal message says that the innovation is short and light, this means that the population thinks the innovation is too long and heavy now. If it is at all possible, you should try to shorten and lighten the innovation. Trying to persuade the audience that the innovation is short and light when they know it is long and heavy is a waste of your money and their time, and in the end will only result in the loss of your credibility to the population.

## 6.11 A Legal Note

The Automatic Message Generator, like the rest of the Galileo System, is a privately owned program and although the owners have granted completely free access and use of the Galileo to any legitimate scientific or educational institution, commercial, government, and private use of the system is strictly controlled. If you wish to use this system for private, government, or commercial purposes, you should contact a representative of the Galileo Owners Group listed on the front of the program or in Appendix 2. The commercial royalties for the use of the program are not expensive, and it is these royalties alone that make free scientific use of program possible.

## 6.12 Comparison of Spaces

When you have several samples you wish to compare, or when you have several time periods and want to see the development of the process over time, then you will need to make use of the Comparison of Spaces operation. Galileo allows you to make two types of comparison: static and dynamic.

*Static comparisons:* Static comparisons are comparisons among several groups when time is not involved. You may wish to compare the differences between men and women, for example, or residents of different villages or countries. These are static comparisons. In this case, you should choose one

of the groups as a standard of comparison. Usually, the total sample can serve as a good standard. In this case you will need to make a copy of your data deck, since you will need one copy for the total sample and a subdeck for each subgroup within the sample. The group which is meant to serve as a standard of comparison is called the MAINSPACE and it must be named on the *MANSPACE* specification card read into the Galileo. Every sample deck that follows will be compared to this main space. All the calculations you will find in the Galileo printout will refer to differences between the subspaces and this main space.

Galileo will now provide a complete output for each of the samples entered, and in addition will give two more valuable statistics. The first of these is the distance each concept has “moved” and the second is the “average motion” of all the concepts. Figure 13 gives an example of these two statistics. Notice it shows that Concept 1 (women’s movement) has “moved” 32.274 Galileos from time one to time two. What this means is that the distance between the location of concept one in the second sample is 35.274 units from the location of the same concept in the mainspace. You may interpret this as the amount of difference in meaning in this concept between the mainspace and the first sample. Be careful, though, since the number refers only to the difference in meaning relative to the other words or concepts in the pair comparisons list, and does not take into consideration meanings the word may have in other contexts. Also, the number is calibrated in the same units as the criterion pair. This means that, if the criterion pair was set at 100 units apart, then the phrase “concept one moved 31 Galileos” means that the difference in meaning between concept one as the mainspace group defines it and as the subgroup defines it is 31% of the difference in meaning between the words in the criterion pair.

The second statistic of interest is the “mean distance moved” at the bottom of Figure 13. This means that the average difference in meaning between the two groups is 42.383 units across all the concepts.

Since all comparisons are made between each group and the MAINSPACE, if you want to find the difference between any two groups, you will have to use one of them as the mainspace. This may mean running the program several times to make all the comparisons you want. This, by the way, is one of the reasons there is a GALILEO MEANS option in the program, which we have not discussed in this book. You may want to have the program punch out means for each subsample so that you do not have to recalculate the means each time you run the program when you are making multiple comparisons.

FIGURE 13

DISTANCES MOVED IN THE INTERVAL BETWEEN TIME 1 AND TIME 2			
REAL	IMAGINARY	RIEMANN	
2.053	4.214	-2.407	
2.378	5.656	-1.407	
2.021	4.085	3.634	
1.768	3.128	3.457	
1.594	2.540	3.971	
1.967	3.870	0.292	
1.949	3.800	3.541	
1.643	2.698	3.499	
1.698	2.883	-0.820	
1.224	1.499	1.390	
1.344	1.807	2.848	
1.822	3.318	-1.103	
1.787	3.195	1.092	
2.034	4.137	1.776	
1.418	2.011	4.741	
MEAN 1.780	3.256	1.634	

## ROW VECTOR CORRELATIONS BETWEEN TIME 1 AND TIME 2

CONCEPT	1 MAGNITUDE	T 2 MAGNITUDE	SCALAR PRODUCT	CORRELATION	ANGLE
1	7.08	8.20	61.54	1.060649	*****
2	7.89	7.37	59.25	1.019409	*****
3	8.92	8.39	68.38	0.913664	24.0
4	8.78	7.72	62.36	0.920123	23.1
5	7.78	7.73	52.26	0.868952	29.7
6	8.64	9.23	79.82	1.001655	*****
7	8.27	10.11	78.97	0.945224	19.1
8	8.58	7.97	62.47	0.913215	24.0
9	5.05	6.66	35.30	1.048337	*****
10	1.61	0.90	0.74	0.507213	59.5
11	3.76	2.77	6.86	0.658190	48.8
12	4.40	3.39	16.03	1.075458	*****
13	8.14	7.91	63.82	0.991126	7.6
14	10.19	9.46	95.10	0.986359	9.5
15	7.20	7.37	41.84	0.788429	38.0

This option is not essential—it is useful to save computing costs in complicated problems and multiple comparisons.

*Time Series Comparisons.* When you have collected data on separate samples arrayed across time, you will be able to show how cognitive or cultural processes are unfolding over time. In this case you do not need to specify a MAINSPACE, but simply enter your samples into the program in their proper temporal order, starting with the first and ending with the last. Such a series is shown in Figure 14. Galileo will then compare each space immediately before it in the series. The result will be a set of “snapshots” of the process, each one made a certain time after the last. This string of snapshots may be assembled to produce a “movie” of the overall process. The movie will be smooth and stable to the extent that the sample sizes in each snapshot are large and the time intervals between the snapshots are small. Of course, the more snapshots you make, the longer the movie will be. While we are speaking metaphorically, it is literally possible to turn your Galileo outputs into a genuine moving picture by photographing each Galileo plot on a frame of movie film and running them through a movie projector. You can make the movie as smooth and precisely detailed as you wish, but you should remember that even a very poor movie made in Hollywood for entertainment can easily cost five or ten million dollars, and to expect to make detailed movies of complex social processes for a few hundred or even a few thousand dollars is extremely unrealistic. If you are one of the fortunate few who have access to large sums of money, it is worth pointing out that the first detailed, precise movie of reasonable length of some important social process will be a landmark scientific achievement that will be remembered for a long time, and almost any of the scientists listed under HELP in Appendix 2 would be eager to help produce such a movie.

## 6.13 Plots

In the meantime, with a small budget you will be limited to a few frames which must be compared one to another in the same way as the static comparisons of the last section were made. The same statistics will be produced by the program for dynamic analyses as for static comparisons, but now the concepts are all plotted on the same plot with lines drawn to show the movements of the concepts over time. (If seldom makes sense to use the dynamic

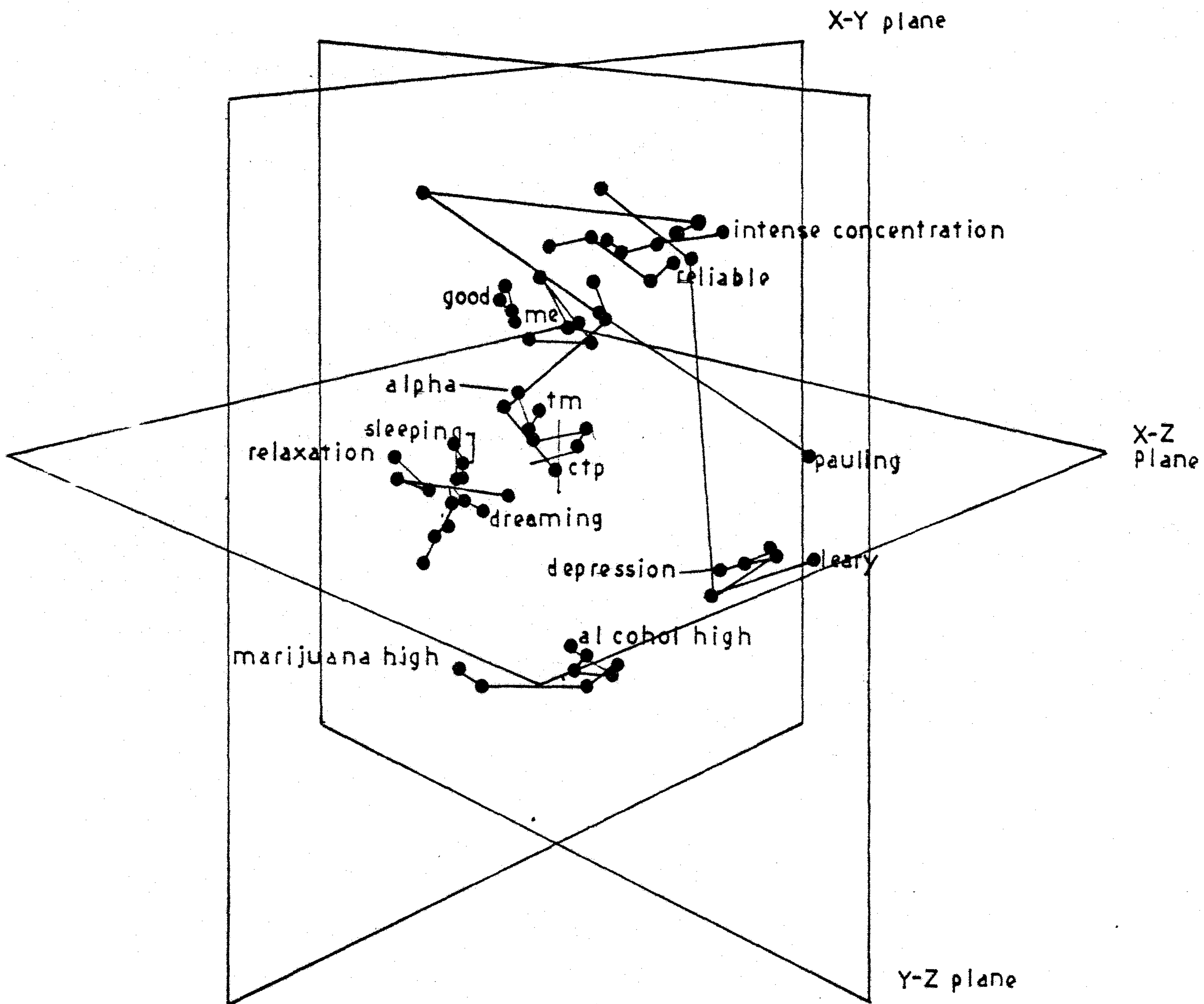


FIGURE 14

plots with static comparisons although this is possible.) Figure 15 shows a static plot of a set of adjectives used to describe men and women as it was seen by a sample of university students. Figure 16 shows the same domain as it was viewed by a sample of men, while 17 shows it as viewed by only the women in the sample. You might copy each of these spaces onto transparencies and project them on top of each other, or plot them in different colors as a device to show the similarities and differences in a graphic way. Figure 14 shows a dynamic plot of an experiment over four points in time showing the way concepts moved across the four periods of time. The numbers of the concepts always occur at the first time period.

Figure 15, 16 and 17 are only pictures of the first two dimensions of the spaces they represent, where Figure 14 represents a projection of the first three dimensions of its space. Neither of these representations is a satisfactory representation of the spaces they describe, since all these spaces are multidimensional, i.e., they have more than two and even more than three dimensions. It is impossible for any scaling program, even Galileo, to represent a multidimensional space completely on a two-dimensional sheet of paper, and you should always remember that the plots are only helpful aids—never a complete or accurate representation of what is actually happening. Properly used, the plots serve as a source of intuition and good ideas, but these intuitions must always be checked against the means matrix. Just as a photograph of a room can often make objects look close together when they are really far apart, the plots can have the same trouble. You should use the plots to get a good idea of the overall shape of the space, but you should never make important decisions based on the plots alone. It is especially unwise to base message strategies on examinations of plots, no matter how carefully, even though it is frequently done commercially. While the chances are good that everything will work out alright, there is a small chance of a truly disastrous error, and such costly errors have been made even by large companies and distinguished market research firms. There is no need to take this kind of risk, since the message generator is not subject to this kind of error. While people may have difficulties holding a multidimensional picture in mind, the computer has no such trouble. The AMG considers all the dimensions—even the ones we can't see—when it makes its calculations.



FIGURE 15  
SALTIEL SEX GALILEO (ALL)  
N = 110-120

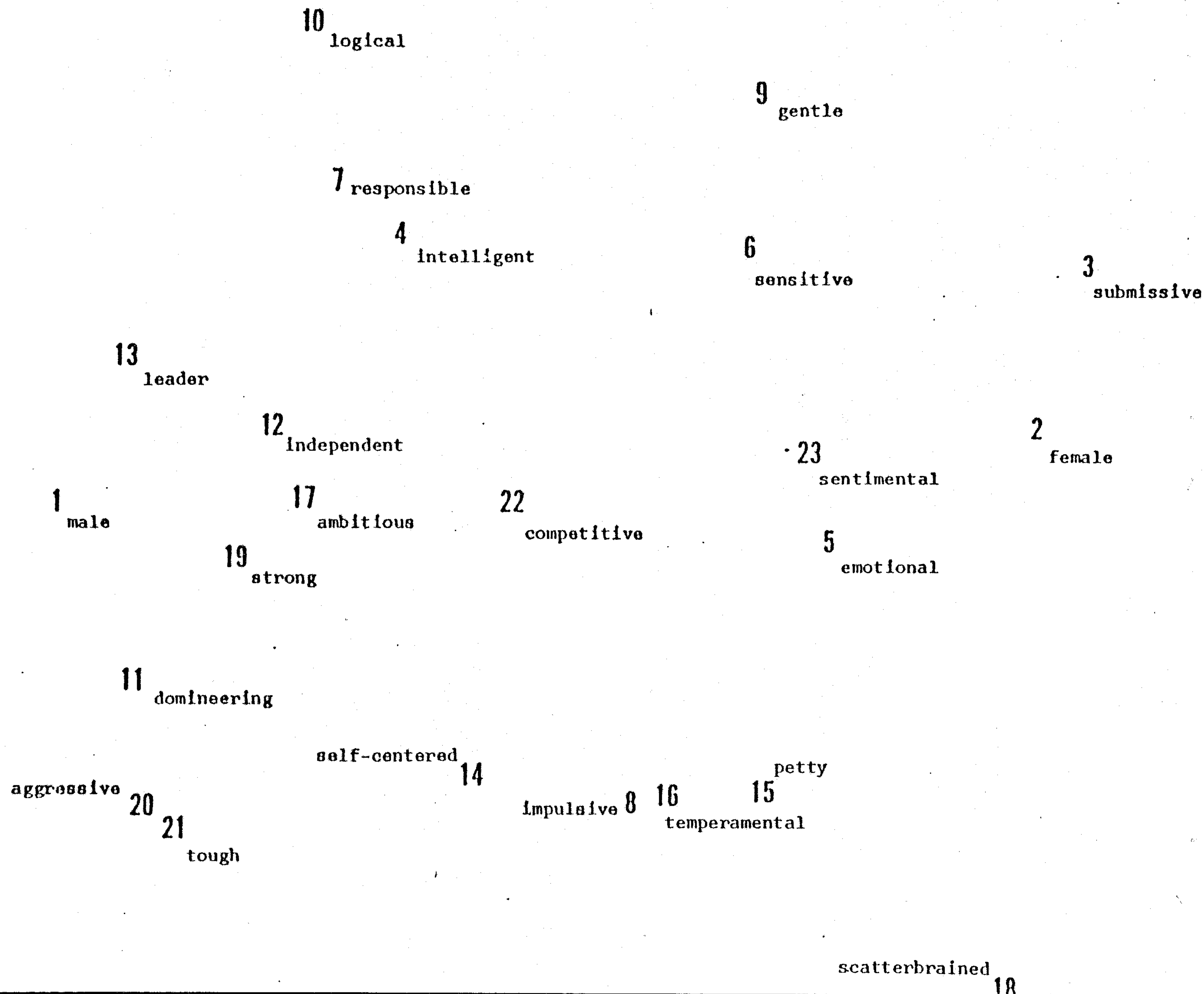


FIGURE 16

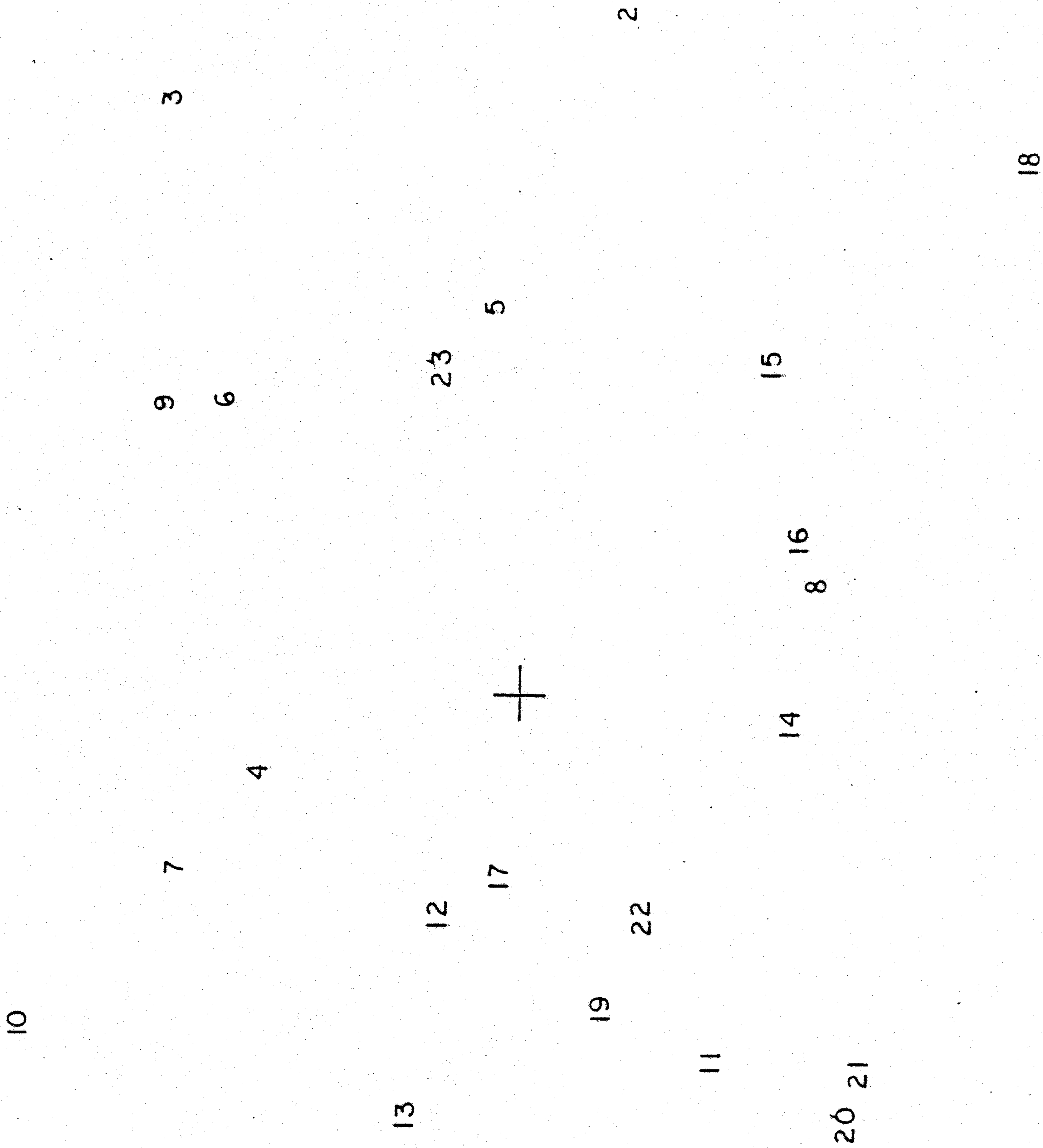


FIGURE 17



## 6.14 Epilogue

The procedures outlined above will give a basic introduction to the Galileo for one who has no previous working acquaintance with the program itself. Even though it is meant as a simple introduction, and even though Galileo is one of the simplest of the prepackaged computer programs to learn, and certainly the easiest of the multidimensional scaling programs, learning to use any computer program is always difficult for a first-time user, and you should expect to put in some study time before succeeding. Moreover, the job of programming a computer—even for the finest of programmers—is always a trial and error (or iterative, as computer people say) process. And it is first and foremost a communication process. At first, you and the computer will not understand each other. Since the computer, regardless of its enormous speed and accuracy, is very dull-witted compared to the average human being, it has virtually no tolerance for error, and will not tolerate the slightest variation in the way it expects you to speak to it. Each time you submit your job the computer will detect another error or two until (finally) they will all be gone and the job will run. This is always a happy moment, even though you are bound to find still more errors in the output that need correction. Do not be discouraged at this, since it is entirely to be expected, and exasperation is a basic emotion for computer workers. Don't be afraid to seek help from your computer consultants, which almost every computer center provides, but remember that in the end it will be you and not they who will make your Galileo run.

The same is true at all stages of the analysis, although if you have done empirical or survey work before you should have no special difficulties with the rest of the Galileo procedures—generally Galileo research is somewhat easier than conventional research, since it is so heavily standardized.

In any event, after a little practice, you will begin to find this book very limited and restricting, since there will be many things you have thought of that might be done with a Galileo that have not been described in this book. In fact, the flexibility of the Galileo computer program is far beyond what has been hinted at in this book. You can find out a great deal about what is possible by reading the program documentation in Appendix 1 carefully, and a great deal of truly sophisticated applications of the Galileo procedures can be found in the bibliography at the end of this book. But it is always true that the most sophisticated and ingenious uses of the program are the ones that haven't been done yet, and you will surely be able to think of ways to

use the Galileo that have not been thought of before. By all means, try them out. If you find difficulty or problems don't be afraid to contact one of the Galileo researchers listed under HELP in Appendix 2 of this book, or even to contact GODI, Inc. They are always interested in applications of the Galileo procedures, and may even volunteer to work with you if your problem strikes their interest. And if they are themselves occupied with other research at the time, you can always get one of the commercial firms listed under HELP to do any part of the work for you for a fee. Commercial firms do Galileo research for prices similar to more conventional market research, and it is well worth the money.

## APPENDIX 2

### HELP!

Galileo Opinion Dynamics International  
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This bibliography was prepared for distribution and presentation at the third annual workshop on metric multidimensional scaling at the International Communication Association annual convention, Acapulco, Mexico, May 17-24, 1980. The references cited herein were compiled from the following sources: the vitae of Joseph Woelfel, George A. Barnett and Michael Cody; conversations with numerous listed authors, in particular James Dinkelacker and N.J. Stoyanoff; materials from my personal files; and from an earlier bibliography by Kim B. Serota dated April 25, 1978. This bibliography contains only Galileo materials not those references which use similar procedures or describe related materials. These are cited in the bibliographies of the individual manuscripts cited in this document. I tried to cite each reference only once and in cases where the document was both a presented convention paper and a published article, both citations are listed. If there are any errors, omissions or new references to be corrected or added please send them to the address presented above.