STUDYING THE STRUCTURE OF EMOTIONAL PROCESSES: PROCEDURES FOR ANALYSIS OF DYNAMIC COGNITIVE PROCESSES

by

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ABSTRACT

This dissertation proposes to describe research procedures and software to investigate the structure of cognitive processes over time. Since prior research has established that cognitive processes are multidimensional, two programs from the Galileo system, ELQM and SPED were modified to allow efficient collection of time series multidimensional data. In this dissertation we provide test data from the emotions domain.

Dissimilarities between 6 emotion concepts, 6 emotion attribute concepts, 3 social settings concepts, and a concept of self are measured in a Galileo space over time. In this space, attributes which seem to be similar are located close to each other, and objects which possess similar attributes are located close to each other. The final dataset collected is separated into several subsets according to the time interval participants spent on the comparisons between each pair of concepts. The dissimilarities data is then converted to coordinates data for each subset and these coordinates are rotated to fit a universal reference frame. How emotions change over time can be studied by comparing the change between different datasets.

1 INTRODUCTION

Cognitive structures such as attitudes, beliefs, emotions and the like are well known to be multidimensional (Barnett & Woelfel, 1979; Woelfel & Fink, 1980; Woelfel et. al., 1988; Vishwanath & Chen, 2006). Cognitive processes, such as attitude and belief change, and the rise and fall of particular emotions, are changes in cognitive structures over time. Although it has been traditional to investigate cognitive processes as unidimensional processes, this can lead to difficulties. Attitude change studies, for example, typically measure change in attitudes or beliefs along a unidimensional scale (e.g., how many paratroopers appear in a photograph, how many hours of sleep are needed each night, or how long a prison sentence ought to be, Stover, 1958; Roberts & Laughlin, 1996; Mellenbergh, 1994).

When additional variables are introduced, such as the level of credibility of the source of a persuasive message, the dimensionality of the configuration of multiple message sources becomes relevant (see Figure 1.1 and Figure 1.2 for details, figures sources from Foldy & Woelfel, 1990).

Analysis of processes in multiple dimensions requires special procedures, and this dissertation will present new procedures to make such analyses easier if not easy. Human emotion is selected as an example to demonstrate these procedures. The reason why human emotion is

Figure 1.1: Treatment 1: Low Force Mean Distances

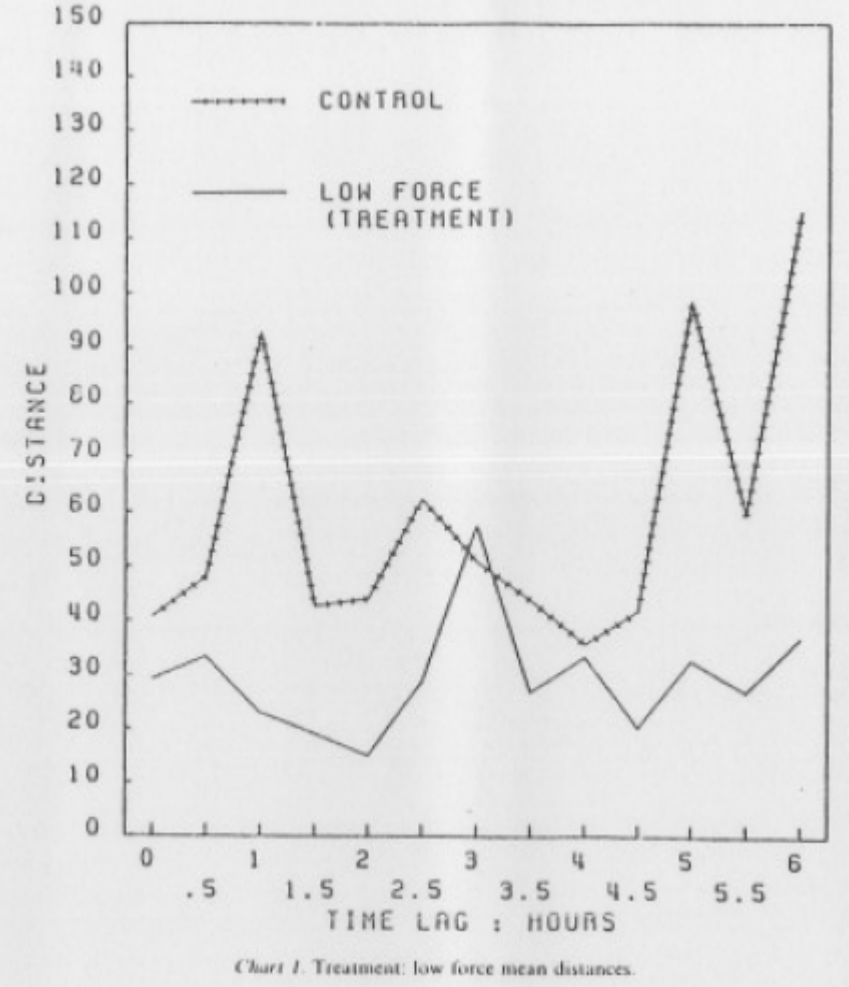


Chart 1. Treatment: low force mean distances.

Figure 1.2: Treatment 2: High Force Mean Distances

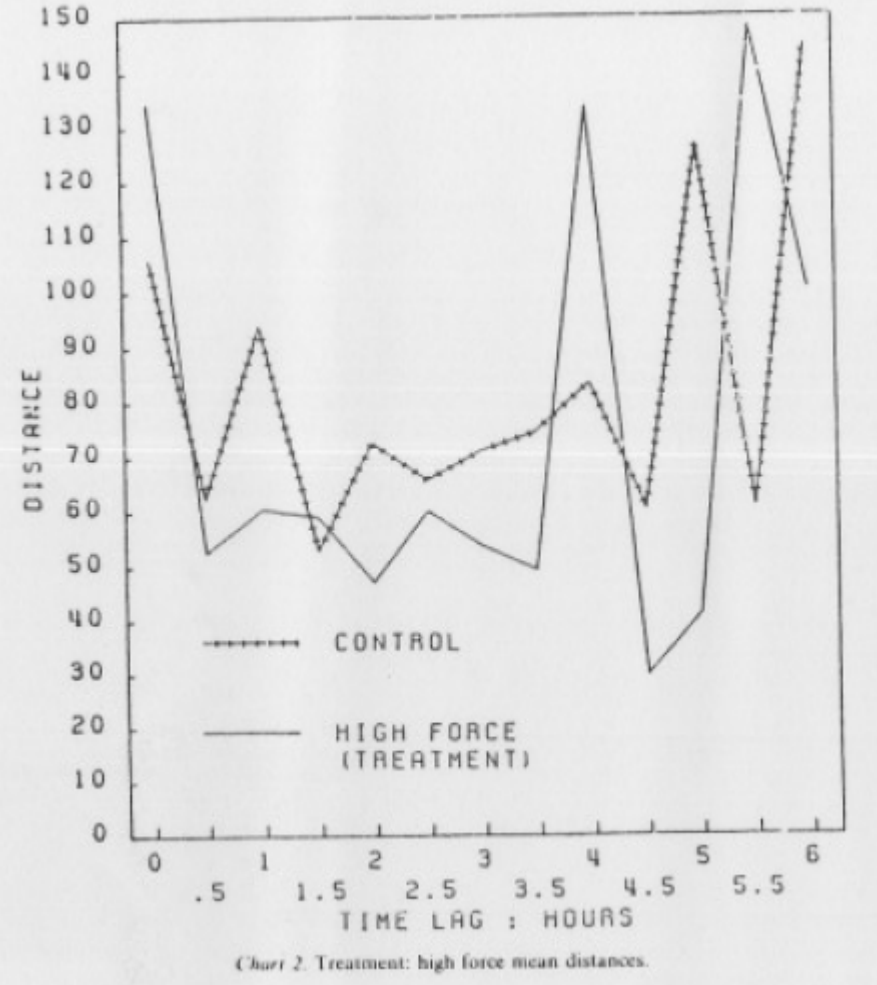


Chart 2. Treatment: high force mean distances.

selective and why it is a valid choice for testing the procedures are discussed in the following section.

2 THEORETICAL FOUNDATIONS

2.1 Cognitive Dynamics

In the study of mind, more and more attentions are paid to connectionism, neural networks, parallel distributed processing, and multidimensional scaling models (Read, Vanman, & Miller, 1997; Dinauer & Fink, 2005). As pointed out by Read et al. (1997), "there are remarkable parallels between key aspects of connectionist models and Gestalt principles—those principles that guided many of the founders of modern social psychology" (pp. 26). Gestalt psychology is a theoretical approach to understand the operation of the brain as a holistic and self-organizing process.

In German, *Gestalt* means "shape"; hence, in plain English, the theory means the whole is different from the sum of its parts. One of the founders of Gestalt Psychology, Max Wertheimer, in *Gestalt Theory*, stated that "there are wholes, the behavior of which is not determined by that of their individual elements, but where the part-processes are themselves determined by the intrinsic nature of the whole" (Wertheimer, 1944, p. 4, reprinted from Social Research, 11(1), February 1944). Read et al. (1997) considered that individual social behaviors do not have a clear meaning if they are separated from the context they are in. Instead, they can only be understood when "integrated with a range of other information, such as other behaviors, the situation, the individual's personality, and

so forth" (Read et al., 1997, p. 27). Hence, "Gestalt processes provided a mechanism by which multiple interacting pieces of information could be integrated within the narrow time frame of social interaction" (Read et al., 1997, p. 27)

Previously, Gestalt theory was regarded as too metaphorical to be implemented in empirical studies until the recent applications of connectionism, neural networks, and multidimensional scaling models in studying social interaction. Apprarently inspired by the knowledge about how brain works, these models construct thought as a network of cognitive concepts where the linkages between these concepts explain how they are connceted. In reality, how one thought leads to another might be explained by such model. When the brain processes a set of concepts (the concept is the basic unit in such system, and a thought consists of several such basic units), the pyschological force is passed through the links to related concepts which causes the formation of another thought.

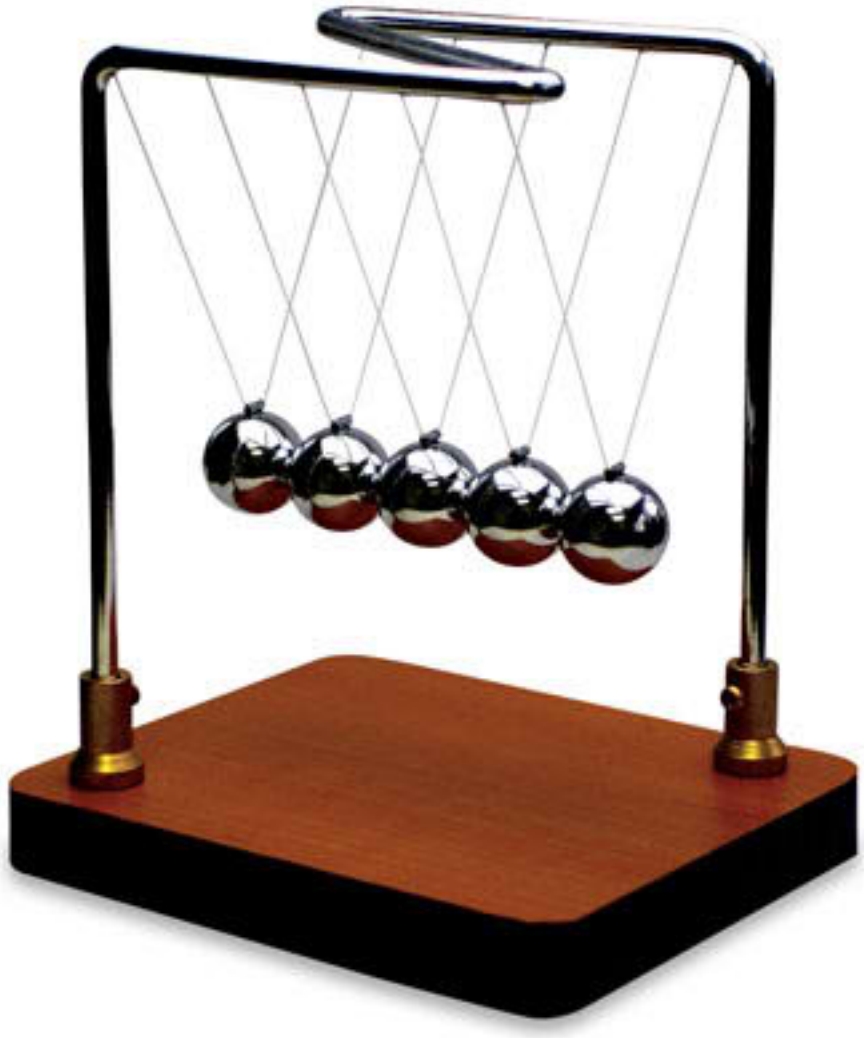
Guided by this approach, associated cognitive concepts are regarded as inter-connecting nodes in a network. The links between these nodes represent the relations between them. The interactions between these nodes could be understood as psychological forces being exchanged betweent the passages created by the links. Such system is not a static one. The structure of a network (including the nodes and the links connecting them) explains how things are connected and related at a

certain time. The holistic structure at the time is the "snapshot" of the structure of the system. Because the nodes keep exchanging forces between them, the connections between the nodes keep changing. As a result, the state of the system changes over time. All the aforementioned models emphasize such "dynamic" characteristics. As described by Read et al. (1997), in such systems, "opposing forces create tensions, which in turn cause change to occur so as to reach some end-state" (p. 36). Several terms, such as *balance*, *consistency*, *equilibrium*, and *harmony*, refer to the preferred state of a dynamical system in which the degree of tension is at a minimum (Read et al., 1997).

2.2 Dynamics of Attitude Change

Dinauer and Fink (2005) posited that "theories of attitude change have failed to identify the architecture of interattitudinal structures and relate it to attitude change" (p. 1). Traditional attitude change theories seem to overlook the organization or structure of related attitudes. Using an analogy of the Newtonian demonstrator (see Figure 2.1), Dinauer and Fink (2005) stated that the change of concept #1 caused by some persuasive message could induce changes in concepts linked to concept #1, even if the link might be indirect to the message (In the example of the Newtonian demonstrator, moving a ball at one end will cause the ball at the other end to move while the intermediate balls remain still).

Figure 2.1: A Newtonian Demonstrator



In their study, Dinauer and Fink (2005) examined and tested two interattitudinal structures: a hierarchical model and a spatial-linkage model. They found out that the spatial-linkage model can explain the attitude dynamics better than the hierarchical model, because the spatial-linkage model is more flexible (Woelfel and Fink's (1980) model posited that all linked concepts, regardless of hierarchical position, can and do affect each other) and provides stronger supports for mathematical analyses. According to Dinauer and Fink (2005), such a model is remarkably similar to a spreading activation model proposed in recent connectionist approaches to interattitude structure. In the spreading activation model, "positive and negative relationships between attitude concepts move from one concept to the next through a network of related concepts" (Dinauer & Fink, 2005, p. 26).

This spatial-linkage model can be applied to study the dynamics of the cognitive system of human beings, such as the changes of attitudes, beliefs, and decisions over time. Fink et al. (Oscillation in Beliefs and Decisions) believe decisions come about after vacillation, wavering, or oscillation. Traditionally, attitude and decision research focus on the outcome of the process rather than the process and its dynamics. As pointed out by Fink et al. (2002), this variable is typically measured only once after an experiment treatment. If the time course is not long enough for a participant to reach to the final decision, the outcome measured could be an intermediate product created by the oscillation which could

be very different from the final decision. Fink et al. (2002) suggested "*systematic* change, in the form of oscillation, can be mistaken for the *random* disturbances in a measurement, which we usually think of as unreliability" (p. 18). If this is overlooked, the reliability of this kind of measurement appears to be lower than expected and the analysis carried out from the construct of the outcome variable might be problematic. To rectify this, Fink et al. (2002) suggested that finding out the time parameters of such oscillations could tell the researchers how long they should wait for the attitude to reach equilibrium or "settle down".

2.3 The Galileo System

The Galileo System is a system built on a set of mathematical procedures for generating the eigenfunctions of cognitive processes in a multidimensional Riemann space. The Galileo System represents the differences between cognitive concepts as psychological distances in a coordinate system. The more similar or closely related two concepts are, the less the psychological distance between them (Woelfel & Fink, 1980; see also Abelson, 1967; Kruskal & Wish, 1978; Torgerson, 1958).

The system uses a data collection mechanism called "pair comparisons" to measure the inter-cognitive-concept distances. According to Woelfel and Fink (1980), "The logic of the method of pair comparisons is very simple: for any n concepts it is only necessary to form the $n(n-1)/2$

nonredundant pairs and estimate the magnitude to difference between each pair on some numerical scale" (p. 45, see Appendix B and C for example). After the data is collected in this way, a mean matrix of the inter-cognitive-concept distances can be yielded. After generating the eigenvectors from this mean matrix, each concept can be represented by a vetor of coordinates in a multidimensional space. On the other hand, this space constructs a reference frame for all the concepts located inside it. As pointed out by Dinauer and Fink (2005), "The space becomes a model of the cognitorium of the individual who generated it" (p. 7).

According to Dinauer and Fink (2005), attitude change is represented by the movement of the concepts in the multidimensional space. If a time series of data about the attitude changes can be obtained (discussed in detail in the following section), the distribution of the change over time can be studied with the aid of a multidimensional coordiante system.

Rooted in the constructivist view, Woelfel and Fink (1980) uses the Galileo system to conceptualize communication (which is the cause of dynamic changes of attitudes) as a thermodynamic process (Fink & Chen, 1995). Fink and Chen (1995) stated two conditions must be met for viewing communication as a thermodynamic process: First, the concepts must be connected by a link; Second, there must exist a difference in potential between the individuals' cognitive structures. As Woelfel and Fink (1980) put it, "The Channel or link offers the opportunity for communication, while the difference in potential provides the motivation

or force" (p. 184). In the Galileo system, the links are depicted as the psychological distances between the cognitive concepts. The force, usually in the format of message, causes the difference between cognitive systems, and as a result, the distances between concepts are changed accordinally. In other words, the interattitudinal structure is changed because the force introduced into the system. In reality, humans keep processing all kinds of messages which in turn change the attitudes to the related concepts. As a result, humans maintain a dynamic attitudinal system of the cognitive concepts. It is a distinct characteristics of the human cognitive system, and it is important to capture this characteristics when studying the change of attitudes.

2.4 Emotion as a multidimensional cognitive process

Emotion, as defined in Merriam-Webster's Collegiate Dictionary, is either "a state of feeling" or "a psychic and physical reaction (as anger or fear) subjectively experienced as strong feeling and physiologically involving changes that prepare the body for immediate vigorous action" (Webster, 1999). This definition represents two groups of theories in studying emotions in the field of sociology and psychology.

The first group of theory views emotion as a state of feeling which means emotions are discrete, fundamentally different entities. This

thought captures our intuition to use different words for describing different emotional feelings. In this view, different emotions can be put into different categories. According to Smith and Ellsworth (1985), this idea that "there is a small set of fundamentally different emotions, has a long and illustrious history in science as well, dating back at least to Aristotle and reemerging in the theory of the four humors, in the works of eighteenth-century philosophers, and in Darwin (1872/1965)" (pp. 813). This categorical approach has become popular in psychology in recent years, fostered by the work of Tomkins, Ekman, and Izard (Smith and Ellsworth, 1985). It successfully describes the fact that no matter what culture is under consideration, people share a consistent set of concepts for describing their basic emotional feelings; these basic emotions are fundamentally different and can be recognized easily.

In this first theoretical group, there are two different methodological paradigms, dimensionality and classification (Mano, 1991). Mano asserts some emotions are more similar than others (contrast, for example, joy and satisfaction versus joy and boredom). For example, some emotions are less arousing than others, such as bored, calm, sleepy, etc; some emotions are defined as negative emotions, such as sad, unhappy, distressed, etc. The dimensionality approach suggests that they differ in their intensity on certain dimensions of emotions, and the classification approach suggests that they belong to different categories of emotions.

In the dimensionality approach most researchers found two dimen-

sions consistently, namely, pleasantness and arousal (Abelson and Sermat, 1962). Some researchers suggested an additional dimension, such as Osgood (1966) and Russell and Mehrabian (1977) who found a control dimension or Scholosberg (1954) who found a sleep-tension dimension. The circumplex model (Russell, 1980) is a circular structure of emotions on such approach. Emotions are describes as points on a circumplex (hence, the space is a two-dimensional one) determined by Pleasantness and Arousal (Mano, 1991). Often, multidimensional scaling (MDS) is applied to reveal the primary underlying spatial dimensions of emotions (Russell, 1980; Mano, 1991). The shortcoming of such approach is although the MDS method applied has measured all the inter-point distances between different emotions, the solution has been reduced to primary dimensions (a subset of total dimensions; normally only two to three dimensions). The real distances between emotions are then projected to these primary dimensions. In other words, the differences between emotions have been explained only with their different intensities on limited dimensions (such as only two dimensions of Pleasantness and Arousal in the circumplex model). As compared to this approach, it is believed by the author that all dimensional loadings should be taken into account because there is no sufficient literature to support disregarding those not-so-prominent dimensions.

The classification approach, on the other hand, focuses on the development of comprehensive typologies of emotions (e.g., Clore, Ortony and

Foss, 1987; Scherer, 1984; Barta and Holbrook, 1990). It challenges the dimensionality approach by pointing out that those dimensions found in dimensionality studies are rather general and they are not particularly informative (Clore, Ortony and Foss, 1987). Instead, a classification scheme is used to identify those psychological states that need to be accounted for in theories of emotion (Clore, Ortony and Foss, 1987). The analyses are based on factor or cluster analytic methods which aim at classifying emotions by assigning them into different groups or clusters. The shortcoming of the classification approach is that emotions cannot be represented by spatially contiguous regions. The differences between emotions in the same categories are hard to find in such a paradigm.

The other group of theorists views emotions as a set of reactions to stimuli people construct according to their previous experiences. Such experiences are influenced by culture and education. These theorists believe that when a person becomes emotional, he or she becomes responsive to the stimulus related to his or her emotional feeling. All of the dimensions might be appraised by the human mind at the same time. Then the human body will try to respond to the stimuli. For example, when a person is becoming angry, his pupils enlarge, blood pressure gets up, breath becomes heavy, and etc. In this view, there are no ultimately different emotions, but rather, emotional concepts are constructed with experiences related to emotional stimuli. Once experienced, responses to certain emotional stimuli are memorized by

a human's mind and act as a reference when similar combinations of stimuli are presented in the future. The emotional concepts are thus actually defined by such experiences. This helps to explain why different people react differently to seemingly identical settings involving similar combinations of emotional stimuli. That is because they have different experiences with the stimuli. For example, imagine in a social gathering that most people laughed at watching an episode of the "slapstick" style (which involves exaggerated physical violence or activities) comedy—"Three Stooges", but one person did not laugh. Perhaps he happened to be a relative of one of the "Stooges" (say, Moe Howard) and he saw Howard got hurt when shooting this episode. That sad memory came back when he saw this episode on TV. This illustrates how differences in experience lead to different reactions of the same setting and then lead to different emotional feelings. Another example is some people are very afraid of snakes, but some people regard snakes as their friends or pets.

This stimulus view and the categorical view can be reconciled if stimuli are measured as concepts together with emotional entities. If this combined view can be represented spatially, dimensionalities can be translated into stimuli. The intensity of an emotional concept in a dimension can be interpreted as how close the concept is to either end of the dimension. For example, valence studies aim at measuring the positive-negative dimension. In the stimulus view, this is equivalent to

measuring how close an emotional concept is to two stimuli—*positive* and *negative*. If the concept (for example, joy), is close to *positive* and far from *negative*, that indicates joy is more a positive emotion than a negative one. Furthermore, classification can be achieved by seeing how emotional concepts are clustered or grouped to each other.

A Galileo space can integrate these disparate views in its spatial modeling mechanism. As discussed before, it 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" (Woelfel et al., 1986). Woelfel et al. stated, "Concepts or objects are assumed to be defined by their dissimilarity relations with the members of a set of 'nearby' objects" and "together, these objects comprise a 'domain' or 'neighborhood'" (1986). In such space, a concept by itself is a node without any attribute. Its attributes are represented by its comparisons to other concepts. Using the same example above, if the emotional concept of joy is close to the concept *positive* and far from the concept *negative*, it means joy is a positive emotion. The close proximity between joy and positive indicates the emotion has a higher intensity on the positive-negative dimension.

2.5 Missing Variable of Time

Time is an important variable missing from both groups of theories. Most studies only consider the structure of emotions at a certain moment and fail to address the change of emotions over time. Subjects are usually perceived to be in some specifically induced emotional state. How emotional feelings change from one state to another is not explained in these studies. By integrating time into the stimulus view, how human beings process different sources of stimuli and react differently to them can be better explained. Using thermodynamics as an analogy, human beings might maintain their emotions in a manner similar to that of a thermodynamic system. The second law of thermodynamics states that "a physical system cannot be stable if it is not in equilibrium," and therefore it will keep on changing until it reaches the equilibrium state (Kincaid et al., 1983). This same principle can potentially be applied to understand the emotional system. For example, human beings strive for reaching to such *equilibrium state* in certain situations, such as being focus on the jobs for better productivity when working or studying, such as being calm when doing meditation, etc. This system, however, is not a closed system. Human beings will receive an immense amount of diverse information each day. (some information will give you an emotional cue and it might change your emotional state) Some of the information is stimulus related to emotions. In other words, people

might become emotional when some emotional stimuli are presented. It is like an information system starts to process the new information and decides the follow-up actions. More information, more apparent the changes are for the system. The time variable can be measured by how long the subject is exposed to the message (stimulus information). Then how the message affects people's emotions and whether this effect will wane over a period of time can be studied.

Fink et al. (2002) used an innovative technique to measure oscillation. They required participants to think about an issue and use a computer mouse to indicate their instantaneous opinions about the issue (Fink et al., 2002). They recorded mouse positions every 18 milliseconds, therefore, they were able to capture trajectories of individual attitudes or decisions. If the participants pressed the mouse button, it meant they had made a final decision and it signaled the end of the trajectory. These trajectories were then used to study the equilibrium length of a linkage, the restoring coefficient, and the frequency and amplitude of oscillation (see Fink et al. 2002 for more details, p. 20–21).

This dissertation proposes another way to measure the time variable in a cognitive process to address the "dynamics" of such process. As discussed before, the Galileo system uses a pairwise comparison mechanism to measure the psychological distances between every pair of concepts. In this system, longer the distance two concepts are away from each other, more different they are to each other, and vice versa. The

parcipants need to traverse every possible pair of a list of concepts when they are taking the pair-comparison-based questionnaire. Traditionally, this traverse process is done in serialized order which means that the first question is to compare the first concept and the second one, the second question is to compare the first concept and the third one, and so on until all possible comparisons between every two concepts are done. This approach has a distinct shortcoming: The range of reaction time to a specific pair of comparison is not well distributed to the whole session of data collection. For example, if the 7th question is the comparison of a pair of concepts which we want to manipulate, the partipants already spend some time answering the 1st to the 6th questions. In other words, when we are looking at the distribution of the answers of the 7th question, it is only a portion of the whole distribution of all answers. To remedy this, this disseration applies a different approach: The order of the first question is shifted across different participants. Suppose the 7th question is still the one we want to manipulate, when the first participant is taking the questionnaire, he or she gets to answet the 1st question first, 2nd question second, and so on (the 7th question *seventh*); when it is the turn for the second participant, he or she gets to answer the 2nd question first, 3rd question second, and so on (the 7th question *sixth*). If the sample is big enough, the distribution of the answers to the 7th question will cover a period from the beginning of the questionnaire to the end. Another possible solution will be to randomize the order of

each question for different participants.

3 PROCEDURES

3.1 Design

The whole experiment consists of two groups: a control group and a treatment group. Both groups were asked to evaluate how different 16 concepts are when they are compared to each other (how these concepts were selected is explained in the following *Phase 1* section). The only difference between these two groups was that the treatment group was given a message before evaluating the differences between concepts. The result for each group will be analyzed and discussed separately at first, and then the difference between two groups is analyzed and reported. A step-by-step explanation of the whole procedure is provided in the following part.

3.2 Phase 1

Conceptualization of Emotional and Related Concepts for Measurement

Ekman et al. (1982) proposed a set of 6 basic emotions after they reviewed 5 prominent emotion studies at the time (Woodworth, 1938; Plutchik, 1962; Tomkins & McCarter, 1964; Osgood, 1966; Frida; 1968). These 6 emotions are: *Anger*, *Disgust*, *Joy*, *Fear*, *Sadness*, and *Surprise*. They were

selected as representatives of basic emotions for this study.

The next phase was to decide what attributes or dimensionalities these basic emotions may have. These attributes were collected through an open-ended survey. A total of 60 undergraduate students at a New York state public university participated in this part of the study. They responded to a survey with 15 open-ended questions. Each question on the survey asked them how they think of the difference between a pair of emotions. As discussed before, there were 6 general emotions selected for this study: *Anger*, *Disgust*, *Joy*, *Fear*, *Sadness*, and *Surprise*. In order to run through all the possible pair comparisons between these emotions, all together there were 15 questions in the survey ($\mathtt{total\ questions} = \frac{n \times (n-1)}{2}$). A typical question looks like this:

> What do you think of *Anger* and *Disgust*?

Then all the responses were combined into a single plain text file and a CATPAC analysis was performed on the file. CATPAC is an artificial neural network text analysis tool which performs neural network, cluster, and perceptual space analyses on qualitative input. It can find how words, as concepts, are related to each other in the whole document, thus allowing the most related concepts to emotions to be pinpointed. CATPAC provides a dendogram report (a tree view of data showing visual classification concepts grouping). Result of CATPAC analysis showed words related to those general emotional concepts (see Appendix

1). Among them, 6 of them are related to the attributes of emotions: *Negative*, *Positive*, *Simple*, *Complicated*, *Unexpected*, *Control*. These attributes can be combined to represent dimensions of emotions: *Negative* and *Positive* are combined as a valence dimension; *Simple* and *Complicated* are combined as a simplicity dimension; *Unexpected* and *Control* are combined as a control dimension. Finally, 3 more concepts were added to represent different social settings (*Work*, *Study*, and *Party*) people deal with in their daily lives and a concept of self (*Yourself*). Altogether there were 16 concepts. These concepts were used to create a Galileo questionnaire.

3.3 Phase 2

Time-Series Multidimensional Data Collection

While a traditional Galileo paired comparison model is appropriate for the measurement of cognitive structures, observing time series data is not fully supported in the traditional toolkit. Foldy & Woelfel (1990) and Woelfel, et. al, 1986) randomly assigned respondents to a waiting period after administering an experimental treatment, and were able to detect important time-dependent effects, but the logistic difficulties of this procedure make it cumbersome. Furthermore, since the Galileo paired comparison questionnaire itself takes at the least several minutes to complete, time dependent effects on the order of minutes or seconds

can't be observed by this method.

To make it possible to observe time dependent effects for short time periods, two of the Galileo programs, ELQM (the ELectronic Questionnaire Maker) and SPED (Simplified Process for Entering Data) were modified. ELQM is a program to design pair-comparison questionnaires. The project definition file, created by ELQM, is then used by SPED to collect data. In this paper, ELQM is modified into QM (Questionnaire Maker). The modified version utilize a seed file plus the usual project definition file. This seed file saves a number which indicates the starting pair with which a respondent will begin the pair-comparison questionnaire. ED (Entering Data), the modified version of SPED, will read in this file to decide which pair comparison is given out first to the respondent; after the respondent finishes the questionnaire, ED will add 1 to the seeded number. In such way, the starting pair comparison question is rotated through cases. For example, the first participant begins the questionnaire comparing the first concept to the second, and the second participant begins it comparing the second to the third, and so on. In order to keep track of time data, a timer function (called GETTIM in the language of FORTRAN) was added to ED. This function is called twice for each pair-comparison question, both before the response and after the response. In this way, two timestamps are recorded for each pair-comparison question and the difference between these two timestamps is the time the respondents spent answering the question. This time

measure may then be used as an indicator for how long the participants are exposed to the emotional stimuli. The following figures show two screen-captures of QM and ED at work (The source codes of QM and ED are available in the Appendix D and E).

QM prepares the Galileo style questionnaire by combining three parts: First, it presents a section for an instruction message (an additional message for the treatment group was also added in this section; in other words, the treatment message was added at the beginning of the questionnaire); Second, it creates questions which rotate through all possible pair comparisons between concepts; Finally, it adds demographic questions. Printouts of QM questionnaires for both control group and treatment group are included in the Appendix B and Appendix C.

Next, ED was used to record participants' responses to the QM questionnaire. Participants were asked to sit in front of a computer running ED and fill out the questionnaire by themselves. ED saved the responses in two data files, one for traditional Galileo multidimensional analysis, the other for time-series data. The time series data are saved in a 17-column table. These columns represent ID, pairID, response, startYear, startMonth, startDay, startHour, startMinute, startSecond, startHectoSecond, endYear, endMonth, endDay, endHour, endMinute, endSecond, and endHectoSecond. The accuracy of the time measurement is at the level of hectosecond (1/100 second).

Figure 3.1: Screecapture of QM at work

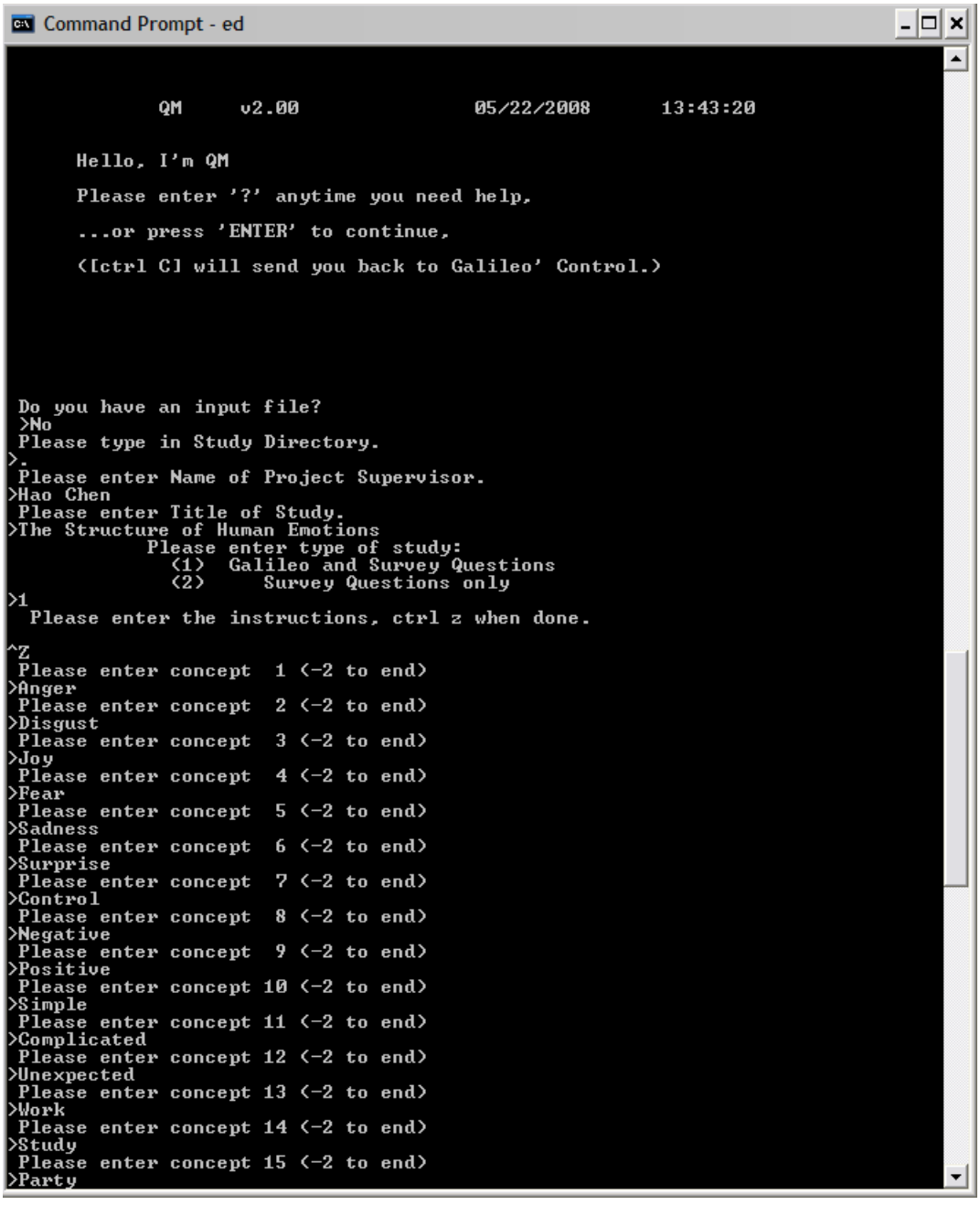


Figure 3.2: Screecapture of ED at work

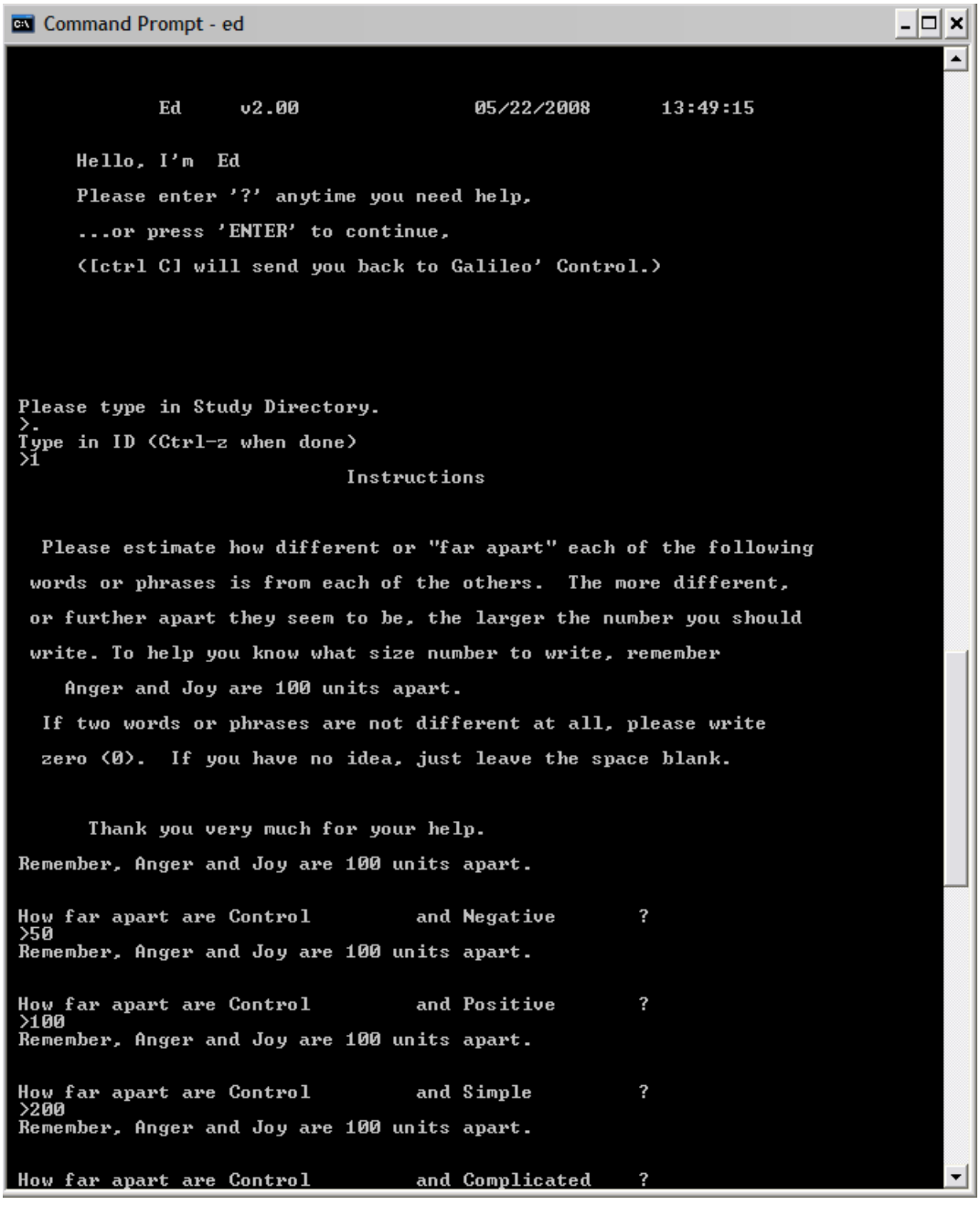


Table 3.1: Time series data sample recorded by ED.

ID	pairID	response	startYear
⋮	⋮	⋮	⋮
2	0405	51	2008
2	0406	60	2008
2	0407	40	2008
⋮	⋮	⋮	⋮

startMonth	startDay	startHour	startMinute	startSecond	startHectoSecond
⋮	⋮	⋮	⋮	⋮	⋮
02	28	15	39	49	31
02	28	15	40	48	71
02	28	15	41	25	95
⋮	⋮	⋮	⋮	⋮	⋮

endYear	endMonth	endDay	endHour	endMinute	endSecond	endHectoSecond
⋮	⋮	⋮	⋮	⋮	⋮	⋮
2008	02	28	15	40	48	71
2008	02	28	15	41	25	70
2008	02	28	15	41	45	25
⋮	⋮	⋮	⋮	⋮	⋮	⋮

3.4 Phase 3

Data Collection for Control Group and Treatment Group

The only difference between the questionnaire used by control group and the one used by treatment group was a message added at the beginning of the questionnaire. The message said "Please also read this statement: 'Anger' and 'Fear' are two very different emotions." This

message was presented once to the participants immediately before they started the questionnaire. It was thought that this message would change participants' opinions about emotions, more precisely, how different *Anger* and *Fear* are from each other. The rest part of the questionnaires were kept identical. The time-series data were used to test whether the longer time the participants were exposed to such message, more differently they would think about the relation between *Anger* and *Fear*.

4 RESULTS

This dissertation is a preliminary step in an ongoing research program. It aims to provide a framework for the follow-up experiments. The sample for the control group consists of 65 participants. Although a relatively small sample, each participant was asked to do a 120-question questionnaire (all questions were not mandatory, however, 64 participants provided at least 112 answers, with one participant provided only 66 answers) and how long each answer took the participant to process was recorded. This results in a dataset with 7701 points of time-related data. The sample for the treatment group consists of 61 participants, with 7205 points of time-related data.

When looking at the descriptive data (mean, standard deviation, and standard error) of time spent on different order of questions, a consistent pattern were found for both control and treatment group. For the first question, participants spent longer time than the rest. The reason could be because participants were getting familiar with the measuring system and spending time in thinking about the research topic. During the study, a misplacement of the starting timestamp for the first question was discovered. It was put before the instruction. In other words, the time recorded for the first question also included the time for reading the instruction. This accounted for the significant longer time for the first question for the control group ($mean = 61.24$, $SD = 57.41$,

and $SE = 7.12$). For the treatment group, this mistake was rectified. As a result, more precise time was recorded for the first question of the treatment group with a significant lower values for the standarad deviation and the standard error of the mean ($mean = 13.10$, $SD = 7.26$, and $SE = 0.93$). For the rest of the questions, there was no significant difference between order of the question asked and time spent on such question. Please see Figure 4.1 and Figure 4.2 for more information (the detail of the values are presented in Table 4.1 and Table 4.2).

Table 4.1: Mean, Standard Deviation, and Standard Error of Time for Different Order of Questions (Control Group).

Order	Mean of Time	Standard Deviation of Time	Standard Error of Time
1	61.2449	57.40639	7.1203
2	10.8222	12.43691	1.5426
3	11.7337	17.61431	2.1847
4	8.5549	10.60036	1.3148
5	11.5363	25.90803	3.2134
6	7.5429	6.18301	0.7669
7	10.6115	16.75620	2.0783
8	11.0928	20.67285	2.5641
9	9.1085	11.98691	1.4867
10	8.5462	15.69656	1.9469
11	5.6278	3.62038	0.4491

12	7.0389	7.05527	0.8751
13	7.9580	10.83775	1.3442
14	6.7443	8.88680	1.1022
15	6.8582	8.19840	1.0168
16	6.6835	8.72488	1.0821
17	8.4317	11.39497	1.4133
18	5.3666	4.76901	0.5915
19	7.0962	7.74885	0.9611
20	9.0580	19.30279	2.3942
21	9.0931	23.04418	2.8582
22	5.7037	4.16733	0.5169
23	4.9586	4.52602	0.5614
24	6.9022	8.37104	1.0382
25	5.2000	4.84137	0.6005
26	5.9511	5.66232	0.7023
27	4.5486	2.75233	0.3414
28	5.3218	5.15831	0.6398
29	6.3042	7.41973	0.9203
30	7.8035	12.45078	1.5443
31	6.6485	9.36936	1.1621
32	4.8092	4.15911	0.5159
33	4.9805	4.32869	0.5369
34	6.3852	9.77480	1.2124
35	5.6355	5.67068	0.7034

36	5.7729	6.71273	0.8326
37	5.1678	4.84805	0.6013
38	9.0042	26.93122	3.3404
39	6.0475	5.82732	0.7228
40	5.7312	7.41578	0.9198
41	5.7738	5.90589	0.7325
42	5.4022	6.35410	0.7881
43	5.1168	6.13199	0.7606
44	4.5482	5.20410	0.6455
45	5.7298	7.87935	0.9773
46	6.4915	9.31966	1.1559
47	4.4897	3.73541	0.4633
48	5.2003	5.36382	0.6653
49	6.5895	8.06983	1.0009
50	4.9077	4.23347	0.5251
51	6.6514	10.19637	1.2647
52	6.1554	7.07514	0.8776
53	5.6169	4.49207	0.5572
54	5.2674	8.51968	1.0567
55	7.4412	15.52376	1.9255
56	5.2629	4.87710	0.6049
57	4.3211	3.42657	0.4250
58	7.4662	18.27842	2.2672
59	6.0382	6.11496	0.7585

60	5.1105	3.92683	0.4871
61	4.9300	4.41573	0.5477
62	5.3791	6.01323	0.7458
63	5.3952	8.53708	1.0589
64	8.1378	16.67445	2.0682
65	4.4855	2.96319	0.3675
66	5.6905	6.45187	0.8065
67	6.7655	18.13783	2.2672
68	5.0489	6.45132	0.8064
69	4.9788	7.19922	0.8999
70	4.1555	3.46242	0.4328
71	4.7930	5.03054	0.6288
72	5.8395	7.68188	0.9602
73	5.3623	8.51209	1.0640
74	4.2073	6.95699	0.8696
75	3.8531	3.63550	0.4544
76	4.3170	4.12806	0.5160
77	4.1725	4.02331	0.5029
78	4.7139	7.63131	0.9539
79	3.5922	3.84571	0.4807
80	3.5567	3.95886	0.4949
81	5.3366	7.69657	0.9621
82	5.0909	6.11768	0.7647
83	3.3270	2.80449	0.3506

84	4.9719	8.21505	1.0269
85	3.9389	3.71629	0.4645
86	5.1748	9.50206	1.1878
87	5.3159	8.62993	1.0787
88	4.3053	4.98911	0.6236
89	3.7270	4.61604	0.5770
90	5.4550	8.68489	1.0856
91	4.5103	4.38884	0.5486
92	3.7675	3.83433	0.4793
93	4.5314	5.04330	0.6304
94	5.3691	7.23634	0.9045
95	4.6136	5.65482	0.7069
96	6.1689	8.91366	1.1142
97	5.9781	15.42702	1.9284
98	6.0737	8.99079	1.1238
99	4.0266	4.14445	0.5181
100	3.4678	2.61024	0.3263
101	4.6116	5.56928	0.6962
102	5.6895	8.88211	1.1103
103	4.7912	5.75858	0.7198
104	7.7563	19.77530	2.4719
105	4.5017	5.54753	0.6934
106	4.1875	6.40945	0.8012
107	3.9922	3.00470	0.3756

108	3.9200	3.44522	0.4307
109	4.5225	6.90493	0.8631
110	7.3602	14.37410	1.7968
111	4.5273	7.77287	0.9716
112	5.0253	9.23354	1.1542
113	4.9121	5.91393	0.7451
114	4.1463	3.55529	0.4515
115	5.9597	18.89967	2.4199
116	4.6302	4.93161	0.6314
117	3.8780	3.22259	0.4195
118	3.7495	4.10752	0.5393
119	4.1927	5.74834	0.7682
120	5.6400	9.41070	1.3583

Table 4.2: Mean, Standard Deviation, and Standard Error of Time for Different Order of Questions (Treatment Group).

Order	Mean of Time	Standard Deviation of Time	Standard Error of Time
1	13.1025	7.26141	0.9297
2	7.6548	4.05293	0.5189
3	6.3333	2.75477	0.3527
4	6.3623	3.63141	0.4650
5	5.9420	3.51457	0.4500

6	5.0766	2.37106	0.3036
7	5.7761	4.01407	0.5139
8	4.9402	2.27134	0.2908
9	5.8552	4.24181	0.5431
10	5.7039	4.86716	0.6232
11	5.3100	1.97054	0.2523
12	5.8190	3.96141	0.5072
13	6.1198	6.26842	0.8026
14	4.7698	2.60438	0.3335
15	5.5338	2.97783	0.3813
16	6.1330	4.37881	0.5606
17	5.3505	3.10423	0.3975
18	5.5131	3.95510	0.5064
19	5.6297	3.12803	0.4005
20	5.1554	2.43040	0.3112
21	5.5362	5.08288	0.6508
22	5.2067	3.01172	0.3856
23	5.8754	4.01195	0.5137
24	4.9498	2.58527	0.3310
25	4.7836	2.88563	0.3695
26	4.4710	2.19971	0.2816
27	4.6082	2.51891	0.3225
28	4.6933	2.89813	0.3711
29	4.6618	2.71953	0.3482

30	5.0392	3.08256	0.3947
31	4.8115	3.00927	0.3853
32	5.2718	2.86831	0.3672
33	5.3698	5.14910	0.6593
34	4.7292	3.39964	0.4353
35	4.5267	2.89804	0.3711
36	4.4436	1.99491	0.2554
37	4.4134	2.29566	0.2939
38	4.6484	2.77350	0.3551
39	4.7834	2.22479	0.2849
40	4.9720	3.21947	0.4122
41	5.0851	5.19243	0.6648
42	4.7108	3.13782	0.4018
43	5.5400	5.12414	0.6561
44	4.7385	2.86003	0.3662
45	4.8005	5.11622	0.6551
46	5.3861	4.80301	0.6150
47	4.4046	2.18210	0.2794
48	4.9946	3.86687	0.4951
49	4.9664	4.06169	0.5200
50	5.1985	3.88262	0.4971
51	4.4115	2.68494	0.3438
52	4.2098	2.51256	0.3217
53	4.8584	4.08410	0.5229

54	5.0207	2.81625	0.3606
55	4.4469	2.51122	0.3215
56	4.8316	3.12505	0.4001
57	4.7415	2.82564	0.3618
58	4.3274	2.23671	0.2864
59	4.8136	3.13746	0.4017
60	4.7980	5.62347	0.7200
61	4.4536	2.75076	0.3522
62	4.6125	3.21272	0.4113
63	4.0280	2.14026	0.2740
64	4.3316	2.57548	0.3298
65	4.8234	4.03689	0.5169
66	4.7534	3.15003	0.4033
67	4.1518	3.13402	0.4013
68	5.1303	8.44810	1.0817
69	4.6452	3.18339	0.4076
70	4.3521	2.28105	0.2921
71	4.1659	2.38213	0.3050
72	4.9562	4.27680	0.5476
73	4.3918	2.74604	0.3516
74	4.3007	2.39836	0.3071
75	4.1439	2.82004	0.3611
76	6.4252	5.80921	0.7438
77	5.2298	7.56779	0.9690

78	4.4175	3.55423	0.4551
79	4.5093	2.96917	0.3802
80	4.6656	3.33465	0.4270
81	4.0411	2.07297	0.2654
82	4.0903	2.99220	0.3831
83	4.3403	3.93845	0.5043
84	4.4977	3.75633	0.4809
85	4.1525	3.14350	0.4025
86	4.9605	4.69494	0.6011
87	4.1349	2.28671	0.2928
88	3.9530	2.20102	0.2818
89	3.7543	2.09881	0.2687
90	3.8356	2.05649	0.2633
91	4.4710	2.93226	0.3754
92	4.7116	3.16093	0.4047
93	4.0433	2.33036	0.2984
94	4.6059	4.09491	0.5243
95	4.3495	3.31965	0.4250
96	4.7275	2.79661	0.3581
97	3.9452	2.16091	0.2767
98	4.4889	3.98389	0.5101
99	3.7846	1.96005	0.2510
100	4.4846	2.58342	0.3308
101	4.3513	2.61604	0.3349

102	4.0934	3.15472	0.4039
103	4.9957	7.91925	1.0140
104	3.7803	1.84582	0.2363
105	4.1069	4.34707	0.5566
106	4.2602	2.98937	0.3859
107	4.8677	4.62636	0.5973
108	3.6120	1.49335	0.1944
109	4.1185	2.05009	0.2669
110	4.5178	3.84216	0.5002
111	4.3230	2.67366	0.3541
112	5.9402	8.79176	1.1855
113	3.6267	2.07513	0.2824
114	4.0160	2.69186	0.3698
115	3.9321	2.44808	0.3363
116	3.7860	1.73068	0.2400
117	3.9596	1.88007	0.2633
118	3.6798	1.84104	0.2630
119	4.2722	2.55566	0.3768
120	3.7988	1.44868	0.2522

Figure 4.1: Mean, Standard Deviation, and Standard Error of Time for Different Order of Questions (Control Group).

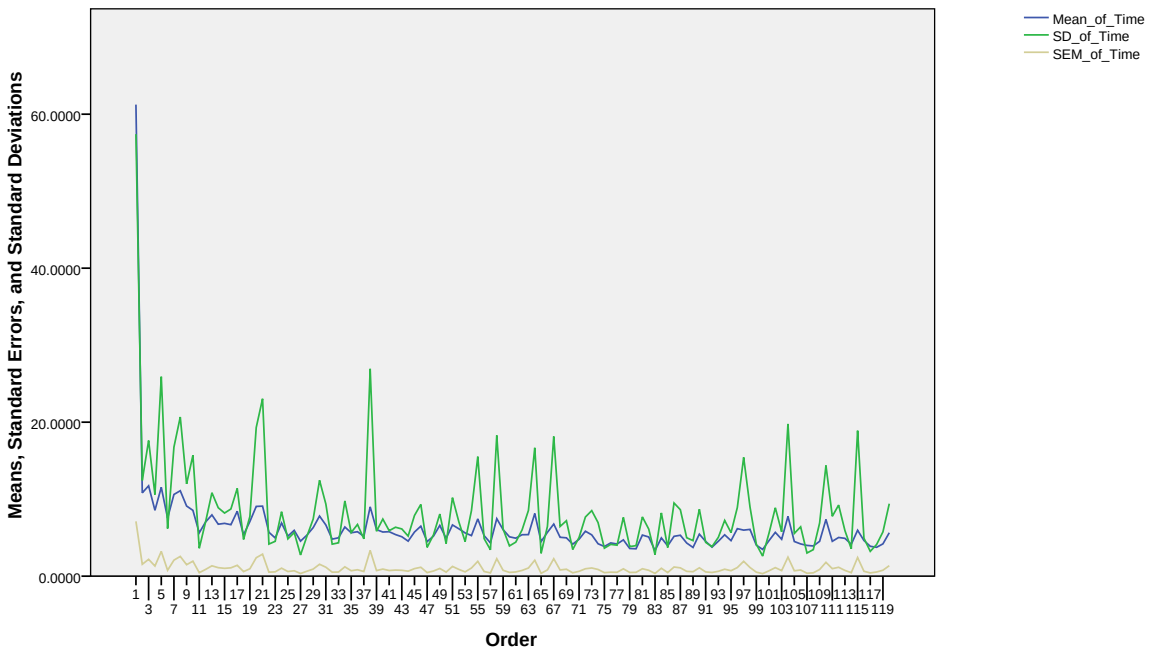
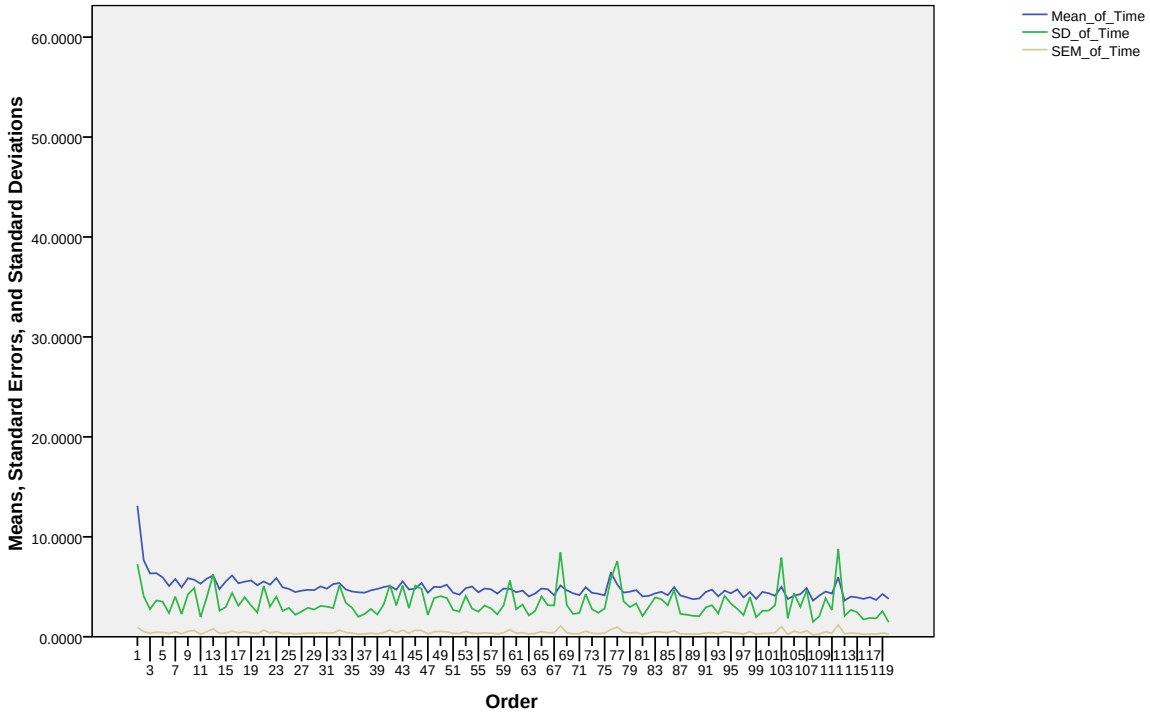


Figure 4.2: Mean, Standard Deviation, and Standard Error of Time for Different Order of Questions (Treatment Group).



5 DATA ANALYSIS

5.1 Statistical Analysis

For the control group, the correlation test shows that the time spent on the pair-comparison question is significantly correlated to the question ($r = .04$, $p < .01$). It is thought that some of the pair-comparisons are harder to estimate than others, hence the participants need more time to process the more difficult comparisons. As a comparison, however, this pattern is not found in the treatment group ($r = .009$, $p = .453$). The possible reason for this might be because when the message is introduced to the treatment group, it creates oscillation for the participants' cognitive system; as a result, the consistent pattern cannot be maintained.

As pointed out by Fink et al. (2002), the humans' perception on a pair of related cognitive concepts is a spring-like relation. When additional forces are introduced to this system, they will cause the oscillation of the attitude change. It is assumed that the greater the attitude change, the greater the amplitude of oscillation (cf. Kaplowitz & Fink, 1982). The standard error of the response can be used as a measure for the amplitude of oscillation. A post hoc analysis shows that the mean distance is significantly positively correlated to the standard error of it for both groups. For the control group, $r = .606$ and $p < .01$; for the treatment group, $r = .626$ and $p < .01$ (see Table 5.1 and 5.2 for

more details). In the Galileo system, bigger the distance means more different two concepts are thought to be while smaller the distance means more similar two concepts are. This analysis shows that when the partcipants are comparing two similar concepts, they do not experience big oscillation and tend to agree with each other; when the partcipants are comparing two dissmilar concepts, they do experience big oscillation and tend to disagree with each other.

Table 5.1: Mean, Standard Deviation, and Standard Error of Response for Pair Comparison (Control Group).

PairID	Mean Distance	Standard Deviation of Distance	Standard Error of Distance
01-02	32.4200	33.36300	4.1700
01-03	106.3000	79.17200	9.9750
01-04	44.0600	35.85900	4.4480
01-05	42.7100	28.78400	3.5700
01-06	79.9200	73.12000	9.2120
01-07	76.7700	105.81500	13.1250
01-08	26.7000	29.98600	3.7480
01-09	87.6200	55.30000	6.9120
01-10	60.1100	51.11700	6.3900
01-11	53.6200	67.38700	8.3580
01-12	52.2300	64.62100	8.0150
01-13	52.9700	45.25600	5.6570

01-14	55.0300	36.30700	4.6490
01-15	96.5700	130.52500	16.4450
01-16	77.2100	66.89300	8.4280
02-03	100.6100	84.96500	10.8790
02-04	57.7200	64.53900	8.0670
02-05	53.2700	50.49400	6.3120
02-06	69.8700	59.28200	7.4690
02-07	62.7800	33.00100	4.1580
02-08	33.2700	43.61100	5.4510
02-09	86.6300	45.51300	5.7800
02-10	59.8400	38.75100	4.9210
02-11	48.8400	25.22400	3.2030
02-12	53.8900	43.41300	5.4270
02-13	68.5900	85.96400	10.8300
02-14	46.8800	34.32900	4.2910
02-15	82.0300	59.73800	7.5870
02-16	103.8400	133.09100	16.9030
03-04	109.7700	117.45100	14.6810
03-05	102.4900	77.86000	9.8090
03-06	41.8600	55.88200	6.9850
03-07	63.0500	87.03700	10.8800
03-08	108.1600	122.41900	15.3020
03-09	36.4900	115.35100	14.5330
03-10	46.4100	76.13200	9.5920

03-11	71.1700	92.47100	11.6500
03-12	46.3000	29.39200	3.7030
03-13	63.6900	32.85500	4.1070
03-14	80.6500	54.31300	6.8430
03-15	31.4600	41.78900	5.2650
03-16	28.0600	31.25800	3.9380
04-05	41.3600	42.09800	5.2620
04-06	58.8300	81.88900	10.3170
04-07	76.4200	113.78400	14.2230
04-08	47.4500	90.36300	11.2950
04-09	92.7600	102.63500	13.0350
04-10	78.9200	139.47800	17.7140
04-11	58.5300	101.25400	12.6570
04-12	43.9500	77.32600	9.6660
04-13	58.5400	26.50700	3.3400
04-14	71.1100	77.41400	9.7530
04-15	79.1700	55.21000	6.9560
04-16	67.5200	52.65100	6.6870
05-06	72.5400	66.62500	8.3810
05-07	65.1600	36.95600	4.6560
05-08	27.7000	39.34800	4.9180
05-09	88.4800	55.72200	7.0200
05-10	55.7300	28.54200	3.5960
05-11	43.5300	62.66600	7.8330

05-12	52.0600	50.57900	6.3220
05-13	55.9500	30.50100	3.8130
05-14	55.6000	50.74700	6.3930
05-15	94.0200	91.96400	11.7750
05-16	77.6700	117.82900	14.7290
06-07	91.1600	117.01600	14.6270
06-08	71.6500	49.78700	6.2730
06-09	40.8900	26.12200	3.2400
06-10	45.4800	25.76900	3.2470
06-11	63.3600	72.43800	9.0550
06-12	38.2600	86.41500	10.7190
06-13	95.6400	150.33900	18.7920
06-14	74.8800	99.04000	12.3800
06-15	42.9700	50.11100	6.2160
06-16	67.2500	83.53900	10.4420
07-08	72.7300	108.20700	13.5260
07-09	56.2300	44.13900	5.4750
07-10	68.9800	105.93000	13.4530
07-11	63.3200	61.59600	7.7600
07-12	79.3300	82.24800	10.3620
07-13	52.3300	56.27000	7.0340
07-14	39.6000	32.18500	4.0870
07-15	73.0800	81.46200	10.4300
07-16	52.8800	76.60600	9.5020

08-09	86.8000	32.19700	4.1570
08-10	68.7200	67.15100	8.3290
08-11	51.8600	72.69000	9.0160
08-12	68.2500	144.02700	17.8640
08-13	47.2300	32.06700	3.9770
08-14	46.4000	37.90400	4.7010
08-15	93.9200	92.53700	11.6590
08-16	69.2200	52.67000	6.5840
09-10	37.2300	27.28500	3.3840
09-11	67.1600	29.78300	3.7520
09-12	58.0200	38.19600	4.7740
09-13	58.6400	49.80600	6.2260
09-14	67.4100	108.67700	13.6920
09-15	36.3100	41.07500	5.0950
09-16	28.4600	29.44500	3.6520
10-11	82.8500	31.01400	3.9390
10-12	68.5200	54.36500	6.7960
10-13	54.4800	36.72600	4.5550
10-14	72.0300	98.34200	12.2930
10-15	46.2700	27.00500	3.4300
10-16	54.9500	64.09900	8.0120
11-12	51.4200	41.39300	5.1340
11-13	56.7300	67.45600	8.4320
11-14	56.9700	94.56100	11.7290

11-15	67.8900	49.13000	6.0940
11-16	54.3600	31.26300	3.9080
12-13	67.5200	72.12000	8.9450
12-14	62.2300	47.36800	5.8750
12-15	47.1900	34.11600	4.2640
12-16	59.2500	65.38200	8.1730
13-14	50.3800	77.80200	9.7250
13-15	92.8700	91.10000	11.4780
13-16	45.2500	38.52300	4.8150
14-15	106.7000	137.07500	17.2700
14-16	52.4800	45.97600	5.7470
15-16	40.4000	38.88800	4.8230

Table 5.2: Mean, Standard Deviation, and Standard Error for Pair Comparison (Treatment Group).

PairID	Mean Distance	Standard Deviation of Distance	Standard Error of Distance
01-02	33.3800	34.25600	4.4220
01-03	99.8500	55.87500	7.2130
01-04	53.4500	36.28300	4.6840
01-05	45.0200	33.40200	4.2770
01-06	65.3800	47.57200	6.0910
01-07	72.0200	71.20900	9.1930

01-08	25.8900	26.77700	3.4280
01-09	91.4900	83.40900	10.6790
01-10	60.9700	35.44500	4.5767
01-11	40.7700	33.95800	4.3840
01-12	41.7300	30.36500	3.9200
01-13	46.5400	33.84500	4.4060
01-14	53.6400	33.49000	4.3600
01-15	83.6600	68.18800	8.9540
01-16	79.3900	61.99700	8.2120
02-03	90.4200	45.13700	5.8270
02-04	59.5700	65.13000	8.3390
02-05	53.6000	35.21200	4.5460
02-06	73.1000	62.33000	7.9810
02-07	70.9500	68.47100	8.7670
02-08	24.2000	23.65100	3.0280
02-09	85.5700	39.21300	5.0620
02-10	65.5000	83.15900	10.9190
02-11	59.4700	53.66600	7.0470
02-12	43.4900	30.49000	3.9690
02-13	45.8000	30.28700	3.9430
02-14	52.1500	30.22300	3.8700
02-15	102.8700	120.33400	15.5350
02-16	89.1700	52.94000	6.8920
03-04	95.5100	68.27500	8.7420

03-05	107.6900	100.70500	12.8940
03-06	29.7000	27.09300	3.4690
03-07	62.6500	105.63500	13.6370
03-08	93.7100	63.42700	8.2580
03-09	19.9300	31.47200	4.0300
03-10	31.3300	22.66600	2.9020
03-11	65.2600	62.16300	7.9590
03-12	45.9200	52.09900	6.7260
03-13	72.7000	55.84700	7.2100
03-14	75.2200	47.88200	6.2870
03-15	24.1200	28.88300	3.7290
03-16	32.2400	49.33900	6.4790
04-05	41.6600	38.74100	4.9600
04-06	57.2100	78.81300	10.0910
04-07	62.5800	64.65600	8.3470
04-08	25.8700	25.10400	3.2140
04-09	75.5200	44.77000	5.7800
04-10	61.6600	37.67000	4.8230
04-11	53.2000	65.63500	8.4040
04-12	36.0700	27.86900	3.5980
04-13	72.1700	120.89000	15.7390
04-14	79.7300	131.60500	17.1340
04-15	85.2000	58.94300	7.6090
04-16	89.9200	117.54500	15.1750

05-06	88.6300	88.58600	11.4360
05-07	60.2800	42.56800	5.5890
05-08	27.8200	31.48700	4.0320
05-09	82.2800	52.52800	6.7810
05-10	71.1000	91.63500	11.9300
05-11	45.9200	29.17900	3.7990
05-12	39.2700	23.50600	3.0600
05-13	50.7200	34.08500	4.3640
05-14	58.2600	80.24500	10.5370
05-15	91.2200	53.30800	6.9400
05-16	82.7800	49.37500	6.4280
06-07	86.7200	93.89300	12.1220
06-08	68.1900	59.91700	7.8010
06-09	37.7300	26.93000	3.5060
06-10	51.1800	28.92700	3.7040
06-11	53.5400	29.19800	3.7380
06-12	16.2000	25.60000	3.2780
06-13	66.8700	39.26700	5.0280
06-14	74.7900	43.98800	5.6320
06-15	33.9700	28.84400	3.6930
06-16	55.6000	42.17100	5.5860
07-08	52.4200	34.34100	4.4710
07-09	48.5400	35.41600	4.7330
07-10	59.4700	39.61600	5.1580

07-11	54.8200	63.58200	8.2080
07-12	69.8200	44.98800	5.8080
07-13	39.4700	48.52400	6.3170
07-14	31.1500	23.84700	3.0530
07-15	60.1500	36.05000	4.6930
07-16	45.2800	87.08800	11.2430
08-09	112.5200	76.95300	10.1040
08-10	61.2200	38.50800	5.0130
08-11	39.6900	28.71900	3.6770
08-12	42.4100	20.35000	2.6490
08-13	41.1000	28.89000	3.6990
08-14	45.3000	32.54200	4.1670
08-15	90.6100	60.49800	7.7460
08-16	96.8600	81.10300	10.5590
09-10	45.5200	55.20600	7.0680
09-11	58.0200	25.85500	3.3100
09-12	60.9200	54.68600	7.0020
09-13	61.4000	50.13900	6.4730
09-14	56.1600	58.71400	7.5800
09-15	21.9200	24.66300	3.1840
09-16	25.9200	44.12900	5.6970
10-11	102.7000	79.65400	10.2830
10-12	61.4400	40.20300	5.2340
10-13	63.3100	28.50800	3.6500

10-14	69.8900	39.21100	5.0200
10-15	45.5200	32.84500	4.2050
10-16	55.1700	42.10000	5.4350
11-12	53.6500	63.34400	8.1780
11-13	40.4200	34.89700	4.5430
11-14	45.3900	53.80600	7.0050
11-15	67.1700	44.76500	5.7790
11-16	53.7300	46.36100	6.0360
12-13	57.7000	38.73400	4.9590
12-14	67.5300	71.68100	9.2540
12-15	52.6100	66.17800	8.6160
12-16	54.0800	35.84900	4.6670
13-14	31.4900	70.06700	8.9710
13-15	94.1800	49.00700	6.3270
13-16	39.5200	54.68100	7.1800
14-15	99.9700	68.15500	8.8730
14-16	40.4300	29.03400	3.7480
15-16	37.0300	33.52400	4.3280

On the other hand, the treatment message plays no strong effects on the designated pair of concepts (*Anger* and *Fear*). For the control group (without message), the distance between these two concepts $\mathrm{d} = 44.06$, $\mathrm{SD} = 35.859$, and $\mathrm{SE} = 4.448$. For the treatment group (with message),

the distance d = 53.45, SD = 36.283, and SE = 4.684. The treatment message was designed to push *Anger* and *Fear* away from each other and the result shows a small change of the distance on the right direction. The effect, however, is not strong. The standard deviations and the standard errors of the distance between two concepts for both groups are very similar. In other word, such message did not cause a significant change of the oscillation when the participants were evaluating this pair. There are several possible reasons to explain this: Firstly, the message was given out once before the questionnaire and it might be forgotten too quickly, even during the data collection; Secondly, the source credibility is not strong enough to convince the participants; Thirdly, the argument strength of the message itself is not strong enough; Lastly, the participants might already hold a strong opinion on the difference between *Anger* and *Fear* before they took the questionnaires and such opinion is not easily changed (cf. Fink et al., 2002). As shown by Figure 5.1 and Figure 5.2, the oscillation of the pair comparison of *Anger* and *Fear* for the control group and the treatment group.

5.2 Galileo Analysis

The whole dataset is then separated into 5 groups according to the time interval of how long each question took: Group 1 is between 0 to 2 seconds (N = 1450); Group 2 is between 2 to 4 seconds (N = 2692);

Figure 5.1: The Oscillation of the Pair of *Anger* and *Fear* (Control Group)

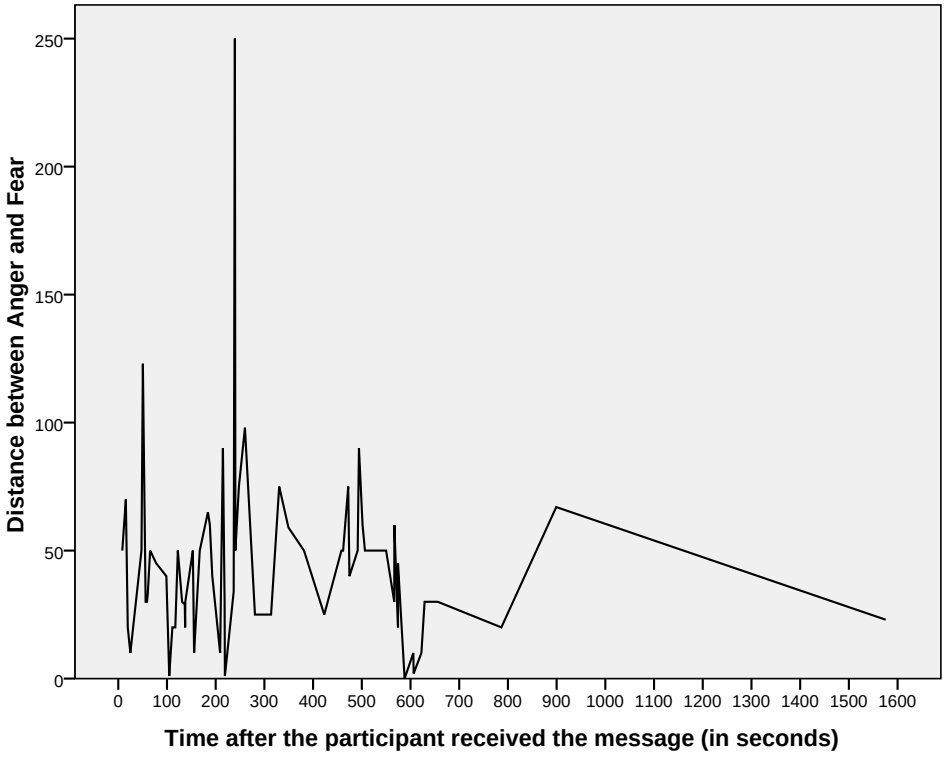
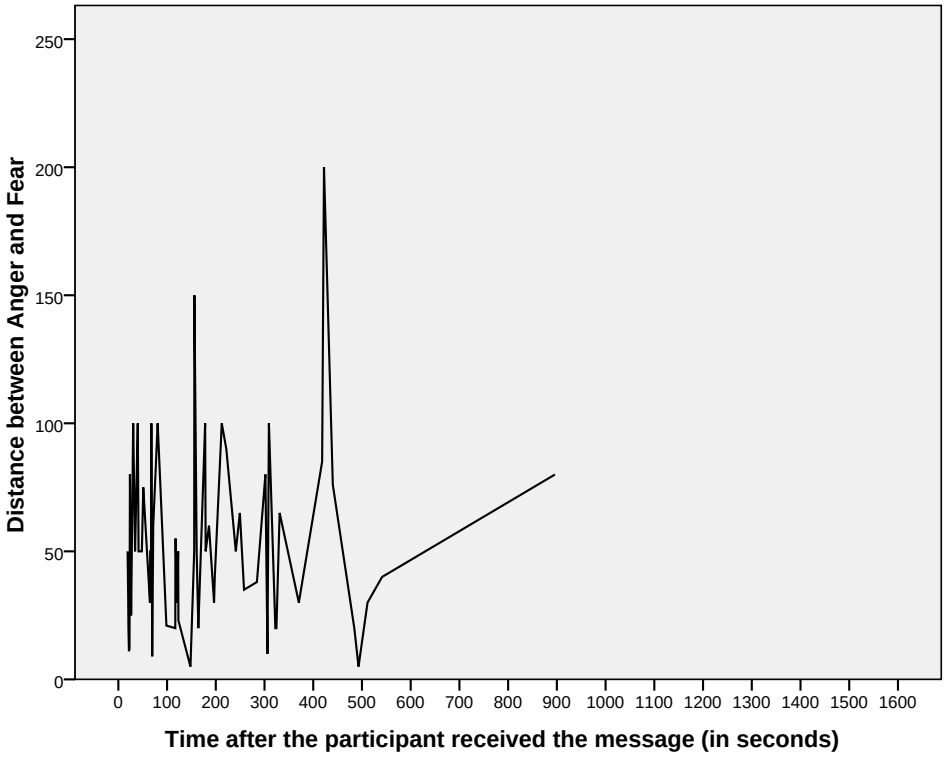


Figure 5.2: The Oscillation of the Pair of *Anger* and *Fear* (Treatment Group)



Group 3 is between 4 to 6 seconds (N = 1621); Group 4 is between 6 to 8 seconds (N = 748); Group 5 is more than 8 seconds (N = 1189). The descriptive statistics on Group 5 shows that the top 5 most frequent pair-comparison questions are *Surprise* and *Control* (33 times), *Complicated* and *Unexpected* (23 times), *Control* and *Negative* (20 times), *Positive* and *Simple* (20 times), and *Unexpected* and *Work* (20 times). As a comparison, the descriptive statistics on Group 1 shows that the top 5 most frequent pair-comparison questions are *Control* and *Positive* (20 times), *Control* and *Complicated* (20 times), *Surprise* and *Positive* (19 times), *Surprise* and *Complicated* (19 times), and *Control* and *Simple* (19 times).

Table 2 shows the change of each concept across 5 groups. The concept of *Yourself* changes least among all 16 concepts: It changes 80.027 units across 5 groups. This indicates no matter how much time the participants spent on processing the pair-comparisons, they thought of themselves very similarly. In other words, the collective self is rather static when compared to other concepts over time. The concepts of *Fear* (203.937 units) and *Study* (181.329 units) change most. The rapid change of the concept *Fear* indicates *Fear* is viewed very differently among people. Though, it is a little surprising that *Study* also changes rapidly over time. The majority of this sample is college student. The author originally assumed *Study* might not change very much, since *Study* is a concept college students deal with daily in their lives and they should have a very similar opinion on this concept. This conflict

can be partly reconciled if the changes over time are viewed separately. Between Group 1 and Group 2 (the reaction time is less than 4 seconds), *Study* only changes 19.210 units, and it is the second smallest changed concept. Between Group 2 and Group 3, *Study* changes 31.680 units, and it becomes the seventh most changed concept. Between Group 3 and Group 4, *Study* changes 65.876 units, and it becomes the fourth most changed concept. Between Group 4 and Group 5, *Study* changes 64.563 units, and it rises to be the No. 1 most changed concept. This indicates for the concept of *Study*, longer the time the participant takes to process the pair relation between *Study* and other concepts, more different views they will have. It might be because longer the time spent, more attributes of *Study* are taken into account. These attributes might be those introduced in this study (among the concepts in the 16-concept list), or they could be outside of the scope of this study depending on their personal experiences. When this gets into more personal-related, one could assume the perception of the concept will become more different. This is a proof that there is no absolute static state of any abstract concepts residing in human's mind, instead, they keep adjusting themselves to reflect the changes of perception.

The above findings could be verified in a different perspective by looking at the changes of pairs of comparisons. The Appendix F demon-

Table 5.3: Changes of Individual Concepts over 5 Groups

Concept	1 and 2	2 and 3	3 and 4	4 and 5	Sum of Change
Anger	39.358	9.686	70.347	46.770	166.161
Disgust	31.258	34.475	54.316	23.111	143.160
Joy	32.445	32.888	67.851	27.790	160.974
Fear	37.129	22.381	83.068	61.259	203.937
Sadness	23.311i	13.734i	30.277i	23.609	90.931
Surprise	40.762	43.607	22.593	34.089i	141.051
Control	34.408i	24.284	47.630i	26.430	132.752
Negative	51.322	27.346i	16.173	31.191	126.032
Positive	48.434	58.619	44.131	26.543i	177.727
Simple	37.668	24.472	49.254i	34.751	146.145
Complicated	25.301	36.683	20.414	40.643	123.041
Unexpected	51.724	9.216	35.009i	51.355i	147.304
Work	13.857	26.046	51.581	36.129	127.613
Study	19.210	31.680	65.876	64.563	181.329
Party	56.122	35.722	11.803	38.092i	141.739
Yourself	19.185i	16.987i	18.369i	25.486i	80.027
Sum of Change	561.49	447.83	688.69	591.81	

strates the changes of each pair or pair-comparisons over 4 time intervals of 5 time points (the 5 groups mentioned before). Among all 120 pair-comparisons, the top 10 most changed and 10 least changed pairs are as follows:

By looking into these changes, one can find out that among the most changed pairs there is no comparison between emotions. On the other hand, among the least changed pairs, the first least changed pair (*Fear* and *Surprise*) and the fifth least changed pair (*Disgust* and *Sadness*) are

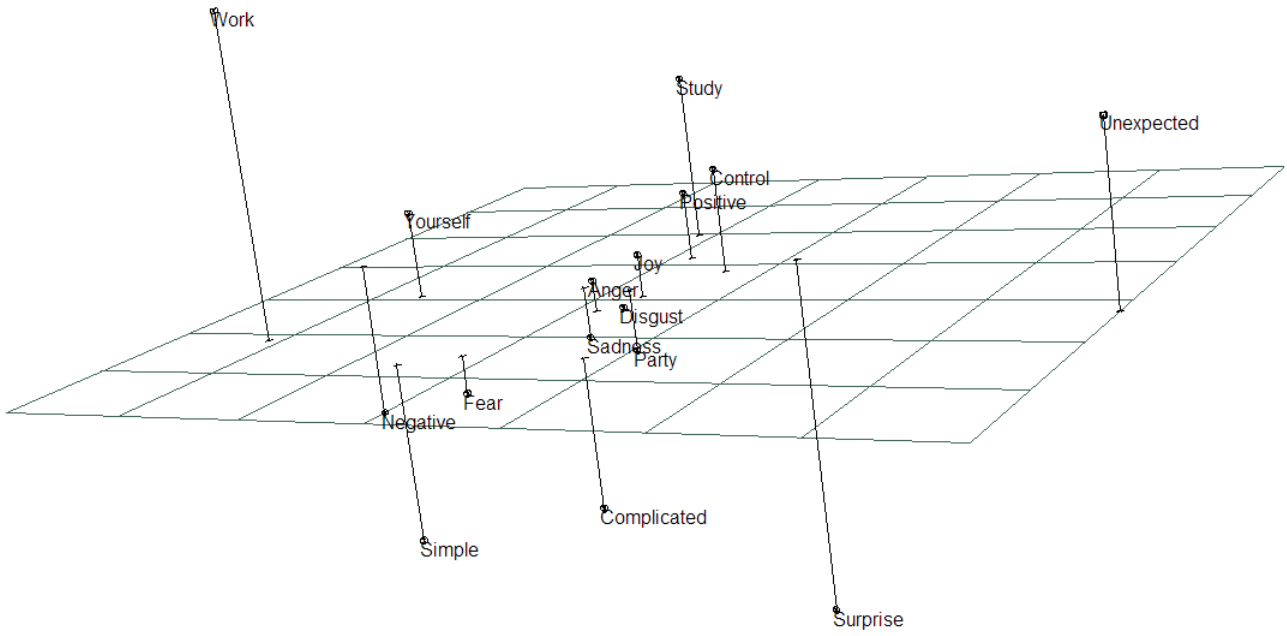
Table 5.4: Changes of Each Pair-Comparison over 5 Groups

Rank	Most Changed Pairs	Units Changed	Least Changed Paris	Units Changed
1st	Fear and Party	447.85	Fear and Surprise	12.11
2nd	Anger and Study	435.76	Control and Study	21.17
3rd	Positive and Study	409.41	Simple and Yourself	24.53
4th	Fear and Positive	307.51	Control and Party	24.73
5th	Study and Party	276.80	Disgust and Sadness	26.65
6th	Sadness and Positive	266.63	Joy and Unexpected	29.14
7th	Unexpected and Yourself	245.04	Disgust and Complicated	33.71
8th	Fear and Work	244.55	Sadness and Simple	34.41
9th	Joy and Negative	243.69	Positive and Yourself	35.64
10th	Joy and Simple	239.52	Positive and Complicated	36.65

about the comparisons between emotions. This shows some support to the fact that these six emotions are very basic terms understood well by human beings. As the result shows, there are not very variance between the perceptions of these emotions. Also, by bringing back the discussion about the concept of *Study*, one can find out that among top 10 most changed pairs over time three pairs are doing with *Study* (*Anger* and *Study*, *Positive* and *Study*, and *Study* and *Party*). Not only one could obtain supports for the surprising disagreement of participants' perceptions of the concept of *Study*, but also could find out in details which *Study*-related pair-comparisons are perceived most differently by the participants.

As discussed before, this dissertation utilized the Galileo system to analyze associative patterns of all the concepts. Galileo is based on a set of mathematical procedures for generating the eigenfunctions of

Figure 5.3: Plot of Group One (0–2 seconds)



cognitive processes in a multidimensional Riemann space. Through the transformation, the coordinates for each concept can be obtained. By plotting these coordinates on a multidimensional Riemann space, the relation between each concept can be interpreted both visually and mathematically. The following figures are the plots of all 16 concepts on a space over 5 points of time:

Figure 5.4: Plot of Group Two (2–4 seconds)

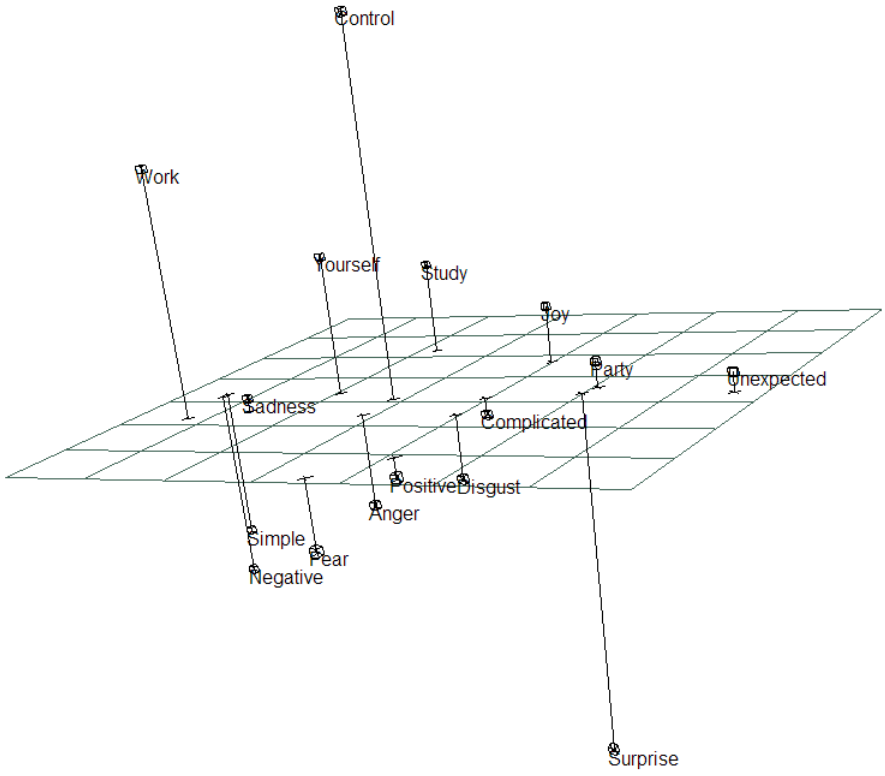


Figure 5.5: Plot of Group Three (4–6 seconds)

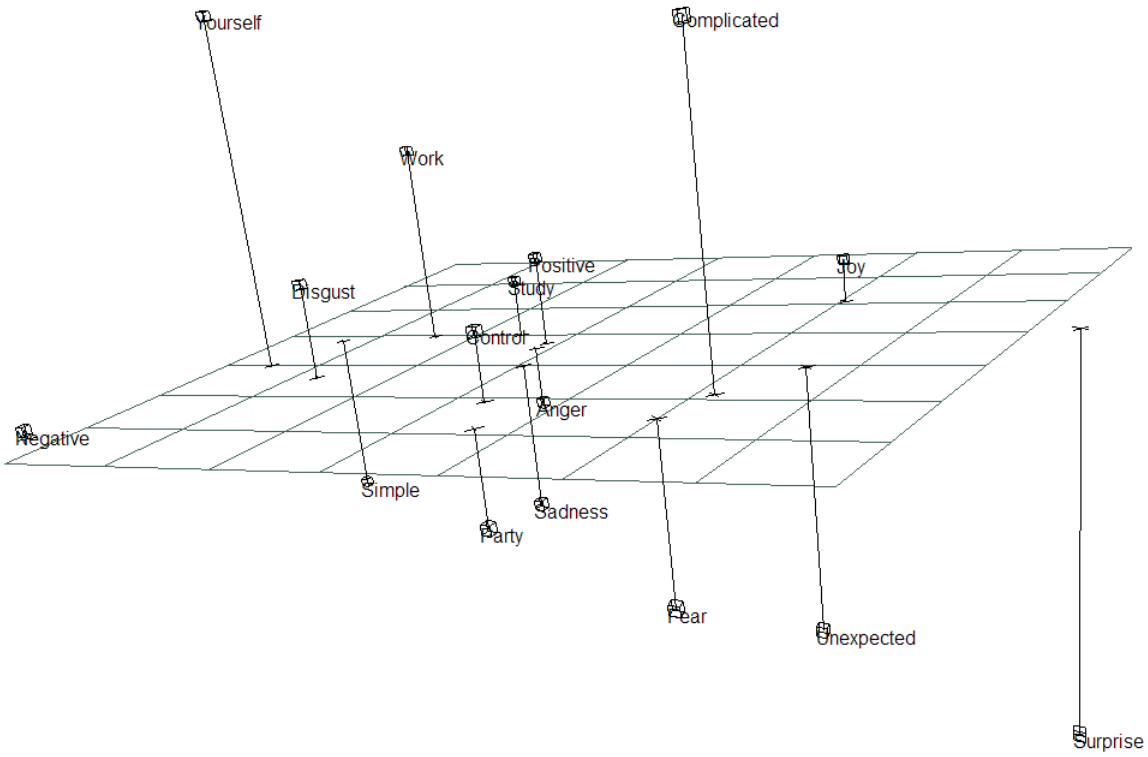


Figure 5.6: Plot of Group Four (6–8 seconds)

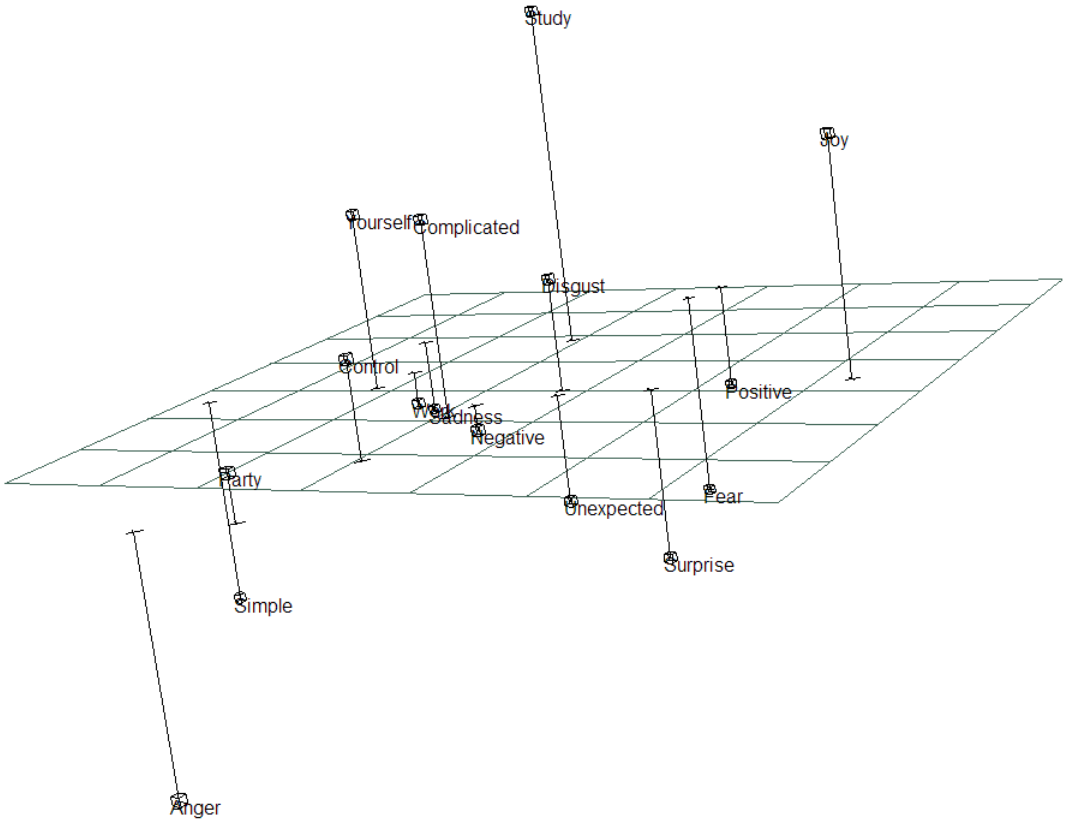
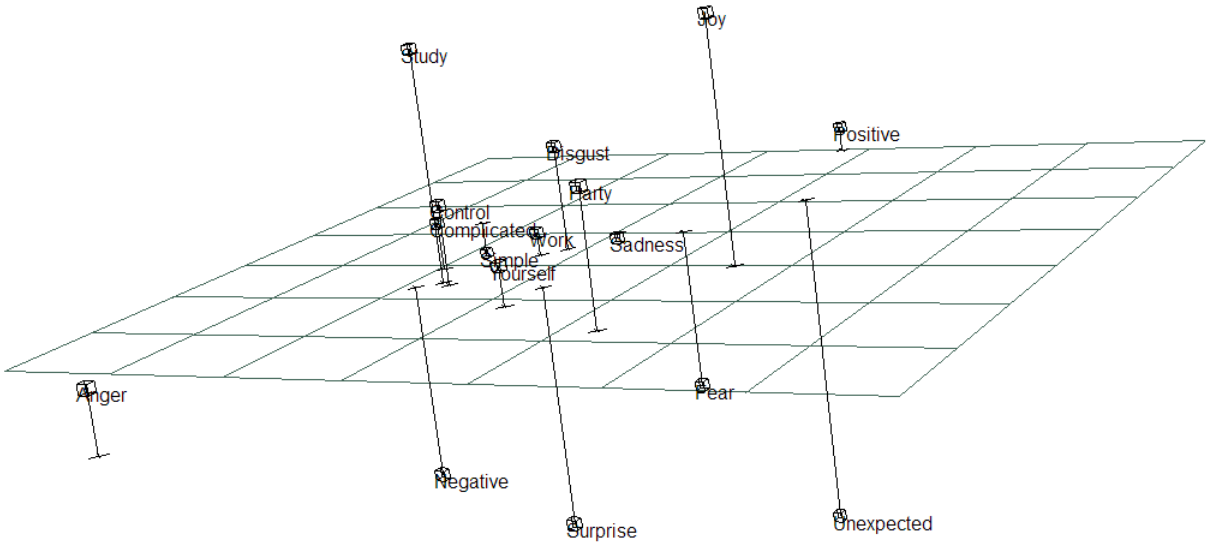


Figure 5.7: Plot of Group Five (over 8 seconds)



In such place, similar concepts are close to each other, and groups of similar concepts form clusters to represent the closeness in relation. Some of the concepts measured in this study are designated to be the concepts related to dimensionality, and they are *Simple*, *Complicated*, *Positive*, *Negative*, *Control*, and *Unexpected*. They could be paired up to form a continuously dimension, for example, *Positive* and *Negative* can form a *Valence* dimension, *Simple* and *Complicated* can form a *Complicatedness* dimension, and so on. If a emotional concept is closer to these dimensionality concepts, it is translated to be more strong on one end of the related dimensions. If the emotional concepts can be lined up on a dimension, such dimension can be thought as an good measure for some attribute of the emotions. For Group 1 plot, the Positive-Negative dimension is a good measure for the valence of the emotions. All 6 emotional concepts, except *Surprise*, are lined up on this dimension. *Joy* is closer to *Positive* than all other emotions, including four emotions usually thought as very different to *Joy* (*Anger*, *Disgust*, *Sadness*, and *Fear*). Those four emotions, instead, are very close to the *Negative* concept, the other end of this Valence dimension. The exception, *Surprise* is, isolated from these concepts. For Group 2 plot, Simple-Complicated is another good measure, showing that *Joy* and *Disgust* are close to *Complicated* while *Fear*, *Sadness*, and *Anger* are close to *Simple*. Again, *Surprise* is the exception which is located away from other emotion concepts and dimensionality concepts. For Group 3 to Group 5 plots (the groups taking longer time),

however, these dimensions become not or only partly associative to the emotions. This might be because of the same reason discussed before: longer the time participants spend on the comparisons, more factors might be taken into account. Including such factors might lead to more personal-oriented experiences, hence more different points of views. In other words, the norms people agree upon might not overlap with personal experiences. The current sample is too small to represent the norms. If more subjects can be included in the future, these differences will be balanced out.

6 DISCUSSION

This paper aims at providing a framework to measure those constantly changing ideas and attitudes by emphasizing measuring the time people spend on processing the differences among the cognitive concepts they deal with. By using a system which can portrait the abstract concepts on a multidimensional Riemann space, the relations between concepts and how the relations change over time can be observed.

After the Galileo transformation, each concept can be represented by a set of multidimensional coordinates. With these coordinates, concepts can be plotted on a coordinate system and the relation between concepts can be viewed visually. Moreover, interesting mathematical analysis can be performed. As is shown before in the results section, a time-series data can be separated into several sets according to the time variables. Each dataset can then be made into a perceptual map with all concepts in it. The differences between the sets will be the change over time. To be able to compare these differences between set, a procedure called rotation is performed first. Rotation will rotate these separated datasets to fit with a same standard, a universal reference frame. As a result, the distance moved between sets of a concept will show how the perception of such concept changes over time. It is an effective way to monitor the change of abstract concepts. For each dataset, it is like taking a *snapshot* which shows how human minds think of the subject for a time or an

interval of time. The precision level for the time, as is measured in the experiment introduced in this proposal, can reach to hectosecond (1/100 second) which means the interval of time can be as small as one hectosecond. If enough data can be obtained, the time difference between each separated set will so small that the *snapshots* can be serialized to make a *movie* representing the real-time change of human's ideas and attitudes.

It can never be over-stressed how important measuring the time variable is for looking into abstract concepts in human's mind, such as ideas and attitudes. This kind of concepts will be activated when people think about them or the concepts related to them. Once activated, these concepts will react actively in human's mind. If more information is fed to the brain, the movement of these activities will be reinforced. On the other hand, if no more information is fed, the activities will be weaken. Human's brain functions in such way to keep adjusting itself to fit with the environment (through the channel of information exchange). Human's emotions belong to this category perfectly. People have a basic idea of what emotions are and they can distinguish the basic ones easily. This is because of the education, cultures and daily interaction to other members of this society. People seek information to reduce uncertainty and avoid chaos. As a result, people's knowledge about emotions converge at some point that most people agree on the definition of emotions. In other words, those basic emotional concepts are understood

very similarly among most people. Nevertheless, this does not mean people will react similarly to a same event. That is because emotional feelings consist of converged social norms and personal experiences. Social norms tend to converge while personal experiences differ greatly.

Future possible researches could consider to add in treatments to see how people react to a source of message, for example, a more credible source versus a less credible source, or adding in information to see whether it will cause some of the concepts to move to a certain direction, etc. The framework is not limited to emotion studies; any attitudes, beliefs or behaviors measurements which focus on changes over time can make use of such framework.

A DENDOGRAM REPORT OF CATPAC ANALYSIS

TOTAL WORDS	5456	THRESHOLD	0.000
TOTAL UNIQUE WORDS	100	RESTORING FORCE	0.100
TOTAL EPISODES	695	CYCLES	1
TOTAL LINES	4230	FUNCTION	Sigmoid (-1 - +1)
		CLAMPING	Yes

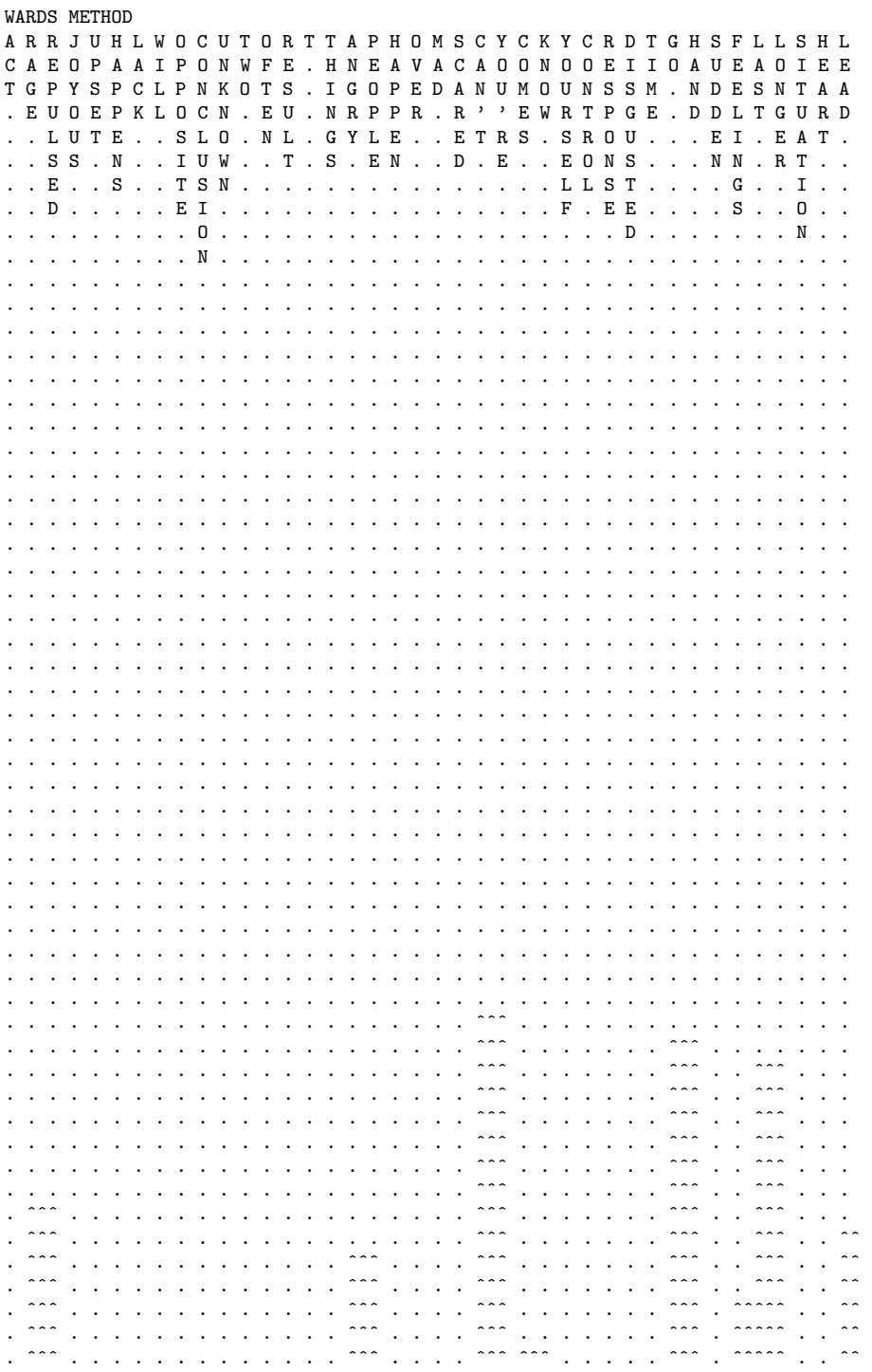
DESCENDING FREQUENCY LIST

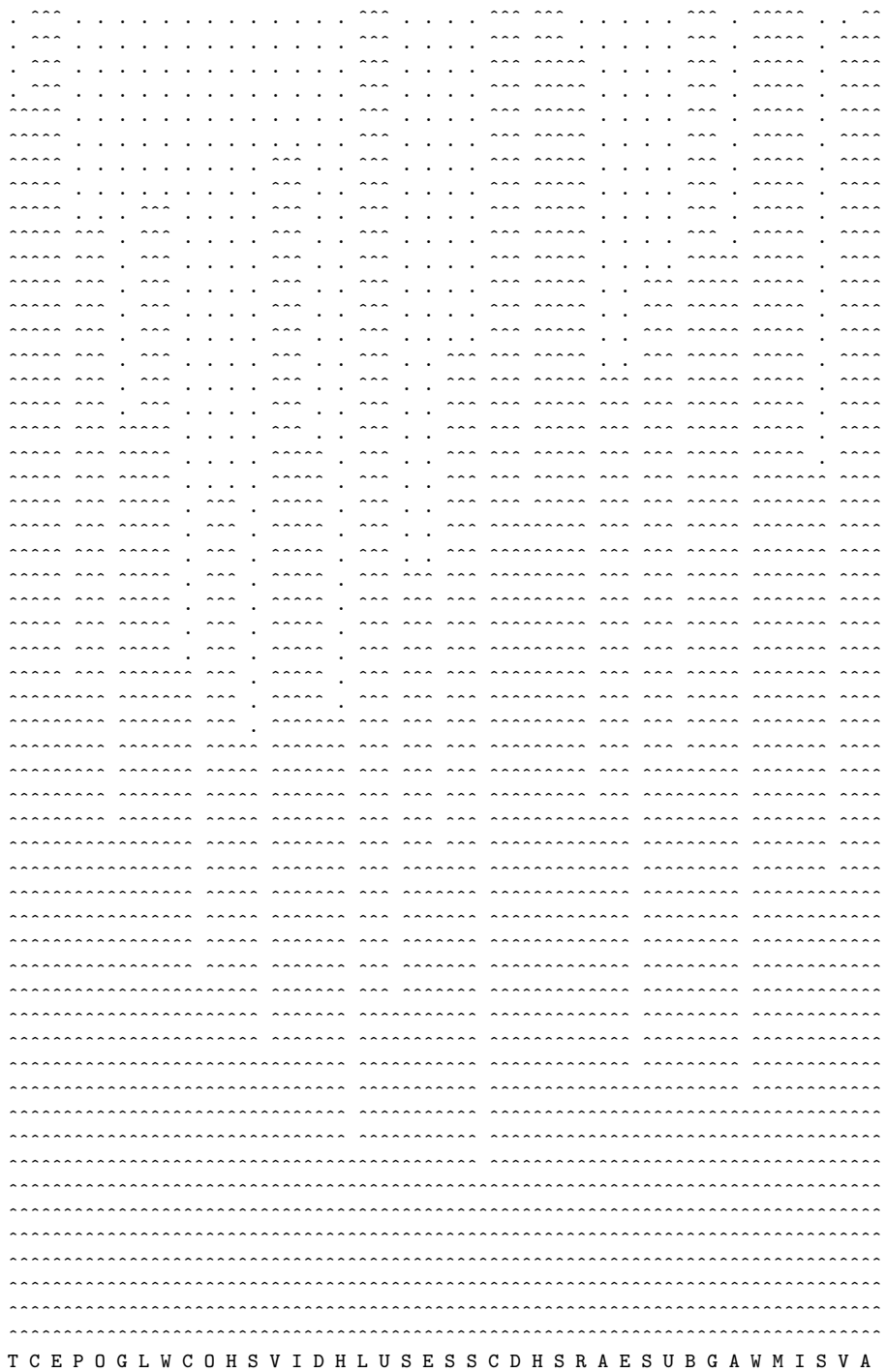
WORD	FREQ	PCNT	CASE FREQ	CASE PCNT
FEAR	407	7.5	208	29.9
ANGER	390	7.1	200	28.8
DISGUST	366	6.7	204	29.4
SURPRISE	308	5.6	157	22.6
HAPPY	292	5.4	165	23.7
SAD	275	5.0	146	21.0
SOMETHING	211	3.9	113	16.3
VS	188	3.4	133	19.1
DIFFERENCE	185	3.4	167	24.0
SADNESS	152	2.8	105	15.1
HAPPINESS	149	2.7	110	15.8
WHAT'S	133	2.4	130	18.7
FEEL	122	2.2	78	11.2
I	122	2.2	80	11.5
FEELING	114	2.1	85	12.2
QUOTE	100	1.8	72	10.4
SURPRISED	99	1.8	69	9.9
MAKES	89	1.6	56	8.1
NEGATIVE	81	1.5	62	8.9
POSITIVE	59	1.1	51	7.3
SOMEONE	59	1.1	36	5.2
ME	50	0.9	31	4.5
WANT	48	0.9	33	4.7
AFRAID	45	0.8	36	5.2
GOOD	44	0.8	39	5.6
EMOTION	42	0.8	32	4.6
REACTION	39	0.7	28	4.0
USUALLY	36	0.7	26	3.7
UNEXPECTED	35	0.6	33	4.7
ANGRY	33	0.6	17	2.4
BAD	33	0.6	27	3.9
MAD	30	0.5	25	3.6
PEOPLE	30	0.5	19	2.7
THINGS	29	0.5	20	2.9
DISGUSTED	26	0.5	16	2.3
HAPPEN	26	0.5	23	3.3
OFTEN	26	0.5	14	2.0
AWAY	25	0.5	22	3.2
HEARTS	25	0.5	10	1.4
I'M	25	0.5	19	2.7
TIME	25	0.5	19	2.7
DUE	24	0.4	13	1.9
EMOTIONAL	24	0.4	17	2.4

ALPHABETICALLY SORTED LIST

WORD	FREQ	PCNT	CASE FREQ	CASE PCNT
ACT	11	0.2	8	1.2
AFRAID	45	0.8	36	5.2
ANGER	390	7.1	200	28.8
ANGRY	33	0.6	17	2.4
AWAY	25	0.5	22	3.2
BAD	33	0.6	27	3.9
CAN'T	11	0.2	10	1.4
CAUSE	12	0.2	10	1.4
CAUSES	19	0.3	13	1.9
CHANGE	14	0.3	11	1.6
COMES	12	0.2	11	1.6
CONCLUSION	18	0.3	10	1.4
CONTROL	17	0.3	14	2.0
DIFFERENCE	185	3.4	167	24.0
DISGUST	366	6.7	204	29.4
DISGUSTED	26	0.5	16	2.3
DOWN	15	0.3	15	2.2
DUE	24	0.4	13	1.9
EMOTION	42	0.8	32	4.6
EMOTIONAL	24	0.4	17	2.4
EMOTIONS	12	0.2	10	1.4
FEAR	407	7.5	208	29.9
FEEL	122	2.2	78	11.2
FEELING	114	2.1	85	12.2
FEELINGS	19	0.3	18	2.6
GO	17	0.3	13	1.9
GOING	12	0.2	12	1.7
GOOD	44	0.8	39	5.6
HAND	19	0.3	9	1.3
HAPPEN	26	0.5	23	3.3
HAPPENS	16	0.3	12	1.7
HAPPINESS	149	2.7	110	15.8
HAPPY	292	5.4	165	23.7
HAVING	12	0.2	11	1.6
HEART	15	0.3	10	1.4
HEARTS	25	0.5	10	1.4
HURT	13	0.2	11	1.6
I	122	2.2	80	11.5
I'M	25	0.5	19	2.7
JOYOUS	11	0.2	11	1.6
KNOW	13	0.2	11	1.6
LACK	15	0.3	15	2.2
LAST	11	0.2	6	0.9

SCARED	24	0.4	19	2.7	LEAD	20	0.4	12	1.7
RESPONSE	23	0.4	19	2.7	LIFE	13	0.2	11	1.6
LEAD	20	0.4	12	1.7	LONGER	11	0.2	7	1.0
OVER	20	0.4	19	2.7	LOTTERY	11	0.2	11	1.6
SITUATION	20	0.4	16	2.3	MAD	30	0.5	25	3.6
STIMULI	20	0.4	9	1.3	MAKES	89	1.6	56	8.1
CAUSES	19	0.3	13	1.9	ME	50	0.9	31	4.5
FEELINGS	19	0.3	18	2.6	NEGATIVE	81	1.5	62	8.9
HAND	19	0.3	9	1.3	OFTEN	26	0.5	14	2.0
CONCLUSION	18	0.3	10	1.4	OPPOSITE	16	0.3	16	2.3
U	18	0.3	3	0.4	OPPOSITES	15	0.3	14	2.0
CONTROL	17	0.3	14	2.0	OUTCOME	16	0.3	12	1.7
GO	17	0.3	13	1.9	OVER	20	0.4	19	2.7
SOMETIMES	17	0.3	14	2.0	PAIN	16	0.3	5	0.7
HAPPENS	16	0.3	12	1.7	PEOPLE	30	0.5	19	2.7
OPPOSITE	16	0.3	16	2.3	PERSON	11	0.2	10	1.4
OUTCOME	16	0.3	12	1.7	POSITIVE	59	1.1	51	7.3
PAIN	16	0.3	5	0.7	QUOTE	100	1.8	72	10.4
UPSET	16	0.3	15	2.2	RACE	15	0.3	8	1.2
DOWN	15	0.3	15	2.2	RAGE	12	0.2	11	1.6
HEART	15	0.3	10	1.4	REACTION	39	0.7	28	4.0
LACK	15	0.3	15	2.2	REPULSED	11	0.2	11	1.6
OPPOSITES	15	0.3	14	2.0	RESPONSE	23	0.4	19	2.7
RACE	15	0.3	8	1.2	RESULT	12	0.2	8	1.2
TWO	15	0.3	13	1.9	SAD	275	5.0	146	21.0
YOU'RE	15	0.3	11	1.6	SADNESS	152	2.8	105	15.1
CHANGE	14	0.3	11	1.6	SCARED	24	0.4	19	2.7
SUDDEN	14	0.3	12	1.7	SHOCK	13	0.2	12	1.7
T	14	0.3	13	1.9	SHOCKED	11	0.2	11	1.6
UNKNOWN	14	0.3	13	1.9	SICK	12	0.2	10	1.4
VERSUS	14	0.3	14	2.0	SITUATION	20	0.4	16	2.3
HURT	13	0.2	11	1.6	SOMEONE	59	1.1	36	5.2
KNOW	13	0.2	11	1.6	SOMETHING	211	3.9	113	16.3
LIFE	13	0.2	11	1.6	SOMETIMES	17	0.3	14	2.0
SHOCK	13	0.2	12	1.7	STATE	13	0.2	12	1.7
STATE	13	0.2	12	1.7	STIMULI	20	0.4	9	1.3
THINK	13	0.2	8	1.2	SUDDEN	14	0.3	12	1.7
WILL	13	0.2	12	1.7	SURPRISE	308	5.6	157	22.6
CAUSE	12	0.2	10	1.4	SURPRISED	99	1.8	69	9.9
COMES	12	0.2	11	1.6	T	14	0.3	13	1.9
EMOTIONS	12	0.2	10	1.4	THINGS	29	0.5	20	2.9
GOING	12	0.2	12	1.7	THINK	13	0.2	8	1.2
HAVING	12	0.2	11	1.6	TIME	25	0.5	19	2.7
RAGE	12	0.2	11	1.6	TWO	15	0.3	13	1.9
RESULT	12	0.2	8	1.2	U	18	0.3	3	0.4
SICK	12	0.2	10	1.4	UNEXPECTED	35	0.6	33	4.7
WINNING	12	0.2	12	1.7	UNKNOWN	14	0.3	13	1.9
ACT	11	0.2	8	1.2	UPSET	16	0.3	15	2.2
CAN'T	11	0.2	10	1.4	USUALLY	36	0.7	26	3.7
JOYOUS	11	0.2	11	1.6	VERSUS	14	0.3	14	2.0
LAST	11	0.2	6	0.9	VS	188	3.4	133	19.1
LONGER	11	0.2	7	1.0	WANT	48	0.9	33	4.7
LOTTERY	11	0.2	11	1.6	WHAT'S	133	2.4	130	18.7
PERSON	11	0.2	10	1.4	WILL	13	0.2	12	1.7
REPULSED	11	0.2	11	1.6	WINNING	12	0.2	12	1.7
SHOCKED	11	0.2	11	1.6	YOU'RE	15	0.3	11	1.6
YOURSELF	11	0.2	10	1.4	YOURSELF	11	0.2	10	1.4


WARDS METHOD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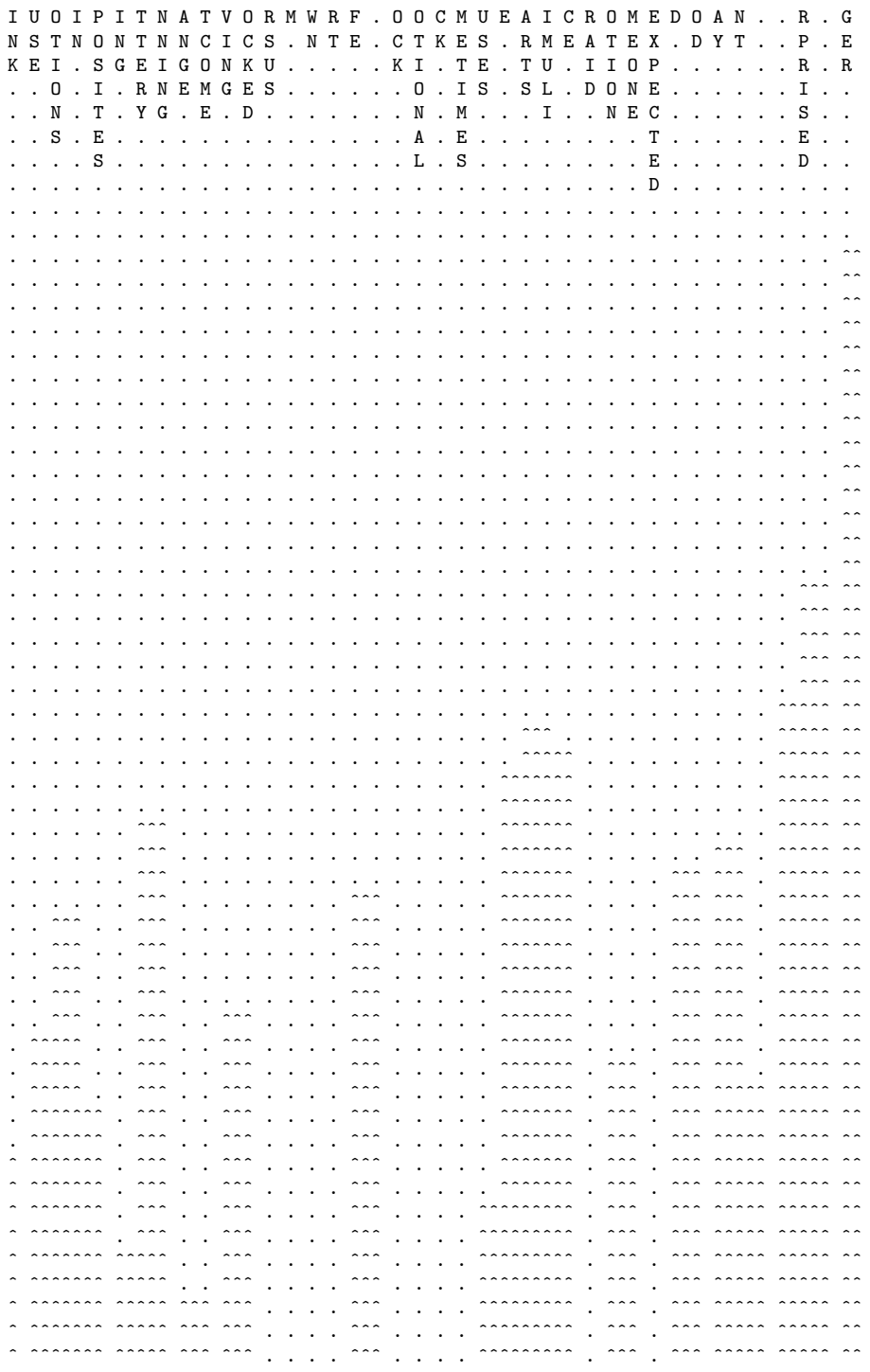

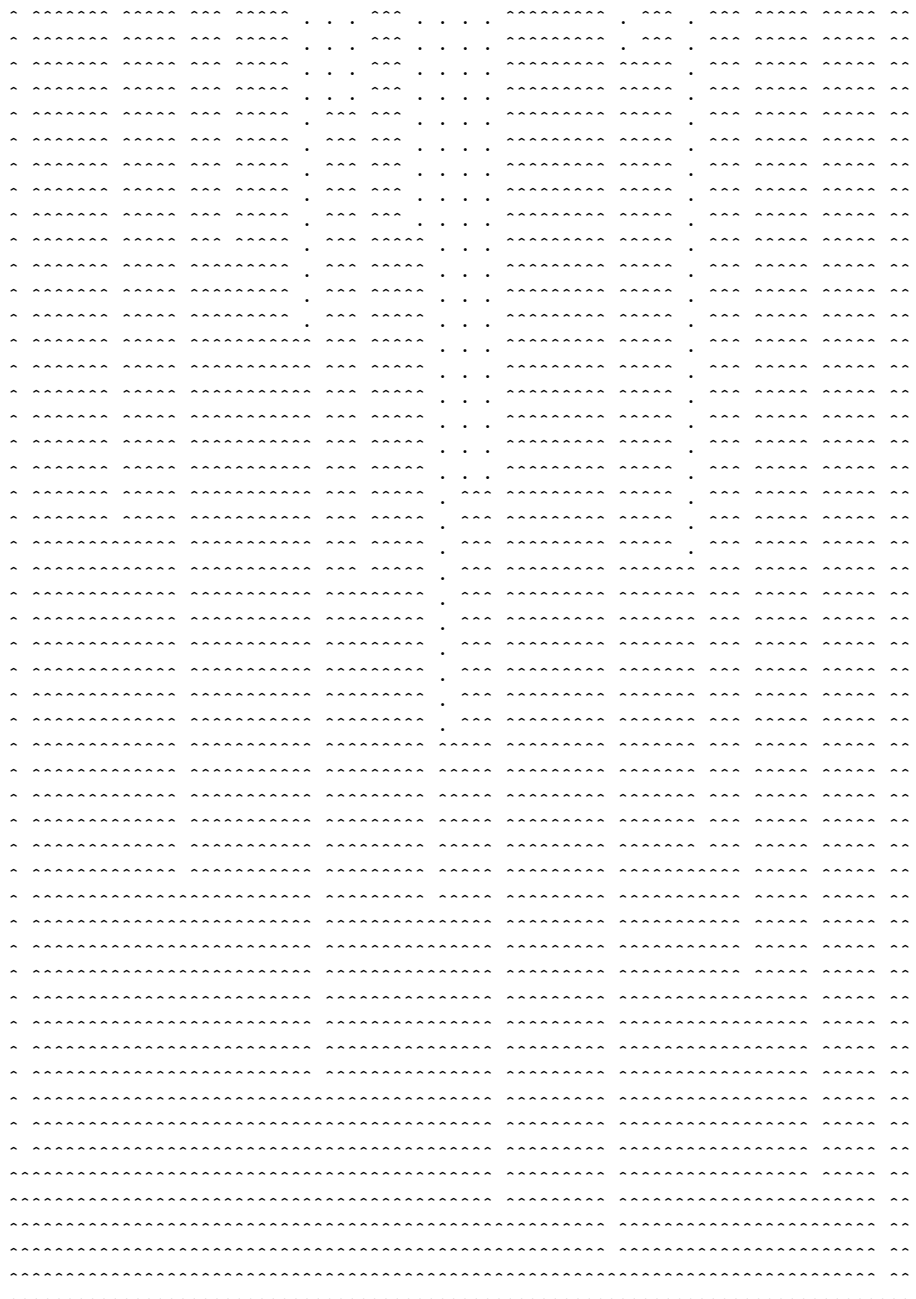

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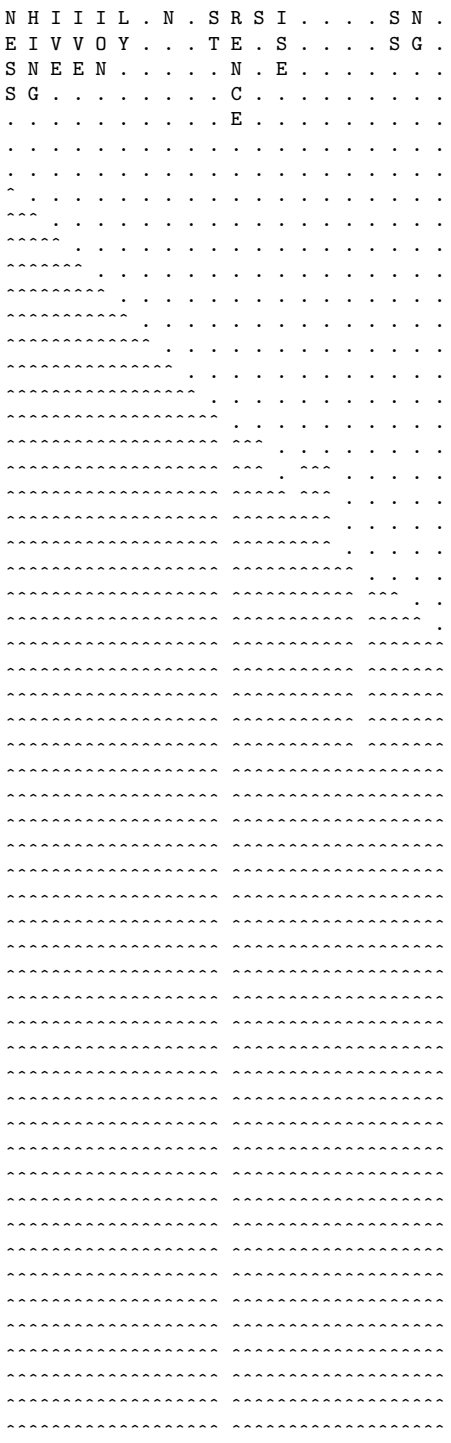

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B PRINTOUT QUESTIONNAIRE EXAMPLE—CONTROL GROUP

Instructions

Please estimate how different or "far apart" each of the following words or phrases is from each of the others. The more different, or further apart they seem to be, the larger the number you should write. To help you know what size number to write, remember:

Anger and Joy are 100 units apart.

If two words or phrases are not different at all, please write zero (0). If you have no idea, just leave the space blank.

Thank you very much for your help.

		Anger and Joy are 100 units apart.			
	COL.				
0102	9-17	Anger	and	Disgust	_____
0103	18-26	Anger	and	Joy	_____
0104	27-35	Anger	and	Fear	_____
0105	36-44	Anger	and	Sadness	_____
0106	45-53	Anger	and	Surprise	_____
0107	54-62	Anger	and	Control	_____
0108	63-71	Anger	and	Negative	_____
0109	72-80	Anger	and	Positive	_____

		Anger and Joy are 100 units apart.			
	COL.				
0110	9-17	Anger	and	Simple	_____
0111	18-26	Anger	and	Complicated	_____
0112	27-35	Anger	and	Unexpected	_____
0113	36-44	Anger	and	Work	_____
0114	45-53	Anger	and	Study	_____
0115	54-62	Anger	and	Party	_____
0116	63-71	Anger	and	Yourself	_____
0203	72-80	Disgust	and	Joy	_____

		Anger and Joy are 100 units apart.			
	COL.				
0204	9-17	Disgust	and	Fear	_____
0205	18-26	Disgust	and	Sadness	_____
0206	27-35	Disgust	and	Surprise	_____
0207	36-44	Disgust	and	Control	_____
0208	45-53	Disgust	and	Negative	_____
0209	54-62	Disgust	and	Positive	_____
0210	63-71	Disgust	and	Simple	_____
0211	72-80	Disgust	and	Complicated	_____

		Anger and Joy are 100 units apart.			
	COL.				
0212	9-17	Disgust	and	Unexpected	_____

```
0213  18-26  Disgust                and  Work                 _____
0214  27-35  Disgust                and  Study                _____
0215  36-44  Disgust                and  Party                _____
0216  45-53  Disgust                and  Yourself             _____
0304  54-62  Joy                    and  Fear                 _____
0305  63-71  Joy                    and  Sadness              _____
0306  72-80  Joy                    and  Surprise             _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0307   9-17  Joy                    and  Control              _____
0308  18-26  Joy                    and  Negative             _____
0309  27-35  Joy                    and  Positive             _____
0310  36-44  Joy                    and  Simple               _____
0311  45-53  Joy                    and  Complicated          _____
0312  54-62  Joy                    and  Unexpected           _____
0313  63-71  Joy                    and  Work                 _____
0314  72-80  Joy                    and  Study                _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0315   9-17  Joy                    and  Party                _____
0316  18-26  Joy                    and  Yourself             _____
0405  27-35  Fear                   and  Sadness              _____
0406  36-44  Fear                   and  Surprise             _____
0407  45-53  Fear                   and  Control              _____
0408  54-62  Fear                   and  Negative             _____
0409  63-71  Fear                   and  Positive             _____
0410  72-80  Fear                   and  Simple               _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0411   9-17  Fear                   and  Complicated          _____
0412  18-26  Fear                   and  Unexpected           _____
0413  27-35  Fear                   and  Work                 _____
0414  36-44  Fear                   and  Study                _____
0415  45-53  Fear                   and  Party                _____
0416  54-62  Fear                   and  Yourself             _____
0506  63-71  Sadness                and  Surprise             _____
0507  72-80  Sadness                and  Control              _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0508   9-17  Sadness                and  Negative             _____
0509  18-26  Sadness                and  Positive             _____
0510  27-35  Sadness                and  Simple               _____
0511  36-44  Sadness                and  Complicated          _____
0512  45-53  Sadness                and  Unexpected           _____
0513  54-62  Sadness                and  Work                 _____
0514  63-71  Sadness                and  Study                _____
0515  72-80  Sadness                and  Party                _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0516   9-17  Sadness                and  Yourself             _____
0607  18-26  Surprise               and  Control              _____
0608  27-35  Surprise               and  Negative             _____
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0609  36-44  Surprise               and  Positive               _____
0610  45-53  Surprise               and  Simple                 _____
0611  54-62  Surprise               and  Complicated            _____
0612  63-71  Surprise               and  Unexpected             _____
0613  72-80  Surprise               and  Work                   _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0614   9-17  Surprise               and  Study                  _____
0615  18-26  Surprise               and  Party                  _____
0616  27-35  Surprise               and  Yourself               _____
0708  36-44  Control                and  Negative               _____
0709  45-53  Control                and  Positive               _____
0710  54-62  Control                and  Simple                 _____
0711  63-71  Control                and  Complicated            _____
0712  72-80  Control                and  Unexpected             _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0713   9-17  Control                and  Work                   _____
0714  18-26  Control                and  Study                  _____
0715  27-35  Control                and  Party                  _____
0716  36-44  Control                and  Yourself               _____
0809  45-53  Negative               and  Positive               _____
0810  54-62  Negative               and  Simple                 _____
0811  63-71  Negative               and  Complicated            _____
0812  72-80  Negative               and  Unexpected             _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0813   9-17  Negative               and  Work                   _____
0814  18-26  Negative               and  Study                  _____
0815  27-35  Negative               and  Party                  _____
0816  36-44  Negative               and  Yourself               _____
0910  45-53  Positive               and  Simple                 _____
0911  54-62  Positive               and  Complicated            _____
0912  63-71  Positive               and  Unexpected             _____
0913  72-80  Positive               and  Work                   _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
0914   9-17  Positive               and  Study                  _____
0915  18-26  Positive               and  Party                  _____
0916  27-35  Positive               and  Yourself               _____
1011  36-44  Simple                 and  Complicated            _____
1012  45-53  Simple                 and  Unexpected             _____
1013  54-62  Simple                 and  Work                   _____
1014  63-71  Simple                 and  Study                  _____
1015  72-80  Simple                 and  Party                  _____
             ------------------------------------------------------
              Anger and Joy are 100 units apart.
       COL.  ------------------------------------------------------
1016   9-17  Simple                 and  Yourself               _____
1112  18-26  Complicated            and  Unexpected             _____
1113  27-35  Complicated            and  Work                   _____
1114  36-44  Complicated            and  Study                  _____
1115  45-53  Complicated            and  Party                  _____
```

1116	54-62	Complicated	and	Yourself	_____
1213	63-71	Unexpected	and	Work	_____
1214	72-80	Unexpected	and	Study	_____

Anger and Joy are 100 units apart.

COL.					
1215	9-17	Unexpected	and	Party	_____
1216	18-26	Unexpected	and	Yourself	_____
1314	27-35	Work	and	Study	_____
1315	36-44	Work	and	Party	_____
1316	45-53	Work	and	Yourself	_____
1415	54-62	Study	and	Party	_____
1416	63-71	Study	and	Yourself	_____
1516	72-80	Party	and	Yourself	_____

What is your gender?_____ (1=female, 2=male)
What is your age? _____ (in years)
What day is today? _____
(1=Monday, 2=Tuesday, 3=Wednesday, 4=Thursday, 5=Friday, 6=Saturday, 7=Sunday)

C PRINTOUT QUESTIONNAIRE EXAMPLE—TREATMENT GROUP

Instructions

Please estimate how different or "far apart" each of the following words or phrases is from each of the others. The more different, or further apart they seem to be, the larger the number you should write. To help you know what size number to write, remember:

Anger and Joy are 100 units apart.

If two words or phrases are not different at all, please write zero (0). If you have no idea, just leave the space blank.

Please also read this statement:

Anger and Fear are two very different emotions.

Thank you very much for your help.

Anger and Joy are 100 units apart.

	COL.				
0102	9-17	Anger	and	Disgust	_____
0103	18-26	Anger	and	Joy	_____
0104	27-35	Anger	and	Fear	_____
0105	36-44	Anger	and	Sadness	_____
0106	45-53	Anger	and	Surprise	_____
0107	54-62	Anger	and	Control	_____
0108	63-71	Anger	and	Negative	_____
0109	72-80	Anger	and	Positive	_____

Anger and Joy are 100 units apart.

	COL.				
0110	9-17	Anger	and	Simple	_____
0111	18-26	Anger	and	Complicated	_____
0112	27-35	Anger	and	Unexpected	_____
0113	36-44	Anger	and	Work	_____
0114	45-53	Anger	and	Study	_____
0115	54-62	Anger	and	Party	_____
0116	63-71	Anger	and	Yourself	_____
0203	72-80	Disgust	and	Joy	_____

Anger and Joy are 100 units apart.

	COL.				
0204	9-17	Disgust	and	Fear	_____
0205	18-26	Disgust	and	Sadness	_____
0206	27-35	Disgust	and	Surprise	_____
0207	36-44	Disgust	and	Control	_____
0208	45-53	Disgust	and	Negative	_____
0209	54-62	Disgust	and	Positive	_____
0210	63-71	Disgust	and	Simple	_____
0211	72-80	Disgust	and	Complicated	_____

```
                ------------------------------------------------------
                 Anger and Joy are 100 units apart.
        COL.    ------------------------------------------------------
0212     9-17   Disgust                 and  Unexpected          _____
0213    18-26   Disgust                 and  Work                _____
0214    27-35   Disgust                 and  Study               _____
0215    36-44   Disgust                 and  Party               _____
0216    45-53   Disgust                 and  Yourself            _____
0304    54-62   Joy                     and  Fear                _____
0305    63-71   Joy                     and  Sadness             _____
0306    72-80   Joy                     and  Surprise            _____
                ------------------------------------------------------
                 Anger and Joy are 100 units apart.
        COL.    ------------------------------------------------------
0307     9-17   Joy                     and  Control             _____
0308    18-26   Joy                     and  Negative            _____
0309    27-35   Joy                     and  Positive            _____
0310    36-44   Joy                     and  Simple              _____
0311    45-53   Joy                     and  Complicated         _____
0312    54-62   Joy                     and  Unexpected          _____
0313    63-71   Joy                     and  Work                _____
0314    72-80   Joy                     and  Study               _____
                ------------------------------------------------------
                 Anger and Joy are 100 units apart.
        COL.    ------------------------------------------------------
0315     9-17   Joy                     and  Party               _____
0316    18-26   Joy                     and  Yourself            _____
0405    27-35   Fear                    and  Sadness             _____
0406    36-44   Fear                    and  Surprise            _____
0407    45-53   Fear                    and  Control             _____
0408    54-62   Fear                    and  Negative            _____
0409    63-71   Fear                    and  Positive            _____
0410    72-80   Fear                    and  Simple              _____
                ------------------------------------------------------
                 Anger and Joy are 100 units apart.
        COL.    ------------------------------------------------------
0411     9-17   Fear                    and  Complicated         _____
0412    18-26   Fear                    and  Unexpected          _____
0413    27-35   Fear                    and  Work                _____
0414    36-44   Fear                    and  Study               _____
0415    45-53   Fear                    and  Party               _____
0416    54-62   Fear                    and  Yourself            _____
0506    63-71   Sadness                 and  Surprise            _____
0507    72-80   Sadness                 and  Control             _____
                ------------------------------------------------------
                 Anger and Joy are 100 units apart.
        COL.    ------------------------------------------------------
0508     9-17   Sadness                 and  Negative            _____
0509    18-26   Sadness                 and  Positive            _____
0510    27-35   Sadness                 and  Simple              _____
0511    36-44   Sadness                 and  Complicated         _____
0512    45-53   Sadness                 and  Unexpected          _____
0513    54-62   Sadness                 and  Work                _____
0514    63-71   Sadness                 and  Study               _____
0515    72-80   Sadness                 and  Party               _____
                ------------------------------------------------------
                 Anger and Joy are 100 units apart.
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       COL.  ---------------------------------------------------------
0516    9-17  Sadness                 and  Yourself                _____
0607   18-26  Surprise                and  Control                 _____
0608   27-35  Surprise                and  Negative                _____
0609   36-44  Surprise                and  Positive                _____
0610   45-53  Surprise                and  Simple                  _____
0611   54-62  Surprise                and  Complicated             _____
0612   63-71  Surprise                and  Unexpected              _____
0613   72-80  Surprise                and  Work                    _____
              ---------------------------------------------------------
               Anger and Joy are 100 units apart.
       COL.  ---------------------------------------------------------
0614    9-17  Surprise                and  Study                   _____
0615   18-26  Surprise                and  Party                   _____
0616   27-35  Surprise                and  Yourself                _____
0708   36-44  Control                 and  Negative                _____
0709   45-53  Control                 and  Positive                _____
0710   54-62  Control                 and  Simple                  _____
0711   63-71  Control                 and  Complicated             _____
0712   72-80  Control                 and  Unexpected              _____
              ---------------------------------------------------------
               Anger and Joy are 100 units apart.
       COL.  ---------------------------------------------------------
0713    9-17  Control                 and  Work                    _____
0714   18-26  Control                 and  Study                   _____
0715   27-35  Control                 and  Party                   _____
0716   36-44  Control                 and  Yourself                _____
0809   45-53  Negative                and  Positive                _____
0810   54-62  Negative                and  Simple                  _____
0811   63-71  Negative                and  Complicated             _____
0812   72-80  Negative                and  Unexpected              _____
              ---------------------------------------------------------
               Anger and Joy are 100 units apart.
       COL.  ---------------------------------------------------------
0813    9-17  Negative                and  Work                    _____
0814   18-26  Negative                and  Study                   _____
0815   27-35  Negative                and  Party                   _____
0816   36-44  Negative                and  Yourself                _____
0910   45-53  Positive                and  Simple                  _____
0911   54-62  Positive                and  Complicated             _____
0912   63-71  Positive                and  Unexpected              _____
0913   72-80  Positive                and  Work                    _____
              ---------------------------------------------------------
               Anger and Joy are 100 units apart.
       COL.  ---------------------------------------------------------
0914    9-17  Positive                and  Study                   _____
0915   18-26  Positive                and  Party                   _____
0916   27-35  Positive                and  Yourself                _____
1011   36-44  Simple                  and  Complicated             _____
1012   45-53  Simple                  and  Unexpected              _____
1013   54-62  Simple                  and  Work                    _____
1014   63-71  Simple                  and  Study                   _____
1015   72-80  Simple                  and  Party                   _____
              ---------------------------------------------------------
               Anger and Joy are 100 units apart.
       COL.  ---------------------------------------------------------
1016    9-17  Simple                  and  Yourself                _____
```

```
 1112  18-26  Complicated            and  Unexpected            _____
 1113  27-35  Complicated            and  Work                  _____
 1114  36-44  Complicated            and  Study                 _____
 1115  45-53  Complicated            and  Party                 _____
 1116  54-62  Complicated            and  Yourself              _____
 1213  63-71  Unexpected             and  Work                  _____
 1214  72-80  Unexpected             and  Study                 _____
              ------------------------------------------------------
               Anger and Joy are 100 units apart.
        COL.  ------------------------------------------------------
 1215   9-17  Unexpected             and  Party                 _____
 1216  18-26  Unexpected             and  Yourself              _____
 1314  27-35  Work                   and  Study                 _____
 1315  36-44  Work                   and  Party                 _____
 1316  45-53  Work                   and  Yourself              _____
 1415  54-62  Study                  and  Party                 _____
 1416  63-71  Study                  and  Yourself              _____
 1516  72-80  Party                  and  Yourself              _____
              ------------------------------------------------------


What is your gender?_____   (1=female, 2=male)
What is your age?   _____   (in years)
What day is today?  _____
(1=Monday, 2=Tuesday, 3=Wednesday, 4=Thursday, 5=Friday, 6=Saturday, 7=Sunday)
```

D SOURCE CODE FOR QM (QUESTIONNAIRE MAKER)

```
      program QM !(Questionairre Maker)
c     Scott Danielsen
c     March 5, 1987
c     All Rights Reserved
c
c     PC VERSION November 27, 1989.
c
c     This program will set up a data element for
c     Newsped, the electronic Questionnairre.
c       Revisited February 8, 2008 to enable time-series --jw
c       -- back where a friend is a friend
c       Henceforward just "QM", to go with it's partner, Ed,
c       the program formerly known as "Sped."
c
c     Hao Chen
c     May 5, 2008
c     -- bug fixed
      common /frm/upper,miss
      character*80 cltnm/' '/,crit/' '/,dir/' '/,studnm/' '/,
     +study/' '/,study2/' '/,study3/' '/,study4/' '/,
     +userp(100,15)/1500*' '/,infile,inst ! we need more files jw 2/8/08
      character*80 study5/' '/
      character*25 lbls(40)/40*' '/
      character*132 form /'(a6,i2.2,'/
      integer*4 lower(100)/100*0/,miss(100),
     +qtype(100)/100*0/,upper(100)
      data ntype/0/,ncons/0/,numpar/0/
c
c     This program will work online or with an input file.
c
      call intro('QM','v2.00')
c
 1001 write(*,160)
 160  format(' Do you have an input file?')
      call yorn(*40,*41)
      call assist('?','el_input.hlp',*1001)
  40  write(*,161)
 161  format(' Please enter name of input file')
      write(*,'(a)') '>'
      read(*,102)infile
      call assist(infile(1:1),'el_infil.hlp',*40)
      open(unit=3,file=infile,err=40)
      open(unit=4,file='temp',err=40)
      lfni= 3
      lfno= 4
      go to 5
  41  lfni= 5
      lfno= 6
c
c
    5 write(lfno,1013)
 1013 format(' Please type in Study Directory.')
      write(lfno,'(a)') '>'
```

```
      nlines=nlines +1
      read(lfni,110,err=999,end=999)dir
      call assist(dir(1:1),'el_sdir.hlp',*5)
  110 format(a71)
      nume=index(dir,' ')-1
      study=dir
      study2=dir
      study3=dir
      study4=dir
      study5=dir
      study(nume+1:nume+10)='/study.dat'
      open(unit=1,file=study,status='unknown',err=5,recl=132)
      study2(nume+1:nume+10)='/study.lbl'
      open(unit=2, file=study2, status='unknown',err=5)
c
c       here make the extra files needed for time series experiments
c       sfile.dat, which keeps track of the starting seed
c       tofile.dat, the time series output file, and
c       intro.dat, for the instructions and treatment. jw 2/9/2008
      study3(nume+1:nume+10)='/sfile.dat'
      open(unit=3,file=study3,status='unknown',err=5)
      study4(nume+1:nume+11)='/tofile.dat'
      open(unit=4, file=study4, status='unknown',err=5)
      study5(nume+1:nume+9)='/inst.dat'
      open(unit=11,file=study5,status='unknown',err=5)
      write(3,75) 1
   75 format(i4)
c
 1002  write(lfno,204)
  204 format(' Please enter Name of Project Supervisor.')
      write(lfno,'(a)') '>'
      nlines=nlines+1
      read(lfni,102,err=999,end=999)cltnm
      call assist(cltnm(1:1),'el_cltnm.hlp',*1002)
c
 1003 write(lfno,205)
  205 format(' Please enter Title of Study.')
      write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,102,err=999,end=999)studnm
      call assist(studnm(1:1),'el_stunm.hlp',*1003)
c
 1004 write(lfno,201)
  201 format(' ',10x,' Please enter type of study:'
     +/' ',12x,' (1)  Galileo and Survey Questions '
     +/' ',12x,' (2)     Survey Questions only ')
      write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,100,iostat=nerr)ntype
      if(nerr.ne.0)call assist('?','el_ntype.hlp',*1004)
c       read and write the instructions for
c       time series experiments  ! jw 2/9/2008
        print*,' Please enter the instructions, ctrl d when done.'
c
        do 2001 i=1,250
        read(*,2003,end=2002) inst
        write(11,2003)inst
```

```
 2001   continue
 2003 format(a80)
c
 2002   go to (1,2)ntype
c
c     collect concept labels if Galileo.
c
    1 ncons=0
   77 ncons=ncons+1
 1005 write(lfno,335)ncons
  335 format(' Please enter concept ',i2,' (-2 to end)')
      write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,101,end=999,err=999)lbls(ncons)
      call assist(lbls(ncons)(1:1),'el_lbls.hlp',*1005)
      if(lbls(ncons).eq.'-2')go to 78
      if(lbls(ncons).eq.' ')go to 1005
      write(2,101)lbls(ncons)
      go to 77
  78  ncons=ncons-1
c
 1006 write(lfno,336)
  336 format(' What is your Criterion Pair?')
      write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,102,err=999,end=999)crit
      call assist(crit(1:1),'el_crit.hlp',*1006)
c
c     collect demographic information.
c
    2 numpar=1
    6 write(lfno,333)numpar
      j=1
  333 format(' Enter userp ',i2,' -1 for end of question,'
     +' -2 to end')
   65 write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,102,end=999)userp(numpar,j)
      call assist(userp(numpar,j)(1:1),'el_parm.hlp',*6)
      if(userp(numpar,j).eq.'-1')go to 66
      if(userp(numpar,j).eq.'-2')go to 55
      j=j+1
      go to 65
c
   66 write(lfno,200)
  200 format(' Enter type of question.'/' ',10x,' (1) Open-Ended'
     +/' ',10x,' (2) Magnitude Estimation'
     +/' ',10x,' (3) Multiple Choice or Likert-Type')
      write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,100,end=999,iostat=nerr)qtype(numpar)
      if(nerr.ne.0)call assist('?','el_qtype.hlp',*66)
c
      if(qtype(numpar).eq.1)then
         miss(numpar)=9
         go to 7
      end if
```

```
c
 1007 write(lfno,667)
  667 format (' Its lower bound.')
      write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,105,end=999,iostat=nerr)lower(numpar)
      if(nerr.ne.0)call assist('?','el_lower.hlp',*1007)
c
 1008 write(lfno,666)
 666  format(' Its upper bound.')
      write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,105,end=999,iostat=nerr)upper(numpar)
      if(nerr.ne.0)call assist('?','el_upper.hlp',*1008)
c
 1009 write(lfno,668)
  668 format(' And its missing value.')
      write(lfno,'(a)') '>'
      nlines=nlines +1
      read(lfni,105,iostat=nerr,end=999)miss(numpar)
      if(nerr.ne.0)call assist('?','el_miss.hlp',*1009)
c
c 67  if(qtype(numpar).ne.3)go to 7
c
c      do 11 i=1,upper(numpar)
c      write(lfno,3001)i
c 3001 format('0Please enter choice ',i2)
c      read(lfni,102,end=999,err=999)choise(numpar,i)
c   11 continue
c
      go to 7
 999  write(6,1313)nlines
 1313 format(' Error reading data on line', i3,/
     +' Try again or check your input file.')
      stop
    7 numpar=numpar+1
      go to 6
   55 numpar=numpar-1
      call frmat(form,numpar)
c
c     write it out.
c
      write(1,103)numpar
      write(1,103)ntype
      write(1,103)ncons
      write(1,102)cltnm
      write(1,102)studnm
      write(1,101)(lbls(i),i=1,ncons)
      write(1,102)crit
      write(1,104)form
      do 310 i = 1,numpar
        write(1,102)(userp(i,j),j=1,15)
        write(1,106)qtype(i),lower(i),upper(i),miss(i)
 310  continue
c      do 310 i=1,numpar
c 310    write(1,102)(choise(i,j),j=1,10)
      write(6,207)study
```

```
  207 format(' All done.  Information stored on file:'/2x,a78
     +//' WHEWPF! Press "ENTER" to return to Galileo Control')
      read(*,*)          ! wait for william
   15 close(1)
      close(2)
      close(3)
      close(4,status='delete')
  100 format(i2)
  101 format(a25)
  102 format(a80)
  103 format(i3)
  104 format(a132)
  105 format(i10)
  106 format(4i10)
      end
c
      subroutine frmat(form,numpar)
c     Scott Danielsen
c     01/08/88
c     all etc.
c
c     This subroutine will generate a character string
c     'form' based on the demographic information supplied
c     by the user.  Users will no longer be required to
c     supply the output format for demographics.
c     This is limited to integer format strings.
c
      common /frm/upper,miss
      character*132 form
      character*80 amiss,aup,acnt,alen
      integer*4 upper(100), miss(100), tstlen, st, tcol/8/
      character*10 intchar
c
c     get the first one, encode to character and
c     count length of string = number of columns.
c
      amiss=intchar(miss(1),lenmiss)
      aup=intchar(upper(1),lenup)
      tstlen = max0(lenmiss,lenup) !tstlen=# of cols in last demo
c      write(string,*) 150
c print*, 'len=', len_trim(string) ! ** debug **
      tcol = tstlen + tcol                !tcol kps trk of # of cols on a ln.
      ncnt=1                              !ncnt kps trk of # of cnsec matches.
      st=10                               !st kps trk of pstin in form stng.
c
c     go through the rest of the demos, compare new (ntest)
c     w/ last (tstlen) and build form accordingly.
c
      do 11 j=1,numpar
          i=j+1
          if(i .gt. numpar)go to 2
          amiss=intchar(miss(i),lenmiss)
          aup=intchar(upper(i),lenup)
          ntest=max0(lenmiss,lenup)
c ntest=# of cols in current demo.
c
          if(tcol+ntest .gt. 80) go to 2
```

```
c
         tcol=tcol+ntest
c
c        keep track of = length columns.
c
         if(ntest .eq. tstlen)then
            ncnt=ncnt+1
            go to 11
         end if
c
c        this is where we actually build the format string.
c        work through an example it is not a diff. algorithm.
c        form = nim where:
c
c                        n = ncnt   |
c                        i = 'i'    |-- e.g. (2I3)
c                        m = tstlen |
c
c
   2     alen=intchar(tstlen,lenlen)
         tstlen=ntest
         if(ncnt .eq. 1)go to 3           !skip if no consec.  matches.
         acnt=intchar(ncnt,lencnt)
         form(st:st+lencnt-1)=acnt(10-lencnt+1:10)
         st=st+lencnt
    3    form(st:st)='i'
         form(st+1:st+lenlen+1)=alen(10-lenlen+1:10)
         st=st+lenlen+1
c
c        if tcol > 80 insert a '/' for new line.
c        (if we go to unformatted data storage,
c         this will not be necessary)
c
         if (tcol + ntest .gt. 80) then
            form(st:st) = '/'
            tcol = ntest
         else
            form(st:st)= ','
         end if
c
         st=st+1
         if(st .gt. 132)then
            write(6,113)
 113        format(' Maximum number of characters execeeded',
     +             ' on format line (132).  Please reconsider.')
         endif
         ncnt=1
c
   11 continue
c
c     all done.  Replace last character of form w/ ')'.
c
      lenfrm=index(form,' ')-1
      form(lenfrm:lenfrm)=')'
      return
      end
c
```

```
      character * 10 function intchar(k,len)
c
c     Scott Danielsen
c     11/10/89
c     all rights reserved
c
      logical skip
      intchar = '          '
c
c     this function will accept an integer and return
c     the right-justified character equivalent.
c
      i=k
      skip=.true.
      do 9 j=1,10
        n=10-j
        real=aint(real*(i/10**n))
        if(real .eq. 0 .and. skip)then
           len=10-j
           go to 8
        endif
        skip = .false.
        intchar(j:j)=char(int(real)+48)
 8      i=i-real*10**n
 9    continue
      return
      end
      integer function strlen(st)
      integer i
      character st*(*)
      i = len(st)
      do while (st(i:i) .eq. ' ')
        i = i - 1
      enddo
      strlen = i
      return
      end
c    -------------------------Cross Training---------------------------
c     CROSS TRAINING SECTION: This set of subroutines will provide
c     for easy migration from system to system in spite of nasty I/O
c     contentions,  system calls. etc.  When porting from one system to
c     another, make sure all system specific commands are used and comment
c     out all others (in most cases this is one or two lines).  This should
c     take, maybe, 10 minutes tops.
c
c     These system specific commands have been clearly commented in the code.
c    ------------------------------------------------------------------
c----------------------------Subrootine Prompt-----------------------
      subroutine prompt
c
c     for da dos
      print 1
c     for da vax
c      print 2
  1   format(' >')  !this one format statement may work on the VAX too.
                    !someone should check it out, then we can lose
                    !this subroutine.
```

```
  2   format('$>')
      return
      end
c-------------------------Subrootine Intro-----------------------------
      subroutine intro(prog,vers)
c
c     Scott Danielsen
c     11/27/89
c
      character*(*) vers
      character*80 hfile
      character*(*) prog
      character*1 ans
c      for da vax
c      character*8 tim
c      character*9 dat
c      for da dos
      integer  hour,minute,second,hund,year,month,day
c
c     for da vax
c      call date(dat)
c      call time(tim)
c      print 101,prog,vers,dat,time
c 101  format(//////////5x,a10,5x,a5,15x,a9,5x,a8)
c      for da dos
c      call getdat(year,month,day)
c      call gettim(hour,minute,second,hund)
c      year = year-1900
c      print 100,prog,vers,month,day,year,hour,minute,second
 100  format(//////////5x,a10,5x,a5,
     +15x,i2.2,'/'i2.2,'/',i4.2,6x,i2.2,':'i2.2,':',i2.2)
c     for everybody!
      write(6,1)prog
    1 format(//'      Hello, I''m ',a2,//,
     +'      Please enter ''?'' anytime you need help,'//,
     +'      ...or press ''ENTER'' to continue,',//,
     +'      ([ctrl C] will send you back to Galileo'
     +' Control.)',//////)
      read(5,226)ans
      if(ans.eq.' ')return
      hfile=prog//'.doc'
      if(ans.eq.'@')hfile='parrot.fun'
      call assist(ans,hfile,*3)
  226 format(a1)
  3   return
      end
c-----------------------------Subrootine Assist-------------------------
      subroutine assist(ans,hfile,*)
      character*1 ans
      character*(*)hfile
      character*80 ifile,htext
c
      j=0
      if(ans.eq.'?'.or.ans.eq.'@')go to 7
      return
c     for dos
   7  continue
```

```
      ifile='c:\galileo\help\'//hfile
c     for mr. vax
c      ifile='[com0.comjoew.galileo.help]'//hfile(1:len)
      open(unit=19,file=ifile,status='old',err=2)
      do 3 i=1,100
      j=j+1
      if(j.eq.22)then
      j=0
      print 300
 300  format('0Press ''ENTER'' to continue.')
      read(5,*)
      end if
      read(19,4,end=5)htext
      write(6,4)htext
    3 continue
    4 format(a80)
      go to 5
   2  print*,' Sorry, I can''t help you. You''re on your own!'
   5  close(19)
      return 1
   6  close(19)
      return
      end
c
      subroutine yorn(*,*)
c
      character*1 ans
    1 call prompt
      read(*,2,end=3)ans
    2 format(a1)
      if(ans.eq.'Y'.or.ans.eq.'y')return 1
      if(ans.eq.'N'.or.ans.eq.'n')return 2
      if(ans.eq.'?')return
      write(*,4)
    4 format(' I need a YES or NO.  Enter ''?'' for help')
      go to 1
    3 write(*,5)
    5 FORMAT(' PLEASE, answer the question.')
      go to 1
      end
```

E SOURCE CODE FOR ED (ENTERING DATA)

```
c  Scott Danielsen
c  All rights absurd
c  February 16, 1986( happy observed birthday George and Abe.)
c
c  PC VERSION November 27, 1989
c
c  Hi, this program allows entry of
c  Galileo type data, demographic type data, and
c  open-ended type data.
c Changed SPED to ED 2/5/2008 to allow entry of time-series data
c Joe Woelfel (Back in the Saddle again)
c
c GETTIM function is picked for the timer
c Hao Chen 5/5/2008
      common/data/numpar,qtype,lower,upper,miss,demos,nlin
      common/gal/nums,addr,ncons,lbls,nlines,npairs,id,crit ! add crit
                                          ! to common block jw 2.7.08
      character*80 cltnm,crit,dir,studnm,study,userp(100,15)
      character*80 sfile ! this is the file that holds the
c                        start seed for time series ! jw 2/7/08
      character*80 tofile ! this is the output file for the
c                             time series data  jw 2/7/08
      character*80 ifile,inst ! inst=the instructions file
      character*25 lbls(40)
      character*132 form/' '/,id*6,pauser*6
      integer lower(100),miss(100),qtype(100),upper(100),nums(500),
     +addr(500),demos(100),nlin(100),numpar,ncons
c      logical ask/.true./
c
      call intro('Ed','v2.00')
c
c     get the name of the study directory & build image of
c     data file.
c
    5 write(*,100)
 100  format(' Please type in Study Directory.')
      write(*,'(a,\)') ' >'
      read(*,110,err=5,end=55)dir
      call assist(dir(1:1),'sp_sdir.hlp',*5)
c
      nume=index(dir,' ')-1
      study=dir
      study(nume+1:nume+10)='/study.dat'
      sfile=dir  ! the time series seed file ! jw 2/7/08
      sfile(nume+1:nume+10)='/sfile.dat'      ! jw 2/7/08
      tofile=dir ! the time series output file jw 2/7/08
      tofile(nume+1:nume+11)='/tofile.dat'    ! jw 2/7/08
      inst=dir                                ! jw 2/9/2008
      inst(nume+1:nume+9)='/inst.dat' !the instructions file
      open(unit=1,file=study,status='unknown',err=4,recl=132)
      open(unit=15,file=sfile,status='unknown',err=4,recl=132) !jw 2/7/08
      open(unit=16,file=tofile,access='append',status='unknown',
     +err=4,recl=132) !jw 2/7/08
```

```
      open(unit=17,file=inst,status='old',err=4) ! jw 2/9/2008
c        inst.dat is the instructions file, written by QM
      go to 3
c
c     this section of code will direct user in case of
c     error opening the data file.
c
    4 noops=noops+1
      if(noops.gt.1)then
      print*,' I''m sorry your study is not active or entry error.'
      print*,' Please check with your supervisor immediately.'
      stop
      end if
      dir=' '
      study=' '
      go to 5
c
c     Read in the relavant information from study file.
c
c 3    write(*,555)
c 555  format('0Data entry (Y/N)?')
c      call yorn(*556,*557)
c 556  ask = .false.
c
    3 read(1,101)numpar
 101  format(i3)
      read(1,101)ntype
      read(1,101)ncons
      read(1,102)cltnm
 102  format(a80)
      read(1,102)studnm
      read(1,103)(lbls(i),i=1,ncons)
 103  format(a25)
      read(1,102)crit
      read(1,104)form
 104  format(a132)
      do 8 i = 1,numpar
      read(1,102)(userp(i,j),j=1,15)
   8  read(1,105)qtype(i),lower(i),upper(i),miss(i)
 105  format(4i10)
c      do 310 i=1,numpar
c         do 309 j=1,10
c         read(1,3001)choise(i,j)
c    309  if(choise(i,j).eq.' ')go to 310
c    310  continue
c
c     Build images of output files, open temporary storage.
c
      call build(*4,dir,numpar,qtype)
c
c     Begin data collection.
c
    7 write(6,445)
  445 format(' Type in ID (Ctrl-c when done)')
      write(*,'(a,\)') ' >'
      read(5,115,err=7,end=55)id
      call assist(id(1:1),'sp_id.hlp',*7)
```

```
      if (id .eq. ' ')go to 7
      ncases=ncases+1
c     Pause here before asking pair-comparison question
c     -- Hao Chen 9/3/2008
      write(6,475)
  475 format('...press ''Enter'' to continue...')
      read(5,476)pauser
  476 format(a6)
      go to (1,2)ntype
c
   1  call askgal(mm)
      call wrtout(mm)
c
   2  call askdem(id,userp)
      print*, form  ! ** debug **
      write(1,form)id,mm,(demos(i),i=1,numpar)
c
c       for time series data, stop after one case jw 2/8/2008
        print*, ' '
        print*,' Thanks for helping, My Friend!'
        print*, ' '
        print*,' May the Simulachron nurture you for all your days!'
        print*,' '
c
c      npairs=0
c      mm=1
c      go to 7
   55 continue
c
c      write(6,177)ncases
  177 format(' You have entered ',i2,' cases.')
c      close(1)
  110 format(a79)
  115 format(a6)
      end
c
      subroutine askdem(id,userp)
c
      common/data/numpar,qtype,lower,upper,miss,demos,nlin
      character*80 userp(100,15)
      character id*6
      integer qtype(100),lower(100),upper(100),miss(100)
     +,demos(100),nlin(100),mm
c      logical ask
c
      int=0
c
      do 10 i=1,numpar
      write(*,1000)i,userp(i,1)
      do 15 j=2,15
      if(userp(i,j).eq.'-1')go to 4
      write(*,100)userp(i,j)
   15 continue
 1000 format(/1x,i3,') ',a76)
  100 format(1x,a79)
c
    4 go to (2,1,3)qtype(i)
```

```
c
c      if(ask)then
c      write((6,100)(choise(i,j),j=1,upper(i))
    3 continue
      go to 1
c
    2 int=int+1
      call open(int,id,demos(i),*10)
c
    1 call retans(demos(i),*888)
c
      if(demos(i).gt.upper(i))go to 5
      if(demos(i).lt.lower(i))go to 5
      go to 10
    5 print*, ' Value out of range, please reenter.'
      go to 1
c
  888 demos(i)=miss(I)
   10 continue
c
c     check for errors.
c     For time series data collection, error checking is disabled
        go to 62 ! disabling error checking jw 2/8/2008
c
 1010 print*, ' '
      write(*,'(a,\)') ' Demographic corrections(Y/N)? '
      call yorn(*61,*62)
      call assist('?','sp_demo.hlp',*1010)
  61  print*, ' '
      print*, ' Type in Question number to correct.'
      print*,' '
      print*,'         (Ctrl-z when done)'
      write(*,'(a,\)') ' >'
      read(*,811,iostat=nerr,end=62)ndemo
      if(nerr.ne.0)call assist ('?','sp_ndemo.hlp',*61)
      if (ndemo.eq.0)go to 61
      if(ndemo.gt.numpar)then
         print*, ' '
         print*, ' Question number out of range, please re-enter.'
         go to 61
      endif
      if(upper(ndemo).eq.0)then
        print*, ' '
        print*, ' Cannot correct an open-ended response.'
        go to 61
      endif
      print*, ' '
   56 write(*,1000)ndemo,userp(ndemo,1)
      write(*,1001)demos(ndemo)
 1001 format(' Incorrect response: ',i10)
      print*,' '
      print*, ' Enter correct response.'
      call retans(ntemp,*666)
      if(ntemp .gt. upper(ndemo).or.
     +  ntemp .lt.lower(ndemo))then
        print*,' '
        print*, 'Value out of range, please reenter.'
```

```
        go to 56
      endif
      demos(ndemo)=ntemp
      go to 61
 666  demos(ndemo)=miss(ndemo)
      go to 61
 811  format(i10)
c
c      end error checking.
c
  62  return
      end
c
      subroutine wrtout(mm)
      common/gal/nums,addr,ncons,lbls,nlines,npairs,id
      integer nums(500),addr(500)
      character*25 lbls(40)
      character*6 id
      st=1
      en=8
      do 17 mm=1,nlines
      if(en.gt.npairs)en=npairs
    5 write(1,107)id,mm,(addr(no),nums(no),no=st,en)
  107 format(a6,i2.2,8(i4.4,i5))
      st=en+1
      en=st+7
   17 continue
      return
      end
c
      subroutine open(num,id,nans,*)
c
c     Scott Danielsen
c     February 16, 1986 (Happy observed birthday George!)
c     all rights reserved
c
c     this will allow open ended interview
c     data to be entered along with demographics and galileo
c     data. Data will be written to [study]quest.dat.
c     [study] and questnn is supplied by newsped where
c     nn=question number.
c
      common /bild/file
      character*79 line
      character file(25)*80,id*6
      logical wrt
c
c     Collect a response.
c
      nans=1
      nline=0
      wrt=.true.
c
      open(unit=25,file=file(num),status='unknown',err=88)
      do 25 kk=1,50000
  25    read(25,14,end=27)ans
  27  backspace 25
```

```
c
   71 print*, ' '
      print*, '(Ctrl-z when done) '
   13 write(*,'(a,\)') ' >'
        read(5,14,err=13,end=99)line
        if(line.eq.' ')go to 71
        if(wrt)write(25,15)id
c        write(25,15)id
        wrt=.false.
        nline=nline+1
        write(25,14)line
      go to 13
c
   99 if(nline .eq. 0)nans=9
      if(.not.wrt)write(25,16)
c      write(25,16)
      close(25)
      return 1
c
   88 print*,' Error opening interview data file.'
      Print*, ' Please contact your supervisor immediately.'
      stop
   16 format('-1')
   15 format(a6)
   14 format(a79)
      end
c
      subroutine inst(crit)
      character*80 crit
      write(6,100)crit
  100 format('1',5x,' Please estimate how different or "far apart" each
     +of the
     +following'/5x,' words or phrases is from each of the others.
     +The more different,'/5x,' or further apart they seem to be,
     +the larger the number you should'/5x,' write.  To help you
     +know what size number to write, remember'//10x,a70//5x,' If two
     +words or pharases are not different at all, please write'
     +/5x,' zero(0).  If you have no idea, we will leave the space
     +blank.')
      return
      end
c
      subroutine build(*,dir,numpar,qtype)
      common /bild/file
      character*(*)dir
      character*80 file(25),ogal
      character*13 gfile/'/galileo.dat'/
      integer qtype(100)
      character*10 intchar,anum
      character*1 ans
c
c     There has got to be a better way.
c       (there is 12-31-87!)
c
c     Now build the image of the gal/demo output file.
c
      nume=index(dir,' ')-1
```

```
      ogal=dir
      ogal(nume+1:nume+12)=gfile
c
      open (unit=1,file=ogal,status='unknown',err=88)
      do 1 j = 1,50000
   1  read(1,131,end=2)ans
   2  backspace 1
c
c     build images of open-ended output files.
c
      do 55 j = 1,numpar
         if(qtype(j) .eq. 1) then
            int=int+1
            nhold=j
            anum=intchar(nhold,len)
            if(anum(9:9).eq.' ')anum(9:9)='0'
            if(anum(8:8).eq.' ')anum(8:8)='0'
            file(int)=dir!//extra//anum(10-len:10)
            file(int)(nume+1:nume+6)='/quest'
            file(int)(nume+7:nume+9)=anum(8:10)!(10-len:10)
            file(int)(nume+10:nume+14)='.dat'
c           print*,' file(int)=',file(int)  ! ** debug **
         end if
 55   continue
      return
c
   88 print*, ' Error opening data file.'
      print*, ' Please contact your supervisor immediately.'
      stop
 131  format(a1)
      end
c
      subroutine retans(newnum,*)
c
c     this subroutine will read a number in character
c     form, verify that it is a number and return
c     an integer.
c
c
      character*80 anum
      integer*4 newnum,charint
c
    1 write(*,'(a,\)') ' >'
      read(5,100,err=2,end=3)anum
      call assist(anum(1:1),'sp_anum.hlp',*1)
      if(anum.eq.' ')return 1
      len=index(anum,' ')-1
      do 4 i=1,len
   4  if(index('1234567890',anum(i:i)).eq.0)go to 2
      newnum=charint(anum)
      return
c
    2 write(6,101)anum
  101 format(1x,a10,' is not a number please re-enter.')
      go to 1
c
   3  print*,' Please don''t give up.'
```

```
      print*, ' Re-enter number.'
      go to 1
c
  100 format(a10)
      end
c
      integer * 4 function charint(anum)
c
c     this will convert an integer in 'character' form into an integer.
c
        character*10 anum
        len=index(anum,' ')-1
        charint=0
        do 9 j=1,len
        charint = charint + (ichar(anum(j:j))-48)*10**(len-j)
 9    continue
        return
        end
c
        character * 10 function intchar(k,len)
        logical skip
        intchar = '          '
c
c     this function will accept an integer and return
c     the right-justified character equivalent.
c
        i=k
c      skip=.true.  ! ** what the hell? **
        skip=.false. ! ** debug **
        do 9 j=1,10
        n=10-j
        real=aint(real*(i/10**n))
        if(real .eq. 0 .and. skip)then
           len=10-j
c            len=11-j ! another bloody hail mary ** debug **
           go to 8
        endif
        skip = .false.
        intchar(j:j)=char(int(real)+48)
 8      i=i-real*10**n
 9    continue
c      print*,'intchar =',intchar,'len - ',len  ! ** debug **
      return
      end
c
      subroutine askgal(mm)
c
      common/gal/nums,addr,ncons,lbls,nlines,npairs,id,crit ! add crit to
                                                !common block jw 2/7/08
      integer nums(500),addr(500),ncons,cell
      character*25 lbls(40)
      character*6 id
      character*80 crit,inst  ! had to type crit jw 2/7/08
c
c  1   if(ask)call inst(crit)
c------------------read the instructions-------------jw 2/09/2008
      do 1, i=1,350 ! up to 350 lines of instructions jw 2/09/2008
```

```
      read(17,2003,end=2002)inst
      write(*,2003) inst
   1  continue
2003  format(a80)
2002  continue
      read(15,711)iseed ! the starting place for time series this time
      is=iseed
      do 11 i=is,ncons-1 ! start the loop were we left off last time jw
      do 9 j=is+1,ncons  ! 2/7/2008
      if(j.le.i)go to 9
c      if(np.eq.8.and.ask)then
         c         np=0
c      end if
c      np=np+1
      npairs=npairs+1
      addr(npairs)=i*100+j
      write(*,399)crit ! moved this statement here jw 2/7/08
  399 format(' Remember, ',a69,/)
c      write(*,1212)addr(npairs),lbls(i),lbls(j)
      write(*,1212)lbls(i),lbls(j)
      call getdat(year,month,day)
      call gettim(hour,minute,second,hund)
      call retans(nums(npairs),*888)
      nums(npairs)=min(nums(npairs),99999)   !if resp is >99999 ans=99999
c      print*,' nums(npairs) = ',nums(npairs)
      call getdat(yeara,montha,daya)
      call gettim(houra,minutea,seconda,hunda)
c          print*,' nums(npairs) again = ',nums(npairs)
c-----------write time series output on tofile.dat-------------
      WRITE(16,712) id,year,month,day,hour,minute,second,hund,
     + addr(npairs),nums(npairs),yeara,montha,daya,houra,
     + minutea,seconda,hunda
 712  format(a6,1x,i4.2,1x,i2.2,1x,i2.2,1x,i2.2,1x,i2.2,1x,i2.2,1x,
     +i2.2,1x,i4,1x,i5,1x,
     +i4.2,1x,i2.2,1x,i2.2,1x,i2.2,1x,i2.2,1x,i2.2,1x,i2.2)
c      print*, yeaR,MONTH,DAY,HOUR,SECOND,HUND,nums(npairs),
c     + YEARA,MONTHA,DAYA,HOURA,SECONDA,HUNDA
      go to 9
  888 nums(npairs)=-1
    9 continue
   11 continue
c      print*,' Im at the end of the 11 loop, is= ',is
      do 111 i=1,is-1  ! now go back through the loop from 1
      do 91 j=2,ncons     ! and end were we started jw 2/7 2008
      if(j.le.i)go to 91
c      if(np.eq.8.and.ask)then
c  399 format('0Remember, ',a69)
c         np=0
c      end if
c      np=np+1
      npairs=npairs+1
      addr(npairs)=i*100+j
       write(*,399)crit ! moved this statement here jw 2/7/08
      write(*,1212)lbls(i),lbls(j)
      call getdat(year,month,day)
      call gettim(hour,minute,second,hund)
      call retans(nums(npairs),*8888)
```

```
      nums(npairs)=min(nums(npairs),99999)   !if resp is >99999 ans=99999
      call getdat(yeara,montha,daya)
      call gettim(houra,minutea,seconda,hunda)
c-----------write time series output on tofile.dat-------------
      WRITE(16,712) id,year,month,day,hour,minute,second,hund,
     +addr(npairs)
     +,nums(npairs),yeara,montha,daya,houra,minutea,seconda,hunda
c      print*, yeaR,MONTH,DAY,HOUR,SECOND,HUND,nums(npairs),
c     + YEARA,MONTHA,DAYA,HOURA,SECONDA,HUNDA
      go to 91
 8888 nums(npairs)=-1
   91 continue
  111 continue
      iseed=iseed+1
      if(iseed.gt.ncons)iseed=1
      rewind 15
      write(15,711)iseed
c
c
      real=npairs/8
      nlines=aint(real)+1
c
c     check for errors
c      for time series data collection, error checking is disabled
       go to 78 ! disabling error correction jw 2/8/2008
c
c      if(.not. ask)then
 1013    print*, ' '
         write(*,'(a,\)') ' Galileo corrections (Y/N)? '
         call yorn(*77,*78)
         call assist('?','sp_gacor.hlp',*1013)
   77    print*, ' '
         print*, 'Type in cell #.  (Ctrl-z when done).'
         write(*,'(a,\)') ' >'
         read(*,711,iostat=nerr,end=78)cell
         if(nerr.ne.0)call assist('?','sp_cell.hlp',*77)
         if (cell.eq.0)go to 77
         do 71,j=1,npairs
         if(cell .eq. addr(j))go to 37
   71    continue
         print*, 'Incorrect cell address, try again'
         go to 77
   37    print*, ' '
         write(*,345)addr(j),nums(j)
 345     format(1x,i4.4,2x,i5)
         print*, 'Enter correct response.'
         call retans(nums(j),*777)
         go to 77
 777     nums(j)=-1
         go to 77
 711     format(i4)
c      endif
 78    return
 1212 format(' How far apart are ',a15,' and ',a15,'?')
       end
c    ------------------------Cross Training----------------------------
c     CROSS TRAINING SECTION: This set of subroutines will provide
```

```
c     for easy migration from system to system in spite of nasty I/O
c     contentions,  system calls. etc.  When porting from one system to
c     another, make sure all system specific commands are used and comment
c     out all others (in most cases this is one or two lines).  This should
c     take, maybe, 10 minutes tops.
c
c     These system specific commands have been clearly commented in the code.
c    ------------------------------------------------------------------
c----------------------------Subrootine Prompt-----------------------
      subroutine prompt
c
c     for da dos
      print 1
c     for da vax
c      print 2
  1   format(' >',\)  !this one format statement may work on the VAX too.
                      !someone should check it out, then we can lose
                      !this subroutine.
  2   format('$>')
      return
      end
c---------------------------Subrootine Intro-----------------------------
      subroutine intro(prog,vers)
c     Scott Danielsen
c     11/27/89
c
      character*(*) vers
      character*80 hfile
      character*(*) prog
      character*1 ans
c      for da vax
c      character*8 tim
c      character*9 dat
c      for da dos
      integer  hour,minute,second,hund,year,month,day
c
c     for da vax
c      call date(dat)
c      call time(tim)
c      print 101,prog,vers,dat,time
c 101  format(//////////5x,a10,5x,a5,15x,a9,5x,a8)
c      for da dos
      call getdat(year,month,day)
      call gettim(hour,minute,second,hund)
c      year = year-1900
      print 100,prog,vers,month,day,year,hour,minute,second
 100  format(//////////5x,a10,5x,a5,
     +15x,i2.2,'/'i2.2,'/',i4.2,6x,i2.2,':'i2.2,':',i2.2)
c     for everybody!
      write(6,1)prog
    1 format(//'      Hello, I''m ',a3,//,
     +'      Please enter ''?'' anytime you need help,'//,
     +'      ...or press ''ENTER'' to continue,',//,
     +'      ([ctrl C] will send you back to Galileo'
     +' Control.)',//////)
      read(5,226)ans
      if(ans.eq.' ')return
```

```
      hfile=prog//'.doc'
      if(ans.eq.'@')hfile='parrot.fun'
      call assist(ans,hfile,*3)
  226 format(a1)
  3   return
      end
c-----------------------------Subrootine Assist-------------------------
      subroutine assist(ans,hfile,*)
      character*1 ans
      character*(*)hfile
      character*80 ifile,htext
c
      j=0
      if(ans.eq.'?'.or.ans.eq.'@')go to 7
      return
c     for dos
   7  continue
      ifile='c:\galileo\help\'//hfile
c     for mr. vax
c      ifile='[com0.comjoew.galileo.help]'//hfile(1:len)
      open(unit=19,file=ifile,status='old',err=2)
      do 3 i=1,100
      j=j+1
      if(j.eq.22)then
      j=0
      print 300
 300  format(' Press ''ENTER'' to continue.')
      read(5,*)
      end if
      read(19,4,end=5)htext
      write(6,4)htext
    3 continue
    4 format(a80)
      go to 5
   2  print*,' Sorry, I can''t help you. You''re on your own!'
   5  close(19)
      return 1
   6  close(19)
      return
      end
c
      subroutine yorn(*,*)
c
      character*1 ans
    1 call prompt
      read(*,2,end=3)ans
    2 format(a1)
      if(ans.eq.'Y'.or.ans.eq.'y')return 1
      if(ans.eq.'N'.or.ans.eq.'n')return 2
      if(ans.eq.'?')return
      write(*,4)
    4 format(' I need a YES or NO.  Enter ''?'' for help')
      go to 1
    3 write(*,5)
    5 FORMAT(' PLEASE, answer the question.')
      go to 1
      end
```

F CHANGES OF MEAN DISTANCES OVER 5 GROUPS

	Changes between Groups				
PairID	Group 1 and 2	Group 2 and 3	Group 3 and 4	Group 4 and 5	Sum of Change
0102	24.750	1.329	21.778	40.843	88.700
0103	43.115	11.473	34.024	73.196	161.808
0104	22.068	7.718	35.600	19.500	84.886
0105	11.155	10.457	11.605	19.127	52.344
0106	18.269	35.769	47.539	22.546	124.123
0107	8.073	33.273	38.646	6.322	86.313
0108	28.917	7.042	4.500	0.893	41.351
0109	41.571	5.821	122.056	22.730	192.179
0110	5.862	61.360	48.222	21.000	136.444
0111	8.951	16.476	13.214	0.929	39.570
0112	1.197	22.058	32.000	123.152	178.406
0113	19.325	29.884	4.173	68.600	121.982
0114	8.083	20.135	203.015	204.525	435.758
0115	55.625	11.625	35.833	16.750	119.833
0116	43.500	13.967	43.800	12.033	113.300
0203	69.030	54.422	69.286	0.278	193.016
0204	27.804	23.229	14.181	39.758	104.972
0205	0.615	2.615	8.250	15.167	26.648
0206	40.054	67.991	72.417	32.945	213.406
0207	19.705	5.954	14.691	18.750	59.100
0208	31.509	11.289	23.032	1.413	67.243
0209	38.552	64.157	115.333	18.714	236.756
0210	6.804	6.004	51.700	44.000	108.509
0211	0.328	6.914	12.386	14.083	33.711
0212	22.553	0.400	64.400	32.650	120.003
0213	25.308	21.038	102.147	80.667	229.160
0214	4.041	29.141	21.200	9.500	63.882
0215	52.146	16.677	7.690	34.667	111.180
0216	44.083	20.100	25.293	49.857	139.333
0304	34.206	19.984	7.278	43.438	104.906
0305	30.810	31.143	69.286	59.050	190.289
0306	11.658	10.524	1.389	86.200	109.771
0307	1.049	55.857	55.500	1.500	113.907
0308	35.541	77.626	83.917	46.607	243.691

0309	41.321	3.579	12.800	56.500	114.200
0310	2.849	11.387	115.962	109.318	239.515
0311	1.939	8.436	13.375	80.500	104.250
0312	12.517	3.094	13.333	0.192	29.137
0313	6.083	10.445	7.972	41.650	66.150
0314	33.864	27.914	32.500	32.500	126.778
0315	30.109	58.312	68.088	41.375	197.884
0316	17.368	13.423	14.857	30.429	76.076
0405	45.812	2.781	9.692	73.000	131.286
0406	1.346	0.769	1.786	8.209	12.110
0407	46.200	36.308	15.641	34.556	132.704
0408	33.810	31.023	2.583	32.667	100.083
0409	20.280	122.357	134.648	30.229	307.514
0410	40.400	32.817	77.417	8.375	159.008
0411	12.154	15.545	111.429	93.571	232.699
0412	60.339	5.458	11.105	28.000	104.903
0413	8.204	79.109	73.167	84.067	244.546
0414	24.014	17.337	53.962	71.000	166.312
0415	35.766	0.042	198.500	213.546	447.853
0416	6.424	15.798	0.389	18.500	41.111
0506	47.716	34.025	11.143	43.667	136.551
0507	14.883	7.101	68.889	26.444	117.317
0508	51.288	4.764	10.338	30.400	96.789
0509	28.943	68.938	91.068	77.679	266.628
0510	20.567	2.601	5.410	5.833	34.411
0511	29.921	20.039	5.682	36.875	92.516
0512	45.688	5.167	1.439	56.727	109.021
0513	17.383	13.854	4.179	20.417	55.832
0514	25.238	3.762	23.417	15.583	68.000
0515	101.466	44.170	10.846	54.556	211.038
0516	34.536	35.508	58.627	93.333	222.005
0607	56.114	59.030	12.000	37.067	164.211
0608	1.750	97.780	85.364	32.286	217.180
0609	19.354	4.822	7.300	55.057	86.533
0610	3.452	14.036	2.717	22.900	43.105
0611	2.684	60.333	53.333	20.417	136.768
0612	60.950	1.450	13.750	11.667	87.817
0613	28.179	3.301	59.347	13.625	104.452
0614	25.981	2.648	21.917	60.250	110.795
0615	17.402	23.214	25.929	41.304	107.848

0616	19.115	54.750	60.250	7.333	141.449
0708	65.214	67.964	0.250	9.722	143.151
0709	8.617	7.398	8.831	17.500	42.345
0710	5.599	5.125	43.400	19.171	73.295
0711	20.950	2.675	21.375	50.750	95.750
0712	56.779	2.008	31.238	13.667	103.691
0713	32.713	34.285	32.607	11.278	110.882
0714	10.183	1.608	9.111	0.270	21.172
0715	3.388	8.533	4.667	8.139	24.726
0716	36.000	14.188	19.632	10.444	80.264
0809	46.742	5.042	10.000	2.857	64.641
0810	8.737	8.112	27.375	10.000	54.224
0811	7.377	8.343	32.190	74.939	122.849
0812	72.625	35.589	9.286	53.778	171.278
0813	17.300	8.388	11.922	9.359	46.969
0814	6.230	1.095	19.810	18.445	45.580
0815	69.659	41.953	5.591	15.700	132.902
0816	21.777	18.220	29.214	81.208	150.419
0910	17.714	14.514	12.300	28.611	73.140
0911	7.764	1.500	4.889	22.500	36.653
0912	5.182	58.033	58.964	15.306	137.484
0913	9.683	48.033	39.107	5.779	102.602
0914	61.456	74.179	146.179	127.600	409.413
0915	17.400	15.529	51.529	40.933	125.391
0916	10.182	6.818	1.611	17.028	35.639
1011	33.750	73.818	68.485	34.933	210.986
1012	19.022	41.285	8.688	52.964	121.959
1013	10.446	14.733	23.723	5.967	54.868
1014	37.632	14.035	3.750	26.250	81.667
1015	2.336	4.550	3.750	196.667	207.303
1016	4.778	4.389	3.675	11.686	24.527
1112	13.368	23.006	39.798	87.209	163.380
1113	29.946	3.125	5.833	31.623	70.528
1114	52.342	3.170	4.246	0.278	60.035
1115	20.382	2.909	15.439	16.379	55.109
1116	1.122	9.146	27.296	45.583	83.147
1213	46.244	9.938	11.786	31.214	99.183
1214	19.915	15.669	12.018	87.208	134.811
1215	18.529	2.091	7.545	127.046	155.211
1216	61.240	88.834	82.614	12.350	245.038

1314	6.814	26.135	4.902	41.611	79.463
1315	1.852	23.425	37.325	69.240	131.843
1316	16.377	22.765	16.172	76.737	132.050
1415	42.121	23.808	125.333	85.533	276.795
1416	21.859	6.451	9.967	32.236	70.513
1516	5.165	12.440	3.764	20.261	41.630

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