ABSTRACT

Title of Dissertation: THE COGNITIVE DYNAMICS OF BELIEFS: THE ROLE OF DISCREPANCY, CREDIBILITY, AND INVOLVEMENT ON MICROPROCESSES OF JUDGMENT

Sungeun Chung, Doctor of Philosophy, 2004

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This dissertation investigates the process of belief change by examining the time course of beliefs. The time course of belief change during judgment provides information about dynamic aspects of the cognitive system, cognitive responses during judgment, and the effect of distal variables on belief change. Several previous studies obtained individual belief trajectories using a computer mouse technique to observe the time course of belief change. Based on characteristics of belief trajectories, this study developed a new framework for their analysis. This framework allows analyses not only of overall but also of micro aspects of belief change during judgment. Hypotheses about the time course of belief changes were developed and tested with four data sets from three previous studies. Total $N = 267$.

This study found the following: (1) Belief change during message receipt reflects the structure and properties of the message; (2) belief change during the post-message

phase shows some oscillatory and some damping dynamics; (3) message discrepancy and source credibility have dynamic effects on belief change during judgment.

This study generally supports dynamic models of belief change. Methodologically, this study suggests that belief trajectories can provide on-line information about cognitive responses and micro belief changes during judgment.

THE COGNITIVE DYNAMICS OF BELIEFS: THE ROLE OF DISCREPANCY, CREDIBILITY, AND INVOLVEMENT ON MICROPROCESSES OF JUDGMENT

by

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DEDICATION

To my father, who must be most delighted with this book.

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CHAPTER I

Introduction

This dissertation investigates the patterns of belief change that people have while processing persuasive messages. Individuals face a number of persuasive messages via various channels. Some of those messages are persuasive enough so that people change their thoughts or beliefs based on those messages. What kinds of messages result in those changes? How do those changes occur? Communication scholars have paid a considerable amount of attention to those questions and there are many theories and empirical findings on the effect of persuasive messages on beliefs.

In the early history of study of persuasion (e.g., Hovland, Janis, & Kelly, 1953; see review by McGuire, 1969), researchers focused on the listing of variables that bring about different outcomes in the message recipient's beliefs. Laswell's (1948, p. 37) comprehensive question, "Who says what in which channel to whom with what effect?", had guided the selection of the variables examined as relevant to persuasion.

Communication studies did not stop with merely listing these variables but attempted to develop process models that could explain how persuasion variables result in belief change. McGuire (1968, 1969, 1972) proposed the reception-yielding model, which posits that the process of belief change due to persuasive messages basically consists of two information-processing stages, reception and yielding, and the effect of variables on beliefs can be explained by their effects on reception and yielding.

Petty and Cacioppo (1986) proposed a theoretical framework for the process of belief change by messages, the elaboration likelihood model (ELM), based on the cognitive-response model of persuasion (Greenwald, 1968; Petty, Ostrom, & Brock, 1981). According to the ELM, a message recipient utilizes one of two different processes or routes of belief change, the systematic or the peripheral, based on the individual's level of cognitive ability and the level of motivation for cognitive processing. For the two different routes of belief change, different kinds of variables have effects on beliefs. For the systematic route, variables related to message argument (e.g., message quality) are effective, but for the peripheral route, source-related variables (e.g., source credibility) are effective. The ELM specifies the process of belief change that explains how certain persuasion variables may have different effects in different situations.

Eagly and Chaiken proposed another dual-process model of belief change, the heuristic-systematic model (HSM; Chaiken, Liberman, & Eagly, 1989;Chen & Chaiken, 1999), which shares a fundamental commonality with the ELM, belief change via two qualitatively different processes, even though some differences in these models exist (see Chaiken, 1987; Eagly & Chaiken, 1993).

The reception-yielding model, the ELM, and the HSM identify some features of the process of belief change by persuasive messages. However, most communication studies do not address an important feature of the process of belief change, the time course of belief change during judgment. The time course of belief change during judgment refers to the recipient's positions over time during judgment. The time course of belief change shows how the recipient's position on an issue moves from his or her initial position to a new stable position as a message is being processed.

The time course of belief change during judgment provides vital information about the cognitive system and the process of belief change by persuasive messages.

First, the time course of belief change provides information aboutthe cognitive system. Several studies have found that belief change takes place during judgment after message receipt without additional information (Brehm, & Wicklund, 1970; Fink, Kaplowitz, & Hubbard, 2002; Gilbert, Krull, & Malone, 1990; Kaplowitz, Fink, & Bauer, 1983; McGreevy [now Hubbard], 1996; Poole & Hunter, 1979; Tesser, 1978; Vallacher, Nowak, & Kaufman, 1994; Walster, 1964; Wang, 1993). The findings of these studies suggest that the cognitive system is dynamic rather than static. However, these studies examined not the whole course of belief change over time but belief change at only some points during judgment. The time course of belief change during judgment provides information about the dynamics of the cognitive system in some detail.

Second, the time course of belief change provides information about structural properties of the cognitive system. There are different models of how concepts are structured in the cognitive system. One model of the cognitive system assumes that there are associative linkages between concepts and that these linkages are spring-like (the spatial-spring model of attitude change; see Fink & Kaplowitz, 1993; Fink, Monahan, & Kaplowitz, 1989; Kaplowitz et al., 1983; Woelfel & Fink, 1980), whereas other models of cognitive structure do not have the same assumption. Different models of cognitive structure have different implications for the time course of belief change during judgment. For example, a spatial-spring model of attitude change predicts oscillatory patterns of belief change during judgment. By testing patterns of belief change implied by different cognitive structures, the time course of belief change will provide information about the structural properties of the cognitive system.

Third, the time course of belief change during judgment provides information about cognitive responses during judgment. Cognitive responses are the recipients' generated issue-relevant thoughts during judgment. According to the cognitive response model of attitude change (Greenwald, 1968; Petty et al., 1981) and the ELM (Petty & Cacioppo, 1981, 1986; Petty & Wegener, 1999), the amount and the valence of cognitive responses are two primary aspects of thinking that affect processes and outcomes of belief change. The time course of belief change during judgment may reflect cognitive responses during judgment.

Fourth, the time course of belief change during judgment provides information about the effects of distal variables on beliefs. Distal persuasion variables may have effects not only on the final outcome of the belief change but also on the time course of belief change. Dynamic effects of distal variables on the belief system may provide information on how those variables influence the belief system.

This dissertation investigates the time course of belief change during judgment. The purpose of this dissertation is to deepen our understanding on the process of belief change and the cognitive system by analyzing the time course of belief change during judgment.

In Chapter 2 of this dissertation, models are proposed for the patterns of belief change over time, the relationship between cognitive responses and the time course of belief change, and the dynamic effect of some distal persuasion variables on belief change. These models are tested with four existing data sets from three different studies (Fink et al., 2002; McGreevy, 1996; Wang, 1993). Kaplowitz et al.'s (1983) spatial-spring model of cognitive forces is explicitly aimed at describing and explaining belief change during judgment. The theoretical rationale of the model and the results of studies based on the model are discussed. Also, characteristics of belief trajectories obtained by those studies are examined. Based on observed characteristics of belief trajectories, a new framework for the measurement of belief change during judgment is introduced.

Based on the spatial-spring model of cognitive forces and the new framework for the measurement of belief change during judgment, patterns of belief change are predicted for different types of messages: univalent messages and mixed-valence messages. The patterns of belief change in response to different types of messages are also predicted for different belief change phases: the message-receipt phase and the post-message phase.

Second, a theory of the role of cognitive responses on belief change and techniques to measure cognitive responses are discussed. Based on this discussion, some relationships between cognitive responses and aspects of belief trajectories are hypothesized.

Third, the dynamic effects of message discrepancy and source credibility on beliefs are investigated in order to explore how these variables influence the belief system. Message discrepancy and source credibility are known as key factors for belief change (Anderson, 1971). Message discrepancy refers to the difference between one's initial position and the position advocated in a message. Two mathematical models on the effect of message discrepancy on beliefs (Fink, Kaplowitz, & Bauer, 1983, a nonlinear model of positional and psychological discrepancy; Laroche, 1977, a nonlinear model of message discrepancy) are discussed. Based on these two mathematical models and other relevant studies, the effects of message discrepancy on beliefs at different time points during judgment are predicted.

Source credibility is one of the oldest concepts in persuasion research (Perloff, 1993) and has been extensively studied from the beginning of modern attitude change research (e.g., Hovland et al., 1953; Hovland & Weiss, 1951). Research has shown that a high credibility source is more persuasive than a low credibility source if attitudes are measured immediately after a message (Hovland & Weiss, 1951), but the effect of source credibility on attitude change is moderated by issue involvement (see Petty & Cacioppo, 1986). Based on results from those studies and other relevant research, the effects of message discrepancy on beliefs at different time points during judgment are modeled.

This dissertation analyzes belief trajectories that were obtained from three different studies (Fink et al., 2002; McGreevy, 1996; Wang, 1993). Chapter 3 of this dissertation describes how the belief trajectories used in this dissertation were obtained, the independent variables that were manipulated, and the dependent variables were that measured in those studies. The techniques used in those studies to obtain belief trajectories are discussed. In addition, the use of a new framework for measurement of belief change during judgment is explained.

Chapter 4 presents the results of tests of proposed hypotheses. Finally, Chapter 5 summarizes the results of the study, and addresses implications of the results, limitations of the study, and questions for future research.

CHAPTER II

Theoretical Rationale and Hypotheses

Theoretical Rationale

Definition of Belief, Judgment, Attitude, and Belief Change

Belief. In this chapter, models of belief change during judgment are proposed. To make theoretical arguments clearer, how the terms of belief and judgment are used in this study is specified. In this dissertation, a belief is defined as subjective knowledge (Kruglanski, 1989). Knowledge is a proposition or propositions (or bodies of interrelated propositions) in which a person has a given degree of confidence (Kruglanski, 1989). When a proposition is believed as true or right by a person, the proposition is a belief to the person. A proposition is a statement about the relationship between an object and attributes. Therefore, beliefs can be understood as associations that people establish between an object and attributes (Eagly & Chaiken, 1993; Fishbein & Ajzen, 1975).

Judgment. Acquisition of knowledge or beliefs is accomplished by bestowing some degree of confidence to a given proposition, which is the process of validation (Kruglanski, 1989). Judgment is the behavior of validating a proposition. Knowledge or beliefs are acquired by judgment.

Attitude. Some beliefs have affective or evaluative content (e.g., "the candy is *good*"). For those beliefs, the belief object is associated with an evaluate attribute. Beliefs with content that is evaluative are classified as attitudes (Kruglanski, 1989). In this dissertation, attitudes are treated as a subclass of beliefs. Kruglanski (1989) stated, "when a person makes an attitudinal statement whereby he or she feels positive about a given object, or considers it to have positive qualities, he or she actually is expressing an opinion or belief of an affective or evaluative type" (p. 112). Evaluative beliefs, that is, attitudes, and non-evaluative beliefs (e.g., "the candy is *red*") may have different implications but both exhibit the generic properties of beliefs (Dinauer, 2003; Kruglanski, 1989). Both are acquired by judgment.

The notion that attitudes are a subtype of opinions and beliefs is found in spatial theories of cognitive system. According to the Galileo spatial model (Foldy & Woelfel, 1990; Woelfel & Fink 1980), a belief can be represented as the distance between any two cognitive objects and an attitude can be represented as the distance between any concept and the self-concept (Neuendorf, Kaplowitz, Fink, & Armstrong, 1987; Woelfel & Fink, 1980).

Belief change. In this dissertation, belief change refers to the motion of the recipient's position on a certain issue from the recipient's prior position. The recipient's prior position may be neutral. When a belief object does not exist in the recipient's cognitive system, the recipient's initial position is assumed to be neutral. With this definition, belief change in this dissertation encompasses both changes from the neutral position to a new position, belief formation, and changes from a certain position to a new position.

A Spatial-Spring Model of Cognitive Forces

Kaplowitz et al.'s (1983) spatial-spring model of cognitive forces is explicitly aimed at describing and explaining belief change during judgment. Kaplowitz et al. used a mechanistic metaphor for belief change, and mathematically derived trajectories of belief change during judgment. The model predicts several dynamic patterns of belief change during judgment, including an oscillatory pattern of belief change (see below).

The model was built on two mechanical metaphors for belief systems. Like an object in a physical system, a concept in a cognitive system is considered to have both a location and a mass in a cognitive space. Belief change is equivalent to motion of a concept in the cognitive space (Fink et al., 2002; Kaplowitz et al., 1983; Woelfel & Fink, 1980). The model assumes that "the amount of acceleration of a concept will be equal to the amount of force acting upon the concept divided by the mass of that concept as in Newtonian mechanics" (Kaplowitz et al., 1983, p. 234).

The model also assumes that concepts in a cognitive space may be linked with each other and that the linkages are spring-like rather than brace-like (see Fink & Kaplowitz, 1993; Fink et al., 1989; Fink et al., 2002; Kaplowitz & Fink, 1982, 1988, 1992, 1996; Kaplowitz et al., 1983). Like the operation of a mechanical spring, the model assumes that when a concept is moving, two opposing forces operate: a force moving the concept away from the initial location and a force restoring the initial position. The existence of restoring forces has been supported to a limited extent by cognitive oscillations found empirically (Fink et al., 2002; Foldy & Woelfel, 1990; Kaplowitz et al., 1983; McGreevy, 1996; Vallacher et al., 1994; Wang, 1993; Woelfel, Newton, Holmes, Kincaid, & Lee, 1986). The spring-like linkage model suggests a parameter for the damping of cognitive motion. Just as the motion of a spring dies out, when beliefs oscillate, it appears that such oscillations usually die out. The model assumes a *cognitive damping* process, in which the patterns of oscillation of the cognitive system depend on the size of the damping forces as compared to the restoring forces.

Based on the above assumptions, the force created by a spring-like linkage between two concepts is modeled by the following equation:

$$F_{A,B} = K_{A,B}\left\lfloor d_{Eq}(A,B) - d(A,B)\right\rfloor, \tag{1.1}$$

where $F_{\mathrm{A,B}}$ is the force created by the linkage between concept *A* and concept *B*, $d_{Eq}(A,B)$ is the equilibrium distance of the linkage, which is the dissimilarity between *A* and *B* specified in the message, $d(A,B)$ is the distance between those concepts in the recipient's cognitive space before the recipient receives the message and $K_{\mathrm{A,B}}$ is the restoring coefficient of the linkage.

Restoring coefficients represent the strength of the spring (Ingard & Kraushaar, 1960). According to Kaplowitz and Fink (1982, 1988, 1992), the restoring coefficient of a message is an increasing function of source credibility of the message, the strength of arguments in the message, and the recency of the message.

With Newton's laws of force and motion and the assumption of a cognitive damping process, Equation 1.1 leads to the following differential equation (Kaplowitz & Fink, 1982, p. 374):

$$m\frac{d^2x^*}{dt^2} + C\frac{dx^*}{dt} + Kx^* = 0\,, \tag{1.2}$$

where x^* is the distance of a concept from its equilibrium location, *t* is time, *K* is the net restoring coefficient on the concept, *m* is the mass of the concept and *C* is a damping coefficient.

If $C^2 > 4Km$, the system is overdamped, and if $C^2 = 4Km$, the system is critically damped. On the other hand, if $C^2 < 4Km$, the system generates an underdamped oscillatory trajectory" (Kaplowitz & Fink, 1982). We solve the differentialequation for the case $C^2 < 4Km$. We define

$$\text{“} r = -\frac{C}{2m}, \tag{1.3}$$

and

$$\omega = \frac{\sqrt{4km - C^2}}{2m}. \tag{1.4}$$

The solution [for Equation 1.2] can be written as

$$x = e^{rt}(a_1 \sin \omega t + a_2 \cos \omega t)\text{ ,”} \tag{1.5}$$

(Kaplowitz & Fink, 1982, p. 376) where e is the exponential function, and a_1 and a_2 reflect initial conditions. Equation 1.5 describes belief change trajectories with a period $= \frac{2\pi}{\omega}$. If we assume that cognitive systems have a damping force as mechanical systems have friction, then $C > 0$ and $r < 0$. In this case, the cognitive motion will be oscillation with damping. In the process of oscillation with damping, the direction of belief change alternates repeatedly, and the amount of belief change in each direction decreases as the belief approaches equilibrium. Figure 1 represents Equation 1.5 when $C > 0$; it shows oscillation with damping.

The model also predicts that average amplitudes of belief trajectories are a positive function of the force created by the message. Equation 1.1 indicates that the force of the message is a function of the difference between the message position and the recipient’s initial position (message discrepancy) and the restoring coefficient. Therefore, the amplitude of belief trajectories increases as message discrepancy increases. Restoring coefficients are assumed to be functions of source credibility, the strength of the message, and the strength of initial attitudes. Therefore, the more credible a source is, the greater the amplitude of the belief trajectory.

Frequency of oscillation is predicted to be a function of the restoring coefficients. The model predicts that higher frequency oscillations should occur with messages from more credible sources, with stronger arguments, and on topics on which the recipient has a stronger initial view (Fink & Kaplowitz, 1993; Fink et al., 2002).

Studies of Cognitive Dynamics

Kaplowitz, Fink, and Bauer (1983). Kaplowitz et al. (1983) tested oscillatory patterns of belief change with multiple time lags over 10 minutes in a between-participants design, in which participants provided their belief position only once. Using a general nonlinear structural model, they found evidence of belief oscillation but no evidence for damping of belief trajectories. They reported that the period of cognitive oscillation was about 13.5 seconds, which corresponds to a frequency of .07 Hz.

The patterns of belief change predicted by the oscillation model can be best observed with trajectories of individual belief change during judgment rather than with cross-sectional data. Fink and Kaplowitz (1993) developed a computer mouse technique to measure belief change during judgment. The technique requires participants to use a computer mouse to indicate their instantaneous beliefs about an issue on a unidimensional continuum while participants are thinking about the message. In the 1993 study, participants' beliefs were measured at least every 18 milliseconds through the mouse position, which provided trajectories of individual beliefs. This technique was used in Fink and Kaplowitz (1993), Wang (1993), McGreevy (1996), and Fink et al. (2002).

Fink, Kaplowitz, and Hubbard (2002). Examining belief trajectories for two separate issues, the appropriate sentence for a convicted armed robber and the appropriate increase in tuition, Fink et al. (2002) found that belief reversals during judgment were quite common (belief reversal percentages were 73% for the criminal-sentencing issue with N = 99, and 59% for the tuition increase issue with N = 91). However, the observed oscillatory trajectories were very different from the sinusoidal pattern of belief trajectories predicted by the spatial-spring model. Trajectories did not show constant periods or gradual damping. Many trajectories showed irregular oscillatory movements. Figure 2 shows one example of belief trajectories for one participant in the criminal-sentence scenario.

Because of the irregularities of the trajectories, Fink et al. (2002) measured pseudo-amplitudes and pseudo-frequencies to capture the amplitude and frequency found in these trajectories. The pseudo-amplitude was defined as half of the difference between the maximum and the minimum values of a belief trajectory, and the pseudo-frequency was defined as the total number of changes of direction divided by the decision time. The total number of changes of direction was evaluated based on the number of waves indicated by the graph of the trajectory. Only waves that moved at least 4% of the range of the scale were counted as true changes because small changes in direction could "reflect random motion rather than cognitive changes" (Kaplowitz & Fink, 1996, p. 296). Fink et al. found, as predicted, that the pseudo-amplitude was correlated with the amount of belief change for the issues employed: The greater the pseudo-amplitude, the greater the amount of belief change. However, pseudo-frequency and the number of changes in direction did not differ between messages from high and low credible sources, which was contrary to the model's predictions. Furthermore, message discrepancy did not seem to have effects on pseudo-frequency.

One possible explanation for the discrepancy between the patterns predicted by the model and those found in the data was suggested by the researchers themselves. As people process an external message, they often generate new thoughts and process them (see, e.g., Greenwald, 1968; Petty et al., 1981; Tesser, 1978). These self-generated messages may create new linkages and make trajectories far more complex than those implied by the simple model that assumes that the restoring force of other linkages except the target linkage are constant.

Belief Trajectories and Belief Change during Judgment

Individuals process self-generated information as well as information given in a message. Belief trajectories are likely to be affected by the self-generated information, which makes it difficult to find a simple effect of external messages on belief trajectories. On the other hand, belief trajectories provide an opportunity to trace the processing self-generated information and its effect on beliefs. Data from McGreevy (1996) give a clue about the local movement in a belief trajectory. McGreevy collected data using the same computer mouse technique as did Fink et al. (2002). McGreevy collected belief trajectories both while participants were reading messages (the message-receipt phase) and while they were thinking after message receipt (the post-message phase). Trajectories obtained in the message-receipt phase show systematic patterns and reveal some relationship between belief trajectories and the information participants were reading.

McGreevy (1996). In the study, participants who were undergraduate students in a large university were presented with information about two candidates for admission to a university. Each participant indicated his or her instantaneous beliefs about two candidates on a line on a computer screen. On the computer screen, there was a horizontal line. “Candidate 1” appeared with “0” at the left end of the line, and “Candidate 2” appeared with “100” at the right end of the line. Participants indicated their evaluations about candidates by the distance between the computer cursor (as moved by a computer mouse) and the lower or upper ends of the line. Because 100 indicates that perfect suitability of Candidate 2, the higher number indicates the more favorability about Candidate 2. Two variables were manipulated, the degree of similarity in quality between two candidates (similar versus different) and distraction (distraction versus no distraction).

Figure 3 shows part of a belief trajectory found for one participant in the similar-candidate and no distraction condition of the McGreevy study. At 139.08 seconds, the participant indicated completion of reading. Figure 3 is a belief trajectory during the message-receipt phase. The trajectory in Figure 3 shows a couple of interesting patterns. First, the trajectory consists of repetitions of a stay and a move. Second, it shows a downward step-like shape up to 90.41 seconds and then an upward step-like shape.

The position movement up to 90.41 seconds shows seven downward steps, each of which consists of a stay and a move. For example, the first step consists of a stay at position 50.00 for 10.34 seconds and a move down to 49.00 with 13.89 points/s speed (see Table 1.1 for the details for all seven movements).[1] There are correspondences found between those seven downward step-like movements and information in the message given to participants in the condition (the similar-candidate condition). The correspondence provides a clue about what local movements of belief trajectories reflect.

Information provided to participants in the similar-candidate condition consists of two paragraphs: One is about Candidate 1 and the other is about Candidate 2. Information about Candidate 1 is as follows (McGreevy, 1996, p. 361, sentence numbers in brackets added):

> **Candidate 1** is a high school senior from New England [1]. He has an impressive academic record and SAT scores [2]. In addition to his academic achievements, he enjoys many activities [3]. He is captain of the schools' debate team, and has won several debate and public speaking competitions [4]. **Candidate 1** is also active in school politics [5]. He is currently President of the student government association (SGA) [6]. His junior year he served as Vice President of SBA and his freshman and sophomore he sat on his class council [7] **Candidate 1** is co-captain of his high school's varsity soccer team [8]. **Candidate 1** claims that debate and student government have helped him develop his leadership and analytical reasoning skills [9]. He credits sports with teaching him the value of hard work and determination [10]. Outside of school, **Candidate 1** is active in the community [11]. Each year he volunteers for his state's Special Olympics program [12]. Through the special Olympics, he serves as an assistant soccer coach for a team of mentally retarded children [13]. **Candidate 1** is also active in his church's youth group [14]. This group serves the community by getting involved in projects such as feeding the homeless, visiting nursing homes, and cleaning up the environment [15]. **Candidate 1** considers himself a well rounded individual who manages his time will [16]. He is extremely excited about starting college and meeting the challenges that await him [17].

Information about Candidate 1 can be grouped into seven parts in terms of content: Introduction: [1]; Academic Achievement: [2]; Extra-curricular Activity: [3], [4]; School Politics: [5], [6], [7]; Sports: [8], [9], [10]; Community Service: [11], [12], [13]; Religious Activity: [14], [15]; and Personality: [16], [17]. Except for the introduction, all information was created to be characteristics that are indicative of success in college (McGreevy, 1996, p. 45). Therefore, the first paragraph has seven pieces of information that are indicative of Candidate 1's success in college.

All seven movements in the trajectory show a repetition of a stay and a move. All seven stays in the trajectory took more significant amounts of time (M = 10.04 s; the minimum time = 2.18 s) than moves. All seven moves were done with a significant speed (M = 3.44 points/s; the minimum speed is 1.30 points/s; the first move took place with a very high speed, 13.89 points/s; the mean speed for moves other than the first one is 1.69 points/s). The belief change by a move ranges from -1.00 to - 4.17 (M = -2.52). All seven moves showed negative belief change, indicating increased favorability toward Candidate 1, which is consistent with the valence of the given message (i.e., the message had positive statements for Candidate 1).

Repetition of a stay and a move suggests that the participant read or thought about a piece of information while holding the computer mouse and then changed his or her belief by moving the computer mouse. Also, the correspondence between the direction suggested by the message and the direction of movements of the trajectory suggests that local movements represent belief change due to processing information at the moment.

It may be assumed that the participant who provided the trajectory in Figure 3 was processing information (i.e., reading and judging) for 10.34 seconds (time for the first stay) and indicated his or her new position by moving the mouse from 50.00 to 49.00 at time point 10.34 seconds. Moving from 50.00 to 49.00 took 0.07 seconds, with a speed of 13.89 points/s. The speed for the move was calculated by dividing the distance on the *y*-axis of the move by the time taken for the move. The participant processed the second piece of information for 3.41 seconds and indicated his or her position by moving the mouse 2.67 units, from 49.00 to 46.33, with a speed of 1.66 points/s.

Sequential repetition of a stay and a move and correspondence between the trajectory and information given to the participants suggest that movements can be analyzed as measures of belief change due to information processed immediately prior mouse movement. The whole belief trajectory can be thought as a series of local belief changes, which are represented in local movements of the trajectory.

Movements in the second part of the trajectory (the message-receipt phase, for this participant from 90.41 to 139.08 seconds) should suggest the same process as movements found in the first part of the trajectory (from the beginning to 90.41 seconds). Position movements in the second part of the message-receipt phase in Figure 3 show the same direction of belief change as suggested by information in the second paragraph of the similar-candidate condition. Information about Candidate 2 in the similar-candidate condition is as follows (McGreevy, 1996, p. 362; sentence numbers in brackets added):

> **Candidate 2** is also a high school senior from New England [1]. He, too, has an impressive academic record and SAT scores [2]. In addition to excelling in his studies, **Candidate 2** is involved in many activities both within and outside of school [3]. In school, he is captain of his high school lacrosse team and member of the debate team [4]. He has served on student government boards all four years

of high school [5]. This year his classmates voted him Vice President of SGA (student government association) for the second year in a row [6]. His freshman year he served on the class council, and his sophomore year he was his class treasurer [7]. **Candidate 2** enjoys combining sports, debate and student government [8]. He claims that these three activities have helped him with his critical thinking, arguing, and leadership skills [9]. Outside of school, **Candidate 2** volunteers for his community's Big Brother/Big Sister program [10]. In addition to serving as a mentor to a child in the community, **Candidate 2** also volunteers as a peer tutor at the local middle school [11]. **Candidate 2** enjoys students of all ages and is looking forward to returning to his summer job as a camp counselor [12]. This will be his third year working for the camp (his freshman year he was a counselor in training) [13]. **Candidate 2** describes himself as confident, motivated, and responsible [14]. He is eager to start college and meet the challenges that lay ahead [15].

Information about Candidate 2 can be partitioned into seven parts in terms of content: Introduction [1]; Academic Achievement [2]; Extra-curricular Activity [3, 4]; School Politics [5,6,7]; Debate Team Activity [8, 9]; Community Service [10, 11,12,13]; and Personality [14,15]. Except for the introduction, all information was selected and tested as characteristics that are indicative of success in college (McGreevy, 1996, p. 45). It is expect that the position would be closer to Candidate 2 as each part of the message is processed.

Position movements in the second half of the message-receipt phase show a gradual increase in favorability toward Candidate 2. The position movements show upward step-like movements. However, the shape of movements for the second part of the message-receipt phase is not as step-like as that found in the first part of message-receipt phase. The trajectory for the second part of message-receipt may be partitioned into several local movements.

These are ten stays of more than 1.00 second. When movements with less than one unit are excluded, there are seven movements (see Table 1.2 for detailed information about the movements for the second part of the message-receipt phase). The directions of all seven movements are the same as the corresponding parts of the messages suggest.

The upward step-like movements in the second part of the message-receipt phase suggest the same process as the movements in the first part of the message-receipt phase do: A stay and a move in the trajectory can be interpreted as an indicator of belief change due to processing information at the moment.

The *U*-shaped movement found in Figure 3 was also found in other cases in the same condition. Among 26 trajectories in the similar-candidate no-distraction condition, 19 trajectories show a *U*-shaped step-like movement (73%). Four of them show no movement during reading (15%). Three trajectories (12%) show other shapes of movements (early quick *W*-shaped, only downward, and *N*-shaped movement).

These results strongly suggest that a local movement, a stay followed by a move, indicates belief change due to processing information immediately prior mouse movement. It can be assumed that local movements during thinking (the post-message phase) represent belief change due to processing information generated by the participants themselves at a given time. In the present study, local movements will be measured and analyzed to find patterns of belief change during judgment.

Vallacher, Nowak, and Kaufman (1994). Step-like movements in the attitude trajectory were found in Vallacher et al. (1994). Vallacher et al. measured attitudes toward a target person 10 times per second over a 2-minute period with a computer mouse, which provides attitude trajectories. Vallacher et al. examined differences in attitude trajectories between messages that had only positive or only negative information (univalent messages) and messages that had both positive and negative information (mixed-valence messages). Vallacher et al. presented three trajectories, one for each participant for each condition: the positive univalent message condition, the negative univalent message condition, and the mixed-valence message condition. Trajectories for all three cases show oscillatory patterns, but the individual trajectory in the mixed-valence condition showed a greater oscillatory pattern than the univalent conditions did.

Individual trajectories provided by Vallacher et al. also show repetition of a stay and a move throughout the trajectory or in part of the trajectory. The positively univalent trajectory (Vallacher et al., 1994, p. 25) shows "stay-move" movements throughout the trajectory (see Figure 4). The negative univalent and mixed-valence trajectories are more complicated than the positive one, but they also show the step-like movement in many places in the trajectories.

*Summary of Studies Using the Computer Mouse Techniqu*e

Two different research groups (Fink & Kaplowitz; Vallacher, Nowark & Kaufman) developed a computer mouse technique. Belief changes during judgment were analyzed with belief trajectories obtained by the computer mouse technique. In both groups' studies, systematic patterns of belief change were found. Fink and Kaplowitz and their colleagues (Fink et al., 2002; McGreevy, 1996; Wang, 1993) found that belief reversals during judgment were quite common (see Table 1.3 for the summary of results from those studies). Vallacher et al. (1994) found that the average position and the average speed of position movement were different between the first 40 seconds and the last 40 seconds; however, in that study the analyses of belief trajectories were limited to some overall aspects of the trajectories.

Belief trajectories found in previous studies show distinctive local movements. The position for each local movement can be identified. With those positions, belief trajectories can be simplified and the effects of distal variables at different time points can be examined.

Notation for Belief Change during Judgment

The following notation and definitions will be used for belief change and local movements:

P_0 = the recipient's initial position on a given belief scale;

P_1 = the recipient's position after the first local movement on the same belief scale as P_0;

P_i = the recipient's position after the *i*-th local movement, where *i* is a non-negative integer;

P_N = the recipient's final position (the number of local movements = *N*);

$\Delta P_{1(0)}$ = the amount of the recipient's belief change after the first local movement from the initial position (i.e., $\Delta P_{1(0)} = P_1 - P_0$);

$\Delta P_{i(0)}$ = the amount of the recipient's belief change after the *i*-th local movement from the initial position (i.e., $\Delta P_{i(0)} = P_i - P_0$);

$\Delta P_{i(i-1)}$ = the amount of the recipient's belief change after the *i*-th local movement from the position for the previous local movement (i.e., $\Delta P_i = P_i - P_{i-1}$).

Hypotheses

Patterns of Belief Change during Judgment

Patterns of Belief Change during the Message-Receipt Phase

When multiple pieces of information are given, the pattern of belief change should be different when messages are received (the message-receipt phase) and when thinking about the message after its receipt (the post-message phase). In the message-receipt phase, each piece of message information can have effects on beliefs. The effects of pieces of information on beliefs should depend on the valence and the strength of the pieces of information (Anderson, 1971; Kaplowitz & Fink, 1992; also see Equation 1.1). The order and valence of the information presented determines the belief trajectory. Therefore, when instantaneous belief change is measured during message receipt, a correspondence between the structure of information in the message and belief trajectory is expected.

Local movements of belief trajectories can be used to test the correspondence between the structure of the message and belief change during the message-receipt phase. First, in the message-receipt phase, it is expected that the sequence of local movements in terms of the direction is affected by the sequence of information presented in the message. If a series of pieces of negative information is presented and followed by a series of pieces of positive information in the message (a sequential mixed-valence message), local movements of belief trajectories are more likely to appear as a series of negative movements followed by a series of positive movements, resulting a *U*-shaped pattern.

However, when only a series of pieces of positive information is presented in the message (a univalent message), unidirectional local movement is expected. The following hypotheses are proposed:

> H1.1 (Sequence of information and sequence of local movements during the message-receipt phase): For a sequential mixed-valence messages, a *U*-shaped or inverted *U*-shaped pattern of local movements (or a series of such patterns) occurs; for a univalent message, a unidirectional (monotonic) pattern of local movement occurs.

During the message-receipt phase, the number of positive belief changes is affected by the number of pieces of positive information in the message, and the number of negative belief changes is affected by the number of pieces of negative information. Therefore, it is expected that the ratio of the number of positive local movements to the number of negative local movements will be greater for (positive) univalent messages than for mixed-valence messages. The following hypothesis is proposed:

> H1.2 (Message type and the ratio of the number of positive local movements to the number of negative local movements during the message-receipt phase): During the message-receipt phase, the ratio of the number of positive local movements to the number of negative local movements in belief trajectories is greater for positively univalent messages than for mixed-valence messages.

The amount of belief change while receiving messages can be thought of as a function of the sum of the effect of each piece of information. The value or message position and the weight or importance of the information in the message can be thought of as basic factors constituting the effect of the information (Anderson, 1971). The effect of information on the amount of belief change in the message-receipt phase can be modeled as:

$$\Delta P_{N(0)} = \sum_{i=1}^{N} w_i P_{M_i} \ , \qquad (1.6)$$

where $\Delta P_{N(0)}$ is the amount of belief change in the message-receipt phase, w_i is the weight of the *i*-th piece of information in the message, and P_{M_i} is the message position of the *i*-th piece of information in the message. The amount of belief change after processing *j*-th piece of information, $\Delta P_{j(0)}$, can be modeled as:

$$\Delta P_{j(0)} = \sum_{i=1}^{j} w_i P_{M_i} \ , \qquad (1.7)$$

If belief trajectories obtained by the computer mouse technique represent belief change while processing information in the message, belief trajectories are expected to show patterns predicted by Equation 1.7. Belief trajectories in the message-receipt phase are expected to consist of belief positions that reflect the weights of pieces of information in the message.

H1.3 (Weights of information in the message and belief trajectories): Belief trajectories in the message-receipt phase will reflect the weights of the pieces of information in the message.

Patterns of Belief Change during the Post-Message Phase

Unlike the message-receipt phase, belief change during the post-message phase depends on memory, self-generated thoughts, and the intrinsic dynamics of information processing. A spatial-spring model of cognitive forces (Kaplowitz et al., 1983) predicts belief change during judgment. If we assume that the concepts in a cognitive system have spring-like linkages, the pattern of belief change is most likely to be oscillation with damping. Oscillation with a damping pattern has two key aspects. One is the oscillatory pattern, that is, the direction of belief change during judgment alternates repeatedly. The other aspect is a damping pattern, that is, the absolute amount of belief change in each direction decreases as the belief approaches equilibrium.

The oscillatory pattern and the damping pattern of belief change can be expressed in terms of local movements of belief trajectories. If there is the oscillatory pattern of belief change during judgment, a belief trajectory will be a sequence of local movements whose directions alternate. If there is a damping pattern of belief change during judgment, the absolute amount of belief change by local movements will decrease.

To test the oscillatory and damping pattern of belief change during judgment, the following hypotheses are proposed in terms of local movements:

> H2.1.1 (The oscillatory pattern for local movements): During judgment, a local movement is more likely to be followed by a local movement whose direction is opposite to the direction of the preceding one.
>
> H2.1.2 (The damping pattern for local movements): During judgment, the absolute amount of belief change by a local movement is smaller than the absolute amount of belief change of the proceeding local movement.

H2.1.1 and H2.1.2 can be summarized in the following model:

$$\Delta P_{i(i-1)} = l_i \Delta P_{(i-1)(i-2)}; -1 < l_i < 0;\ i \geq 2, \qquad (1.8)$$

where l_i is a constant for the *i*-th local movement. H2.1.1 predicts that l_i should be negative. H2.1.2 predicts that the absolute value of l_i should be less than 1.00. When the absolute value of l_i is less than 1.00, the absolute amount of belief change by a local movement will be smaller than the absolute amount of belief change of the proceeding local movement.

A damping oscillatory trajectory can be divided into multiple parts in terms of the direction of belief movement. When the local movement framework is applied to test oscillatory patterns of a belief trajectory, there are two possibilities about the relationship between local movements and belief change in one direction. A single local movement may constitute one movement for belief change. On the other hand, a set of local movements that have the same direction may constitute one movement for belief change. To differentiate the two situations, the former is named a *micro* local movement (or just a local movement) and the latter is a *macro* movement.

To describe macro movements, the following notation is needed.

$\tilde{P}_1$ = the recipient's position after the first macro movement, which is a set of the micro local movements that are consecutive and have the same direction. That is,

$$\tilde{P}_1 = P_0 + \Delta P_{1[1(0)]} + \Delta P_{1[2(1)]} + \ldots + \Delta P_{1[n(n-1)]}\,, \qquad (1.9)$$

where n is the number of consecutive micro local movements that have the same direction. $\Delta P_{1[1(0)]}$ indicates the difference between belief position of the first micro local movement of the first macro movement and the starting position of the first macro local movement. The general form of $\Delta P_{1[1(0)]}$ is $\Delta P_{i[j(j-1)]}$, which indicates the difference between the belief position of the *j*-th micro local movement of the *i*-th macro local movement and belief position of the (*j* - 1)st micro local movement of the *i*-th macro local movement. The position by *i*-th macro local movement can be expressed as follows:

$$\tilde{P}_i = P_{i[0]} + \Delta P_{i[1(0)]} + \Delta P_{[2(1)]} + \ldots + \Delta P_{[n(n-1)]} \ . \quad (1.10)$$

The following notation will be used for belief change by a macro local movement.

$\Delta\tilde{P}_1$ = the amount of the recipient's belief change after the first macro local movements from the initial position (i.e., $\tilde{P}_1 - P_0$).

$\Delta\tilde{P}_{i(0)}$ = the amount of the recipient's belief change after the *i*-th macro local movements from the initial position (i.e., $\tilde{P}_i - P_0$).

$\Delta\tilde{P}_{i(i-1)}$ = the amount of the recipient's belief change after the *i*-th macro local movements from the position for the previous set of local movements (i.e., $\tilde{P}_i - \tilde{P}_{i-1}$).

For a macro local movement, the alternation of direction (the oscillatory pattern) is always true by definition. However, the hypotheses about the damping pattern can be proposed for macro local movements.

H2.2 (The damping pattern for macro local movements): During judgment, the amount of belief change of a macro local movement will be smaller than the amount of belief change of the proceeding macro of local movement.

The above hypothesis can be expressed as the following equation:

$$\Delta\tilde{P}_{i(i-1)} = \tilde{l}_i \Delta\tilde{P}_{(i-1)(i-2)}; -1 < \tilde{l}_i < 0; i \geq 2 \,, \quad (1.11)$$

where $\tilde{l}_i$ is a constant for *i*-th macro local movement. H2.2 indicates that the absolute value of $\tilde{l}_i$ should be less than 1.

Cognitive Responses and Local Movements during the Post-Message Phase

According to the cognitive response approach, beliefs are a function of the valence and the number of thoughts that individuals generate in response to messages

(Petty et al., 1981). Most studies guided by the cognitive response approach have used the thought-listing technique to assess the valence and the number of thoughts generated by message recipients (Cacioppo, Harkins, & Petty, 1981). The thought-listing task aims at obtaining the thoughts that took place during judgment before the final judgment is formed. Thoughts during judgment are assumed to have effects on beliefs. However, because the thought-listing technique is a memory-based measurement (Mackie & Asuncion, 1990), and is administered after the final judgment is made, the final judgment may influence the reporting of thoughts, which could threaten the validity of the thought-listing task (Greenwald, 1981; Miller & Baron, 1973; Miller & Colman, 1981).

Assuming that the message recipient updates his or her beliefs with positive or negative self-generated thoughts (i.e., on-line modification of beliefs), and that those belief changes are reflected in belief trajectories, belief trajectories can be an alternative method to assess recipient-generated thoughts during judgment. Moreover, because belief trajectories obtained by the computer mouse technique are relatively instantaneous, belief trajectories and local movements provide observations that are free from the influence of the final judgment that may affect in the thought-listing technique. Thus, the thought-listing technique and the computer mouse technique may both be validated by their correlation.

Message type, cognitive responses, and local movements. Different types of messages (e.g., univalent versus mixed-valence messages) are assumed to cause different cognitive responses. Specifically, the ratio of the number of positive cognitive responses to the number of negative cognitive responses is expected to be greater for positively univalent messages than for mixed-valence messages. If local movements in belief trajectories reflect belief changes due to cognitive responses, it is expected that the ratio of the number of positive local movements to the number of negative local movements will be greater for positively univalent messages than for mixed-valence messages, which leads to the following hypothesis:

> H3.1.1 (Message type and the number of local movements): During the post-message phase, the ratio of the number of positive local movements to the number of negative local movements is greater for positively univalent messages than for mixed-valence messages.

It is expected that a decision maker will have more thoughts in difficult decision situations than in easy decision situations, especially when the decision is dichotomous. When mixed-valence messages are given, the decision is more difficult than when univalent messages are given. Mixed-valence messages are expected to generate more cognitive responses than univalent messages. This difference in the number of thoughts will be reflected in belief trajectories in which the number of total local movement will be greater for mixed-valence messages than for univalent messages:

> H3.1.2 (Message type and the total number of local movements): During the post-message phase, the number of local movements is greater for mixed-valence messages than for univalent messages.

The cognitive response approach argues that a message exerts its effect on beliefs through recipient-generated cognitive responses during judgments (Greenwald, 1968; Petty et al., 1981). Assuming local movements reflect cognitive responses during judgment, the following hypothesis is proposed:

H3.1.3 (Mediating role of the number of local movements between message type and the final decision): The effect of message type (univalent versus mixed-valence) on the final decision is mediated by the number of positive and the number of negative local movements.

Cognitive responses and local movements. The thought-listing technique attempts to measure cognitive responses during judgment based on participants' recall. Local movements in belief trajectories measure belief changes during judgment. If belief changes during judgment result from cognitive responses during judgment, a positive relationship is expected between local movements in belief trajectories and cognitive responses collected by the thought-listing task.[2]

H3.2.1 (Cognitive responses and the number of local movements): There will be a positive relationship between the number of positive local movements and the number of positive thoughts, and between the number of negative local movements and the number of negative thoughts.

The cognitive response approach argues that the numbers of positive and negative cognitive responses have effects on beliefs. This argument has been supported by studies that used the thought-listing technique to measure cognitive responses during judgment (Cacioppo & Petty, 1979; Greenwald, 1968; Osterhouse & Brock, 1970; Petty & Cacioppo, 1977, 1979). If local movements in belief trajectories represent belief change resulting from cognitive responses, the numbers of positive and negative local movements have effects on beliefs. Furthermore, similarities are expected between the effect of the numbers of positive and negative thoughts on beliefs and the effect of the numbers of positive and negative local movements on beliefs. Because of the scale difference between these two kinds of measures, the effect sizes may not comparable. But it is expected that the ratio of the effect of the number of positive thoughts on beliefs to the effect of the number of negative thoughts on beliefs will not be different from the ratio of the effect of the number of positive local movements on beliefs to the effect of the number of negative local movements on beliefs.

H3.2.2 (Effects of cognitive responses and local movements on beliefs): The ratio of the effect of the number of positive thoughts on beliefs to the effect of the number of negative thoughts on beliefs will be the same as the ratio of the effect of the number of positive local movements on beliefs to the effect of the number of negative local movements on beliefs.

Dynamic Effect of Distal Variables on Beliefs

The Effect of Message Discrepancy on Beliefs during Judgment

Brock (1967) found that as message discrepancy increases, the number of counterarguments to the message increases and the degree of acceptance of the message position decreases. These results suggest that message discrepancy exerts a negative effect on the acceptance of a message. However, before the recipient begins to generate counterarguments, message discrepancy may exert a positive effect on beliefs. Gilbert et al. (1990) found that people first entertain an assertion as true before they reject it ("Spinozan procedure model"). Hence, an extremely discrepant message can be thought of as an appropriate assertion at the beginning of its consideration and therefore has a positive effect on beliefs. After recipients generate counterarguments, an extremely discrepant message is expected to exert a negative effect on beliefs.

Even though there has been no systemic investigation of the *dynamic* effect of message discrepancy on beliefs during judgment, the *static* effect of message discrepancy on the beliefs has been modeled and tested. Two mathematical models of message discrepancy on belief change are worthy of note: Fink, Kaplowitz, and Bauer's model (1983) and Laroche's model (1977). Let

P_0 = the recipient's initial position on a given belief scale;

P_M = the position of a message on the same belief scale as P_0;

D_P = the positional discrepancy between the message and the recipient's initial position (i.e., $P_M - P_0$);

ψ_0 = the recipient's subjective rating of his or her initial position on a given belief scale (ψ_0 usually assumed to be 0);

ψ_M = the recipient's subjective rating of the position advocated by the message on the same attitude scale;

D_ψ = the psychological discrepancy between the subjective rating of the position advocated by the message and the subjective rating of the recipient's initial position (i.e., $\psi_M - \psi_0$).

Fink et al.'s (1983) message discrepancy model of the final judgment after processing a message is:

$$P_N = \frac{w_0 P_0 + w_M^* \Delta(\psi) P_M}{w_0 + w_M^* \Delta(\psi)}, \qquad (2.1)$$

where w_0 is a weight for the initial position, w_M^* is a weight for the message after removing the discounting effect of psychological discrepancy, and $\Delta(\psi)$ is the discounting function of psychological discrepancy. The model suggest that the weight for new information, w_M , may be decomposed into two parts as indicated in the following equation:

$$w_M = w_M^* \Delta(\psi). \qquad (2.2)$$

The equation for belief change between the initial judgment and the final judgment can be derived from Equation 2.1:

$$\Delta P_{N(0)} = P_N - P_0 = \frac{w_M^* \Delta(\psi)}{w_0 + w_M^* \Delta(\psi)} D_p. \qquad (2.3)$$

Fink et al. (1983) suggested that psychological discrepancy should be distinguished from positional discrepancy. Fink et al. defined positional discrepancy as discrepancy that is "expressed in units that have a widely shared meaning in a given culture (e.g., dollars, hours, or miles in American culture)" (p. 415). Psychological discrepancy is "the level of discrepancy between two positions as experienced by an individual" (p. 415). They claimed that whereas the amount of belief change increases as a function of positional message discrepancy, the weight of the positional message discrepancy on attitude change is discounted by psychological discrepancy (Equation 2.2). They assumed that the effect of psychological discrepancy diminishes exponentially as psychological discrepancy increases. That is,

$$\Delta(\psi) = e^{-kD_\psi}, \qquad (2.4)$$

where k is a positive constant and D_ψ is the psychological discrepancy. Psychological discrepancy is a linear function of the ratio of the message discrepancy with the personal range of the scale of the issue (Fink et al., 1983). For the individuals who have the same personal range, the equation can be expressed as:

$$\Delta P_{N(0)} = \frac{w_M^* e^{-kD_p}}{w_0 + w_M^* e^{-kD_p}} D_p . \tag{2.5}$$

The above equation predicts that the weight of positional discrepancy diminishes exponentially as the positional message discrepancy increases; as a result, as positional discrepancy increases, the amount of belief change increases up to a certain point and then decreases, resulting in a nonmonotonic function of message discrepancy on beliefs. Figure 5 represents this model.

Laroche's mathematical model (1977) also suggests a nonmonotonic function of message discrepancy on beliefs. Laroche's (1977) model is built on the following assumptions: (1) "The recipient is in a stable cognitive equilibrium before the communication" (p. 247); (2) "This equilibrium is altered by the message as long as there is a discrepancy between the recipients' position and the communication" (p. 247); (3) "The source must have some credibility to the recipient" (p. 247); (4) "The content of the communication must not be perfectly ego involving to the recipient" (p. 247); (5) "If the source is perfectly credible and the content of the communication perfectly non-ego-involving, the amount of change is identical to the discrepancy" (p. 247); (6) "For the same discrepancy and the same ego involvement, the greater the credibility of the source, the greater the change in attitude" (p. 248); and (7) "For the same discrepancy and the same source credibility, the lower the ego involvement of the recipient with the contents of the communication, the greater the attitude change" (p. 248).

Laroche's mathematical message discrepancy model is as follows:

$$\Delta P_{N(0)} = D_P e^{-\gamma D_P} , \tag{2.6}$$

where $\gamma = -k\ln(C) - k'\ln(NI); \gamma > 0$; D_P is message discrepancy; *C* is credibility; and *NI* is noninvolvement.

Figure 6 represents Laroche's model, which shows that as message discrepancy increases, the amount of belief change increases up to a point and then decreases. The nonmonotonic change in belief by message discrepancy has been found by several studies (Aronson, Turner, & Carlsmith, 1963; Bochner & Insko, 1966; Freedman, 1964). However, an increasing pattern without nonmonotonicity was found in Fink et al. (1983), Kaplowitz et al. (1986), and in Kaplowitz and Fink, with Mulcrone, Atkin, and Dabil, (1991).

Both Fink et al.'s (1983) model and Laroche's model incorporate the effect of source credibility. Like Anderson's information integration model (1971), source credibility moderates the effect of message discrepancy on beliefs in these two models (see Figures 5 and 6). Specifically, both models suggest that the greater the source credibility, the greater the effect of message discrepancy on beliefs.

Kaplowitz et al. (1983) and Fink et al. (2003) investigated some aspects of the dynamic effect of message discrepancy on beliefs during judgment, employing three levels of discrepancy. Kaplowitz et al. (1983) estimated the amplitudes of the belief trajectory using a between-participants design. They found that the amplitude of oscillation is greatest for the most discrepant of the messages. This result suggests that the message with the greater discrepancy corresponds to the one with the greatest impulsive force. Kaplowitz et al. also found that as discrepancies increase, the estimated equilibrium increases, which suggests that message discrepancy has a positive effect on final belief. Fink et al. (2002) found a significant relationship between the final judgment and pseudo-amplitude for only one of the two issues used (the criminal-sentencing scenario). However, there was no significant effect of message discrepancy and source credibility on the number of changes in belief trajectories and the pseudo-frequency of belief trajectories.

The effect of message discrepancy on beliefs during judgment can be more thoroughly investigated by examining local movements of belief trajectories. Using local movements, we can identify the effect of message discrepancy on the first local movement, on the second movement, and so on up to the final local movement. In this way, we may identify how the effect of message discrepancy changes throughout the belief change process. Because cognitive responses play an important role in belief change during judgment, the relationship between message discrepancy, cognitive responses and local movements is examined.

Message discrepancy, cognitive responses and local movements. Brock (1967) investigated the relationship between message discrepancy and counterarguing. In his experiment, participants were told that they were going to evaluate a statement regarding an increase in tuition in their university; the proposed increase would represent a small, moderate or large discrepancy. Then they were asked to list their thoughts before reading the statement. Brock (1967) found that as message discrepancy increased, the number of counterarguments increased while individuals anticipated messages. Toy (1982) found that as message discrepancy increased, the number of counterarguments linearly increased and the number of supportive arguments linearly decreased. Counterarguments are negative thoughts about the message position or the message source, which are assumed to cause negative belief change. Negative belief change during judgment should appear as a local movement whose direction is opposite to the advocated message position. Therefore, the findings of Brock (1967) and Toy (1982) suggest that message discrepancy should increase the number of local movements in the opposite direction to the advocated message position. If message discrepancy (i.e., $P_M - P_0$) is positive, greater message discrepancy should increase the ratio of the number of positive local movements to the number of negative local movements.

H4.1.1 (Message discrepancy and local movements): Assuming the message discrepancy is positive, as message discrepancy increases, the ratio of the number of positive local movements to the number of negative local movements will decrease.

Message discrepancy and initial belief change. Recall that Gilbert et al. (1990) found that people initially accept both true and false information as true before they assess the truth value of the information, which suggests that messages with different positions are all entertained as true at the beginning of judgment. Accepting the advocated message position at the beginning of judgment is consistent with a positive linear relationship between message discrepancy and belief change at the beginning of judgment. Assuming the maximum amount of belief change is the position advocated by the message, the relationship between message discrepancy and belief change by the first local movement in the belief trajectory can be modeled as follows:

$$\Delta P_{1(0)} = mD_P;\ 0 < m \leq 1. \qquad (2.7)$$

The relationship between message discrepancy and initial belief change is hypothesized to be as follows:

H4.1.2. (Message discrepancy and initial belief change): The greater the message discrepancy, the greater the belief change of the first micro local movement in the direction advocated by the message.

Message discrepancy and final belief change. In most studies of the effect of message discrepancy on beliefs, beliefs were measured only once, at the end of judgment. Existing models of message discrepancy, including Fink et al.'s model and Laroche's model, were created to explain the relationship between levels of message discrepancy and final judgment. Therefore, the two models are applied to predict the final judgment.

Both Fink et al.'s model and Laroche's model predict a curvilinear relationship between message discrepancy and final judgment, which can be expressed as follows:

H4.1.3 (Message discrepancy and final belief change): As message discrepancy increases, the amount of final belief change will increase up to a certain point and then decrease.

Change of effect of message discrepancy on beliefs over time. H4.1.2 proposes a positive linear relationship between message discrepancy and belief change at the beginning of the judgment, whereas H4.1.3 proposes a curvilinear relationship between message discrepancy and belief change at the end of the judgment. The difference in the effect of message discrepancy on beliefs at the beginning versus the end of the judgment may be explained by the effect of message discrepancy on counterarguments and local movements during judgment (H4.1.1). H4.1.1 predicts that the greater message discrepancy, the greater number of counterarguments and local movements in the opposite direction to the position advocated by the message. H4.1.1 suggests that both the amount of belief change generated by highly discrepant messages and the amount of belief change generated by moderately discrepant message decrease over time but the amount of decrease in belief change due to counterarguments is greater for highly discrepant messages than for moderately discrepant message.

If the difference in the amount of decrease in belief change during judgment between highly discrepant messages versus moderately discrepant message exceeds the initial difference in belief change between highly discrepant messages versus moderately discrepant message at the beginning of judgment, a nonmonotonic relationship between message discrepancy and belief change at the end of the judgment will be found. This idea may explain why extremely discrepant messages sometimes result in smaller belief change than moderately discrepant messages (Aronson et al., 1963; Bochner & Insko, 1966; Freedman, 1964). Extending H 4.1.1 and H4.1.2, H4.1.4 is proposed:

> H4.1.4 (Change of effect of message discrepancy on beliefs): Assuming message discrepancy is positive, the effect of message discrepancy on beliefs decreases over time during judgment in the direction advocated by the message.

The Effect of Source Credibility on Beliefs during Judgment

Source credibility, cognitive responses and local movements. Cook (1969) investigated the relationship between source credibility, counterarguing, and attitude change. Cook asked participants to write down counterarguments during the reading of a written message, in which either a university professor, a highly credible source, or a high school student, a low credible source, recommended the frequency with which people should brush their teeth. Cook found that the high credibility source was more persuasive and that a significantly greater number of counterarguments was written when the message was attributed to the less credible source than when the same message was attributed to a highly credibility source. These findings suggest greater negative belief change during judgment in response to messages from a low credibility source than messages from a highly credibility source. Assuming message discrepancy is positive, the ratio of positive local movements to negative local movements in the belief trajectories is expected to be greater for messages from a highly credibility source than for messages from a low credibility source.

Hass (1972, 1981) proposed and found that the effect of source credibility on the number of supportive arguments and counterarguments depends on the level of involvement with the message issue. Hass (1981) argued that when an individual is uncommitted on an issue and open to new information, a highly credible source induces fewer counterarguments than a low credibility source because people are more likely to anticipate erroneous statements from a low credibility source than from a highly credible source. However, when the issue is highly involving and the message position has negative implications for recipients, a process of resistance occurs. For resistance to persuasion to be successful, Hass (1981) argued that resistance must be "in proportion to the force of the persuasive attack" (p. 164). As a result, high involvement and negative consequences result in more counterarguing for a message from a highly credible source, who is perceived as able to present a stronger attack.

Hass (1972) found that when the level of involvement was low, more counterarguments were generated in anticipation of a message from a low credibility source than a highly credible source. In the high involvement condition, the number of counterarguments was not significantly different between high and low source credibility conditions. These results showed that the effect of source credibility on cognitive response depends on the level of involvement with the message issue.

According to the elaboration-likelihood model of attitude change (ELM; Petty & Cacioppo, 1981), when issues are highly involving and recipients have the ability to process messages, the quality of message arguments is the main factor that determines cognitive responses and attitude change. Petty and Cacioppo (1981) stated that, "Favorable cognitive response will be elicited only if the message recipient finds the message arguments to be compelling" (p. 266). The ELM suggests that when an issue is highly involving, message arguments rather than source credibility will affect cognitive responses because recipients are likely to scrutinize message arguments. Therefore, for highly involving issues, no significant difference is expected in the ratio of positive local movements to negative local movements between messages from a high credibility source and messages from a low credibility source.

> H4.2.1 (Source credibility and the ratio of local movements): Assuming that message discrepancy is positive, for less involving issues, the ratio of positive local movements to the number of negative local movements will be greater in a message from a high than a low credibility source. However, for highly involving issues, the ratio of positive local movements to the number of negative local movements will not differ between messages from a high and a low credibility source.

Source credibility and initial belief change. If an assertion is entertained as true before it is rejected (Gilbert et al., 1990), a message position is more likely to be thought of as a reasonable position at the beginning of judgment regardless of the level of source credibility. Therefore, it is expected that there is no difference in the amount of belief change at the beginning of judgment between high and low credibility sources. Applying the local movement framework, the relationship between source credibility and the first local movement is hypothesized as follows:

> H4.2.2 (Source credibility and initial belief change): Controlling for message discrepancy, the amount of belief change by the first local movement from a message with a high credibility source will not differ from the same message from a low credibility source.

Source credibility and final belief change. As in message discrepancy research, in most studies of source credibility beliefs were measured only once, at the end of judgment. Therefore, findings from existing studies on source credibility can be applied to the final judgment. Petty, Cacioppo, and Goldman (1981) found that source credibility has an effect on beliefs for less involving issues but no effect for highly involving issues. When recipients are highly involved and have the cognitive ability to process message arguments, they are more likely to scrutinize message arguments, in which case message arguments have an effect on beliefs but the effect of source credibility on beliefs will be weak.

> H4.2.3 (Source credibility and final belief change): For less involving issues, the amount of final belief change will be greater for a message from a high than a low credibility source. However, for highly involving issues, there will be no difference in the amount of final belief change between messages from a high and a low credibility source.

Regarding the effect of source credibility on beliefs, both Fink et al.'s model and Laroche's model predict that as source credibility increases, the effect of message discrepancy on the amount of belief change increases.

> H4.2.4 (The moderating role of source credibility on the effect of message discrepancy on final beliefs): As source credibility increases, the effect of message discrepancy on final beliefs increases.

Change of effect of source credibility on beliefs over time. H4.2.3 and H4.2.4 provide important information about the changing effect of source credibility on beliefs during judgment. These hypotheses suggest that for less involving issues, the effect of source credibility may be absent at the beginning of judgment but increases over time during judgment due to positive cognitive responses to a message from a high credibility source and negative cognitive responses to a message from a low credibility source. However, for highly involving issues, no significant effect is expected in both at the beginning of judgment and at the end of judgment. No significant change in the effect of source credibility is expected for highly involving issues. The following hypothesis is proposed:

> H4.2.5 (Change of effect of source credibility on beliefs): For less involving issues, the effect of source credibility on beliefs increases over time during judgment. However, for highly involving issues, no significant change in the effect of source credibility is expected.

CHAPTER III

Method

The present study analyzes data from three different previous studies (Fink et al., 2002; McGreevy, 1996; Wang, 1993). These three studies investigated patterns of belief change during decision making employing the computer mouse technique (to be described below). Decision topics and manipulated independent variables were different, but in all three studies the same method, the computer mouse technique, was used to measure belief change during decision making. Using the computer mouse technique, the three studies provided four sets of belief trajectories (two sets from Fink et al., one set from McGreevy, and one set from Wang).

McGreevy Study (1996)

McGreevy's study employed a decision to choose one of two candidates for admission to a university. One hundred and two undergraduate students were given information about the two candidates. Then participants were asked to think about the admission decision and indicate their instantaneous beliefs about which applicants should be admitted. McGreevy measured belief change both while participants were reading messages (the message-receipt phase) and after participants finished reading (the post-message phase) (see Appendix E for the decision scenario used in McGreevy's study).

Independent Variables

In McGreevy's study, two independent variables were manipulated: candidate similarity (similar versus different), and distraction (distraction versus no distraction).

Candidate similarity. Candidate similarity was manipulated by varying the degree of difference in suitability for college between two candidates (similar versus different). In the similar-candidate condition, positive information about Candidate 1 (i.e., characteristics that are indicative of success in college) was followed by positive information about Candidate 2. Suitability of the two candidates was expected to be similar in the similar-candidate condition. On the other hand, in the different-candidate condition, negative information about Candidate 1 (i.e., characteristics that do not fit with success in college) was followed by positive information about Candidate 2. Suitability of Candidate 1 was expected to be less than Candidate 2 in the different-candidate condition. A manipulation check showed that candidate similarity was successfully manipulated, $F(1, 97) = 46.14$, $r^2 = .32$, $p < .01$ (see McGreevy, 1996, pp. 157-158).

In the McGreevy study, because the decision was dichotomous, positive information about one candidate can be assumed to have negative implications on the evaluation of the other candidate. Focusing on Candidate 2, in the similar-candidate condition, a series of negative pieces of information is followed by a series of positive pieces of information. Again, focusing on Candidate 2, in the different-candidate condition, a series of positive pieces of information is followed by another series of positive pieces of information. The message in the similar-candidate condition can be considered mixed-valence information and the message in the different-candidate condition can be considered univalent information.

Distraction. Distraction was manipulated by varying environmental noise. In the distraction condition, participants were placed in a room in which feedback sound from a camera and VCR hookup were constantly heard (see McGreevy, 1996, p. 116). In the no distraction condition, there was no noise. A manipulation check indicated that participants who received the noise distraction reported being more distracted than participants who did not received the noise distraction, $F(1, 96) = 66.04$, $p < .01$; $r^2 = .41$ (see McGreevy, 1996, p. 159).

Dependent Variables

In McGreevy, positions about suitability of applicants were measured on a scale in which zero indicated complete favorability for Candidate 1 and 100 indicated complete favorability for Candidate 2. Higher values on the scale indicated greater favorability about Candidate 2. This scale assumed that the variable was unidimensional. In other words, favorability about Candidate 1 and favorability about Candidate 2 were assumed to be related to perfectly negatively linearly related. This was a reasonable assumption because the decision was dichotomous.

Positions were measured over time during judgment using the computer mouse technique. From belief trajectories, the following dependent variables were obtained to test proposed hypotheses: belief positions of local movements, the number of positive and negative local movements, and the number of changes in direction.

Belief positions of local movements. Belief trajectories provided thousands of belief positions for each individual. Among these thousands of belief positions, the present study focuses on local movements. A local movement consists of a stay and a move. A *stay* is defined as a set of consecutive belief positions that do not have a significant change in a certain period time (see below for coding procedures). A *move* is defined as a set of consecutive positions between two stays. Moves represent belief change during judgment. Stays represents temporarily stable belief positions during judgment. Belief positions of local movements are belief positions of stays. Among the thousands of belief positions, positions for micro local movements, $P_1, P_2, \ldots, P_N$, and macro local movements, $\tilde{P}_1, \tilde{P}_2, \ldots, \tilde{P}_N$, were extracted as key positions of belief trajectories.

From $P_1, P_2, \ldots, P_N$, the amount of belief change by the *i*-th micro local movements will be derived, that is, $\Delta P_{1(0)}, \Delta P_{2(1)}, \ldots, \Delta P_{N(N-1)}$. Also, the amount of belief change by the *i*-th macro local movements, $\Delta\tilde{P}_{1(0)}, \Delta\tilde{P}_{2(1)}, \ldots,, \Delta\tilde{P}_{N(N-1)}$ will be derived from $\tilde{P}_1, \tilde{P}_2, \ldots, \tilde{P}_N$. The average of the absolute value of $\Delta\tilde{P}_{i(i-1)}$, that is, $\frac{1}{N}\sum_{1}^{N}\left|\Delta\tilde{P}_{i(i-1)}\right|$, will be used as a measure to reflect an overall aspect of belief movement, which is analogous to oscillation amplitude.

The number of positive and negative movements. Local movements are either upward or downward. Because higher numbers indicate greater favorability about Candidate 2, upward movements are positive belief changes toward Candidate 2 (or negative belief changes toward Candidate 1) and downward movements are negative belief changes toward Candidate 2. The number of positive and negative movements will be analyzed.

The number of changes of direction. The number of changes of direction in belief trajectories will be counted. A belief trajectory has *N* macro local movements, i.e., $\tilde{P}_1, \tilde{P}_2, \ldots, \tilde{P}_N$. Therefore, the total number of changes of direction will be *N* - 1.

Final decision. The final position, P_N, was expected to be either 0 indicating preference of Candidate 1, or 100, indicating preference of Candidate 2. The participants' final decision was obtained form the final position, which is a dichotomous variable.[3]

Distinctiveness of Two Phases in Belief Trajectories

In McGreevy's study, participants' instantaneous positions on the issue were measured both during the message-receipt phase and the post-message phase. Participants were asked to indicate the end of each phase by clicking the computer mouse button. When participants followed the instructions correctly, two phases in the trajectories should be distinguishable. However, some participants did not follow the instructions correctly, which resulted in providing belief trajectories in which the two phases cannot be distinguished. When participants followed the instructions correctly, two distinctive mouse-clicks were expected, one to indicate the end of the message-receipt phase and one to indicate the end of the decision.

The results showed that the number of clicks varied. Out of 102 cases, one case had no clicks (1.0 %); 11 cases had only one click (10.8 %); 71 cases had two clicks (69.6 %); 14 cases had three clicks (13.7%); 3 cases had 4 clicks (2.9 %); one case had 14 clicks (1.0 %); and one case had 17 clicks (1.0 %).

The no-click case was excluded because the two phases (the message-receipt phase and the post-message phase) could not be distinguished in this case. For the one-click cases, the click appeared either in the middle of the trajectories (4 cases) or the end of the trajectories (7 cases). When the click appeared at the end of the trajectories, the two phases could not be distinguished. On the other hand, when the click appeared at the middle of the trajectories, the trajectories showed up and down movement after the click and then showed a long stay at the end of the trajectories, which is assumed to indicate the end of the decision. In the latter cases, the two phases can be identified and distinguished. Therefore, four one-click cases in which the click appeared in the middle of the trajectories were included for the further analysis.

Out of 71 two-click cases, 13 cases showed less than one-second intervals between the two clicks. In one case, the interval between two clicks was approximately 72 milliseconds; in another cases, it was approximately 92 milliseconds. When two mouse clicks occur in quick succession, it is difficult to judge whether the two clicks are two distinctive clicks or a single double-click. All 13 cases with less than one-second intervals between clicks had the two clicks at the end of the mouse movement. As the three-click cases showed (see below), some participants might have made an additional click at the end of the decision to provide a definite indication of the end of their decision. Therefore, 13 two-click cases with less than a 1 second interval between two clicks were not included for the analysis.[4]

The three-click cases showed two patterns. Eleven out of 14 cases showed one click in the middle of the trajectory and two clicks at the end of the decision (Pattern 1). On the other hand, three cases showed two clicks in the middle of the decision trajectory and one click at the end of the decision (Pattern 2). In all cases of Pattern 1, the last two clicks showed the same position and appeared at the end of the trajectory. Positions for last two clicks were either at or near 100 or at or near 0, which indicated the end of the decision. This pattern suggests that participants added a click at the end of the decision. One reason that participants might have added a click at the end of the decision would be found in the computer program. The computer program continues to run after the two clicks. Participants might add an additional click to assure that the end of the decision was clearly indicated. All cases of Pattern 1 showed two distinctive phases by two distinctive groups of clicks.

Cases of Pattern 2 also showed two distinctive phases by two distinctive groups of clicks. Two cases of Pattern 2 had very short intervals, 114 ms and 696 ms (approximately), which was likely to be an indication of the end of one phase. The other case in Pattern 2 has the interval of 3.60 second (approximately), but the difference in position between the two clicks was small (1.60 points) and the trajectory clearly showed two distinctive phases. Therefore, all three-click cases were included for the analysis.

There are three cases with 4 clicks. Two cases showed two distinctive phases. The last two clicks of those two cases had the same position, which was either at or near 100 or at or near 0. However, the other case did not show two distinctive phases, so this case was dropped. Also, the 14 and 17 click cases were dropped. In summary, one no-click case, 7 one-click cases, 13 two-click cases, one four-click case, one 14-click case, and one 17-click case were not included in the analysis. In total, 24 cases out of 102 were dropped, making the valid number of cases used from McGreevy (1996) 78.

Data Coding

In the McGreevy data, the computer program recorded the mouse movement approximately every 24 milliseconds. From each trajectory, positions for local movements were extracted using another computer program that was written for this specific purpose (see Appendix A for the flow chart of the algorithm of the computer program and Appendix B for codes of the computer program).[5] The duration of a stay in a trajectory varies depending on two constraints: (1) the amount of position difference that indicates a significant change, the maximum position difference; (2) the minimum amount of time that constitutes a stay, which will differentiate a stay from temporary stops during a move.

Two kinds of tasks, graphical examination and hypothesis testing, were conducted to find the most appropriate values for the maximum position difference and the minimum stay length. Then, positions of local movements were extracted using these values.

Graphical examination. Graphical examination was conducted for a belief trajectory that had relatively complicated movements. Using different maximum position differences and different minimum stay lengths, several sets of key points were extracted. Then, extracted key points were compared with the original belief trajectory (see Figure 8). Graphical examination suggests that key points with a 1 or a 2 point maximum position difference reflect the original trajectory better than other values. Also, graphical examination suggests that key points with approximately 1 s or 2 s minimum stay length reflect the original trajectory better than other time lengths.

Hypothesis testing. In addition to graphical examination, hypothesis testing was used to find the best values for the maximum position difference and the different minimum stay length. Hypothesis 3.1.2 was tested with different sets of data that were created with different values for constraints (see the Results chapter for a detailed analysis of Hypothesis 3.1.1). The results showed that using a minimum stay length of 2 s and a maximum position difference of 1 point provided the highest R^2 (0.18, Adjusted R^2 = 0.14) (see Table 2.1 for R^2s for other data sets) for the proposed model. Using those values (the minimum stay length = 2 s and the maximum position difference = 1 point), key points were extracted.

Reliability and Validity of the Computer Mouse Technique

The computer mouse technique requires participants to indicate their beliefs while their beliefs change. The uniqueness of measurement using the computer mouse technique lies in that (1) the time at which a belief is reported is not forced but left to the participant, and (2) participants indicate their beliefs multiple times. Because participants are not forced to indicate their beliefs at a certain time, there could be disagreement between belief change and the motion of the computer mouse. There are four possible cases when participants measure their positions instantaneously using a computer mouse: (1) no computer mouse movement when a belief has not changed; (2) no computer mouse movement when a belief has changed; (3) computer mouse movement when a belief has not changed; (4) computer mouse movement when a belief has changed. Whereas the first and the fourth cases indicate agreement between the computer mouse motion and belief change, the second and third cases indicate disagreement between the computer mouse motion and belief change, which indicate errors in measurement. The second case is an error of non-reporting, which can be found when the participant fails to indicate his or her belief change. The third case is an error of false reporting, which can occur when the participant does not control the computer mouse movement effectively.

Fink et al. found spike-like changes in belief trajectories, with immediate movement in the opposite direction after reaching a position. The frequency of these spike-like changes was not reported. Fink et al. assumed that the spike-like movement resulted from a hasty correction when a participant had overshot an intended position. They did not consider spike-like movements as valid changes of direction. Also, Fink et al. found small movements ("vibrations") in belief trajectories; they did not treat such movements (i.e., those movements of less then 4% of the scale) as intended movements. These vibrations and spikes-like movements can be said to be errors of false reporting. The stricter the criterion for the valid measurement employed, the less the probability of the error of false reporting, but the greater the probability of non-reporting error.

In order to minimize the error of non-reporting, participants were trained in how to use the computer mouse to indicate their instantaneous belief change. McGreevy (1996) trained participants with real decisions that the participants reported having had made recently. McGreevy instructed participants to talk aloud the sequence of thoughts they went through to reach their final decision. Participants were also asked to move a computer mouse to indicate their beliefs about the alternatives while talking and thinking. After having completed this process, participants went through the same process with a different decision without talking aloud. The training and the main experiment were individually administrated by the experimenter. This training should minimize non-reporting error.[6]

Wang Study (1993)

Similar to McGreevy (1995), Wang's study (N = 66) employed a decision to choose one of two candidates for admission to a university. Participants, all Caucasian undergraduate students, were asked to listen to a message that described two college applicants, an African American high senior and a Caucasian high school senior. After participants listened to a recorded message on a tape recorder, they were asked to indicate their decision on a computer screen by moving a computer mouse between the two alternatives over time (see Appendix F for the decision scenario used in Wang's study).

Independent Variables

In Wang's study, one message variable, whether the target was described in an individuated way or stereotypically, and one situational variable, whether participants were distracted or not, were manipulated.

Individuation. In Wang's study, participants were given information about an African American applicant followed by information about a Caucasian applicant. In the message, the African American candidate was described in a *stereotypical* way in one condition (the no-individuation condition) or described against stereotypes of the African American applicants in another condition (i.e., in an *individuated* way, the individuation condition). The Caucasian applicant was described stereotypically. Information about the Caucasian applicant was the same in both conditions. Only traits that were not significantly related to success or failure in college were selected to describe applicants. Individuation was found to be successfully manipulated, $F(1, 62) = 46.44$, $p < .01$ (see Wang, 1993, pp. 116 - 117).

Based on the literature on racial attitudes (e.g., Bobo & Kluegel, 1991; Jackman & Senter, 1983) and on individuation (see, e.g., Wilder, 1978, 1981), Wang (1993) predicted that Caucasian participants could have a more positive attitude toward the African American applicant when the applicant was described in an individuated way than stereotypically, because individuation modifies ingroup favoritism and creates uncertainty in one's preference for ingroup members.

Remember that all traits used to describe applicants were neutral in terms of probability of success in college. Therefore, for participants, who were all Caucasians, stereotypical information about the Caucasian applicant was expected to have positive implications due to ingroup favoritism whereas stereotypical information about the

African American applicant was expected to have negative implications due to ingroup favoritism. However, individuated information about the African American applicant was expected to have less negative and more positive implications than stereotypical information because of decreased ingroup favoritism.

The message in the no-individuation condition contained stereotypical information about the Caucasian applicant and stereotypical information about the African American applicant, which means that the message in the no-individuation condition is univalent. The message in the individuation condition contained stereotypical information about the Caucasian applicant and individuated information about the African American applicant, which means that the message in the individuation condition is more mixed-valence than the message in the no-individuation condition.

Distraction. Participants were situated either in a quiet room (no distraction condition) or in a room in which there were distracting noises due to tape recording, rustling papers and crunching food (distraction condition). Distraction was successfully manipulated, $F(1, 62) = 64.04$, $p < .01$ (see Wang, 1993, p. 117).

Dependent Variables

Belief position. In Wang's study, participants were asked to indicate their probability of choosing candidates by moving a computer mouse on a scale. Participants were given unlimited time for judgment. The name of the African American applicant was appended on the left end of the scale and the name of the Caucasian applicant was appended on the right end of the scale. Mouse locations on the scale were converted into numbers, which represented the probability of choosing the Caucasian applicant.

From belief trajectories, key points were extracted and the following dependent variables were obtained: belief positions of local movement, the number of positive and negative local movements, and the number of changes in direction.

Final decision. The final position, P_N, was expected to be either 0 indicating preference of the African American applicant, or 100, indicating preference of the Caucasian applicant. Final decision is a dichotomous variable that was obtained from the final position, P_N.[7]

Data Coding

In the Wang data, positions were measured approximately every 33 millisecond. Because the same measurement scale was used in both McGreevy study and Wang study, the same values for constraints (the minimum stay length = 2 s and the maximum position difference = 1 point) were applied to the Wang data for coding.

Fink, Kaplowitz, and Hubbard Study (2002): 1. Criminal-Sentencing Issue

Ninety-nine undergraduate students participated in Fink et al.'s (2002) study. Using the computer mouse technique, each participant indicated his or her beliefs on two issues that were presented with scenarios. One of the two issues was criminal sentencing (the other issue was tuition increase issue; see below).

The scenario used for criminal sentencing in the study was the same scenario in Kaplowitz and Fink (1991). In the criminal-sentencing scenario, participants were asked to read sentencing guidelines for the crime of armed robbery. The sentencing guidelines stated that ten years is the appropriate sentence for armed robbery. Then participants were asked to indicate their opinion about the proper sentence for armed robbery. Next, participants received a message about a judge's sentence to a defendant who allegedly committed armed robbery. The participants also received the text of the speech the judge supposedly delivered in sentencing the defendant (see Appendix G for the decision scenario used for the criminal-sentencing issue).

After reading the message, participants were asked to think about the issue and indicate their position about the appropriate sentence for the defendant over time using a computer mouse. They were told to indicate when they made their final judgment. After completing their judgment, participants were asked to list all thoughts they had about the issue.

Independent Variables

Two independent variables, message discrepancy and source credibility, were manipulated in the criminal-sentencing scenario.

Message discrepancy. Three levels of message discrepancy were manipulated by varying the judge's sentence for the defendant: 17 years (small discrepancy), 30 years (moderate discrepancy), or 50 years (extreme discrepancy). This criminal-sentencing scenario was created by Kaplowitz et al. (1991). Kaplowitz et al. found the median sentence that participants proposed for armed robbery to be ten years in pilot studies with students at the same university at which their experiment was conducted. According to Kaplowitz et al., different levels of message discrepancy were created by keeping the ratio of successive steps to be approximately constant (see Lodge, 1981). (The ratio of the small discrepancy position to the initial position is 1.70, the ratio of the moderate to the small discrepancy position is 1.76, and the ratio of the extreme to the moderate discrepancy position is 1.67.)

In Fink et al.'s (2002) study, initial positions for each participant on the issue were also measured after participants had read the sentencing guidelines but before they were presented with the judge's sentencing message in which message discrepancy was manipulated. The mean initial position was 10.12 year (*SD* = 4.95), which was close to the one suggested by the fictitious sentencing guidelines. Using individual initial positions and message discrepancy, individual message discrepancies for each participant were obtained. In this study, individually measured message discrepancy was used as an explanatory variable rather than manipulated message discrepancy. In four cases out of ninety-seven, individual discrepancy was found to be less than zero (-13 years and -3.60 years in the low source credibility and 17 years message discrepancy condition; -3.60 years and -1.10 years in the high source credibility and 17 years message discrepancy condition). Theses cases were dropped for the analysis because the proposed models were restricted to the condition in which the discrepancy between message position and the recipient's initial position is positive; the valid number of cases used from the criminal-sentencing data was 93.

Some hypothesis testing required using a grouped variable rather than a continuous variable. For those analyses, three groups were created based on individual message discrepancy. The first group had discrepancies of 0.00 to 14.60 years (*M* = 7.51, *n* = 31); the second group had discrepancies of 14.80 to 30.00 years (*M* = 21.16; *n* = 31); the third group had discrepancies of 34.40 to 48.00 years (*M* = 41.04; *n* = 31).

Source credibility. To manipulate different levels of source credibility, the judge was described as either not respected in the state (low source credibility) or as one of the most respected judges in the state (high source credibility). Manipulation checks showed that credibility was successfully manipulated (Fink et al., 2002, p. 22). (No quantitative assessment of the manipulation check of the source was provided.) Messages were the same in all conditions except for message positions (sentences) and descriptions of the source.

Dependent Variables

In the present study, the following variables were used as dependent variables for the criminal-sentencing data: the belief positions of local movement, the number of positive and negative local movements, the number of changes in direction, the number of positive and negative thoughts about the message position.

Belief positions of local movements. In Fink et al.'s (2002) the criminal-sentencing scenario, the appropriate sentence for an armed robbery was measured with the computer mouse technique. The operationalization for micro and macro local movements that was used in McGreevy's study was applied for the criminal-sentencing scenario study.

The number of positive and negative local movements. Local movements are either upward or downward. Upward movements are positive belief changes toward more severe sentencing.

The number of changes in direction. The same operationalization as McGreevy's study was applied for the criminal-sentencing scenario study.

The number of positive and negative thoughts about the message position. After completing their judgment, participants were asked to list all thoughts they had about the issue when they were deciding the issue. Participants self-reported thoughts were classified into positive and negative thoughts about severe sentencing. The coding procedure and inter-coder reliabilities were not reported.

Data Coding

In the criminal-sentencing data, positions were measured approximately every 77 milliseconds. For the time constraint, the minimum stay length, the value found in McGreevy data, 2 s, was used. However, for the position constraint, the maximum Belief Change, a new value was needed because the range of the scale used in the criminal-sentencing scenario was different from the McGreevy study; the average range in belief change was 8.90 in the criminal-sentencing data whereas the average range in position in the McGreevy data was 71.51.

To find the best values for the maximum position difference, Hypothesis 4.1.2 was tested with different sets of data that were created with different values for constraints (see the Results chapter for a detailed analysis of Hypothesis 4.1.2). To evaluate performance of the different values for the constraint, three criteria were used: R^2, the sample size, and the number of statistically significant predictors. The results showed that 2.7 years as the maximum position difference provided the relatively high R^2 (0.23, Adjusted $R^2 = 0.18$), a relatively large sample size ($N = 81$), and the highest number of statistically significant predictors (see Table 2.2 for results for other data sets) for the proposed model. Using those values (the minimum stay length = 2 s and the maximum position difference = 2.7 years), key points were extracted.

Fink, Kaplowitz, and Hubbard Study (2002): 2. Tuition-Increase Issue

For the tuition-increase issue, the scenario used in Fink et al. (1983) was used in Fink et al.'s study (2002). In the tuition-increase scenario, the message was a statement in which various tuition increases were advocated. Participants were told that the statement was written by a state legislator. After reading the statement, participants were asked to think about the issue and indicate their position about the appropriate amount of tuition increase using the computer mouse technique (see Appendix H for the decision scenario used for the tuition-increase issue).

The Level of Issue Involvement

Compared to the criminal-sentencing issue, the tuition-increase issue was more likely to be perceived to have important consequences to participants, who were college students. In the introduction of the message for the tuition increase, participants were told that the Board of Trustees of their university recently voted to increase undergraduate tuition, which would be effective the following fiscal year. However, there was further discussion within the university about the appropriate tuition for the following year (Fink et al., 2002). In the present study, the tuition-increase issue is considered as a highly involving issue whereas the criminal-sentencing issue is less involving issue. However, because two issues differ in ways other than the level of involvement, differences in belief change between two issues cannot be exclusively attributed to the level of involvement (Jackson, 1992).

Independent Variables

Like the criminal-sentencing scenario, message discrepancy and source credibility were manipulated in the tuition-increase scenario.

Message discrepancy. Message discrepancy was manipulated by varying the advocated tuition increase as a 9% increase (small discrepancy), a 15% increase (moderate discrepancy), or a 22% increase (extreme discrepancy). Participants' initial positions on the tuition increase were measured before they were presented with the message. The initial position mean on the tuition increase was 0.00 % (*SD* = 0.02). For the tuition-increase issue, individual message discrepancies were virtually equal to the manipulated message discrepancies.

Source credibility. To manipulate different levels of source credibility, the legislator, the hypothetical writer of the statement about the tuition increase, was described as one whose knowledge of the issues and willingness to be fair to students were often questioned (low source credibility) or as one who was praised by student groups (high source credibility). Manipulation checks showed that credibility was successfully manipulated (see Fink et al., 2002, p. 22). (No quantitative assessment of the source of the manipulation check was provided.). Messages were the same in all conditions except for message positions (proposed tuition increase) and descriptions of the source.

Dependent Variables

In the present study, the following variables were used as dependent variables for the tuition-increase data: the belief positions of local movement, the number of positive and negative local movements, the number of changes in direction, and the number of positive and negative thoughts about the message position.

Belief positions of local movements. In Fink et al.'s (2002) tuition-increase scenario, the appropriate amount of tuition increase was measured with the computer mouse technique. The operationalization for micro and macro local movements that was used in McGreevy's study was applied for the tuition-increase study.

The number of positive and negative local movements. Local movements are either upward or downward. Upward movements are positive belief changes toward a tuition increase.

The number of changes in direction. The same operationalization as in McGreevy's study was applied for the tuition-increase scenario study.

The number of positive and negative thoughts about the message position. After completing their judgment, participants were asked to list all thoughts they had about the issue. Participants self-reported thoughts were classified by Fink et al. into positive and negative thoughts about tuition increase.

Data Coding

Positions were measured approximately every 77 milliseconds for the tuition-increase issue. Like the criminal-sentencing data, Hypothesis 4.1.2 was tested with different sets of data that were created with different values for constraints to find the best values for the maximum position difference (see the Results chapter for a detailed analysis of Hypothesis 4.1.2). The same criteria used for the criminal-sentencing data, R^2, the sample size, and the number of statistically significant predictors, were used to evaluate performance of the different values for the constraint. The results showed that using the maximum position difference of 3.0% provided the highest R^2 (0.14, Adjusted R^2 = 0.08), and relatively large sample size (N = 90), and the highest number of statistically significant predictors (see Table 2.3 for results for other data sets) for the proposed model. Using those values (the minimum stay length = 2 s and the maximum position difference = 3.0 %), key points were extracted.

CHAPTER IV

Results

This chapter presents the hypothesis testing results. In total, twenty hypotheses were tested with various analyses. Different data sets were used to test the hypotheses (see Table 3.1). In all the present analyses, the alpha level was set as equal or less than .05. For the testing of directional hypotheses, one-tailed significance testing was used. Otherwise, two-tailed significance testing was used.

Patterns of Belief Change during the Message-Receipt Phase

Message Structure and Patterns of Belief Change

Regarding the relationship between the sequence of information and the sequence of local movements, H1.1 was proposed:

> H1.1: For a sequential mixed-valence messages, a *U*-shaped or inverted *U*-shaped pattern of local movements (or a series of such patterns) occurs; for a univalent message, a unidirectional (monotonic) pattern of local movement occurs.

The McGreevy data set was used to test H1.1. To analyze patterns of belief trajectories, five ordinal time points for each trajectory were selected. First, the time point after the first micro local movement, the starting point of the second stay, was selected. Second, for each participant's trajectory, the starting point of the 25-percentile rank of the stays, the 1st quartile point, was selected. For example, if a trajectory has 12 stays in total, the starting point of 4th stay is the 1st quartile point. Third, the starting point of the 50-percentile rank of the stays, the mid-point, was selected. Fourth, the starting point of the 75-percentile rank of the stays, the 3rd quartile point, was selected. Lastly, the time point for the final stay was selected. Positions in those six time points, which include the starting point, can show overall patterns of belief change for each trajectory: whether patterns of trajectories are *U*-shape or unidirectional.

In McGreevy's study, a series of pieces of positive information about Candidate 1 was presented first and next a series of pieces of positive information about Candidate 2 was presented (a sequential mixed-valence message) in the similar-candidate condition. Because higher numbers indicate more favorability toward Candidate 2 on the scale, a *U*-shaped pattern of local movements is expected in the similar-candidate condition. On the other hand, in the different-candidate condition, a series of pieces of negative information about Candidate 1 was followed by a series of pieces of positive information about Candidate 2 (a univalent message), in which a positive unidirectional pattern is expected.

For this test, cases with at least five micro local movements were used (N = 62). Positions were subtracted by the initial position (50.00); therefore, the dependent variable was the amount of belief change from the initial position, $\Delta P_{i(0)}$. Table 3.2 shows the means and standard deviations of the amount of belief change by ordinal time of local movements, candidate similarity, and distraction. Figure 9 represents the amount of belief change by ordinal time and candidate similarity.

Figure 9 shows a *U*-shaped pattern of beliefs over time for the similar-candidate condition, as expected. On the other hand, belief change for the different-candidate condition is somewhat different from the expected unidirectional pattern. In the first half of the trajectory in Figure 9, the amount of belief change does not increase toward Candidate 2 but stays around the neural (initial) position. Negative information about Candidate 1 did not increase favorability toward Candidate 2. After the midpoint, two conditions basically show the same pattern, which was expected because the second half of pieces of information was exactly same in both conditions.

A repeated-measures analysis of variance was conducted to test Hypothesis 1.1. The dependent variable was the amount of belief change from the initial position. Results showed that the amount of belief change was greater in the different- than the similar-candidate condition, $F(1, 58) = 23.21$, $p < .01$, and partial $\eta^2 = .29$. The amount of belief change as a function of ordinal time showed statistically significant linear ($F[1, 58] = 58.96$, $p < .01$, partial $\eta^2 = .50$), quadratic ($F[1, 58] = 31.25$, $p < .01$, partial $\eta^2 = .35$), and cubic ($F[1, 58] = 26.85$, $p < .01$, partial $\eta^2 = .32$) effects. Also, there was a statistically significant interaction effect between the quadratic function of ordinal time and candidate similarity, $F(1, 58) = 4.40$, $p = .03$, and partial $\eta^2 = .07$, which indicates that the quadratic effect of ordinal time on belief change is different between the similar- and the different-candidate conditions (see Table 3.3 for ANOVA results).

To examine different effects of ordinal time between the similar- and the different-candidate conditions, a repeated-measures analysis of variance was conducted separately. The dependent variable was the amount of belief change from the initial position. In the similar-candidate condition, ordinal time showed statistically significant linear ($F[1, 28] = 19.97$, $p < .01$, partial $\eta^2 = .42$), quadratic ($F[1, 28] = 32.95$, $p < .01$, partial $\eta^2 = .54$) and cubic ($F[1, 28] = 13.62$, $p < .01$, partial $\eta^2 = .33$) effects. Of these three effects, the quadratic effect showed the highest partial η^2. On the other hand, in the different-candidate condition, ordinal time showed a statistically significant linear ($F[1, 32) = 45.83$, $p < .01$, partial $\eta^2 = .59$), quadratic ($F[1, 32] = 6.40$, $p = .02$, partial $\eta^2 = .16$) and cubic ($F[1, 32] = 14.07$, $p < .01$, partial $\eta^2 = .38$) effects. Among three effects, the linear effect showed the highest partial η^2, which indicates that the pattern of beliefs in the different-candidate condition (univalent message) is mainly linear (see Table 3.4 for ANOVA results).

Both graphical and statistical results showed that belief trajectories were shaped according to the information in the message. As hypothesized, correspondences between messages and patterns of belief trajectories were found. These correspondences between messages and belief patterns measured by the computer mouse technique provide evidence about validity of the computer mouse technique to measure belief change during judgment. The structures of the message and belief changes in response to the message were reflected in the output of the measurement by the computer mouse technique. H1.1 was supported by the McGreevy data.

Message Type and the Number of Local Movements

Regarding the relationship between message type (univalent vs. mixed-valence message) and the ratio of the number of positive local movements to the number of negative local movements during the message-receipt phase, H1.2 was proposed:

> H1.2: During the message-receipt phase, the ratio of the number of positive local movements to the number of negative local movements in belief trajectories is greater for positively univalent messages than for mixed-valence messages.

In McGreevy's study, 16 pieces of positive information about Candidate 1 is followed by 14 pieces of positive information about Candidate 2 in the similar-candidate condition. In the different-candidate condition, 15 pieces of negative information about Candidate 1 is followed by 14 pieces of positive information about Candidate 2. If local movements reflect belief change in response to information in the message, it is expected that the ratio of the number of positive local movements to the number of negative local movements is greater in the different-candidate condition (the univalent message condition) than the similar-candidate condition (the mixed-valence message condition). Instead of the ratio of the number of positive to the number of negative movements, the following formula was used, which was named the positivity of movements:

$$Positivity_{Movements} = \log(p+1) - \log(q+1), \qquad (3.1)$$

where p is the number of positive movements and q is the number of negative movements. Equation 3.1 is a logarithmic transformation of the ratio of the number of positive movements to the number of negative movements after adding 1 to the number of positive movements and to the number of negative movements. If the number of positive movements is equal to the number of negative movements, positivity will be zero. The above formula is used because it provides not only information about the proportion of positive movements to negative movements, but also because it has a relatively normal distribution (the skewness of positivity of movements is .12, *ns*, in the message-receipt phase, and -.41, *ns*, in the post-message phase).

Table 3.5 shows the means and standard deviations of positivity of movements by condition. Results from ANOVA showed that positivity of movements was greater in the different-candidate condition than the similar-candidate condition, $F(1, 74) = 10.71$, $p < .01$, and partial $\eta^2 = 13$ (see Table 3.6 for ANOVA results). Results showed that message recipients generated more positive local movements than negative local movement in response to a (positive) univalent message compared to a mixed-valence message.

Also, as expected, in the similar-candidate condition, the mean of positivity of movements was -.02 (*SD* = .63), which indicates the number of positive and the number of negative movement is about equal. On the other hand, in the different-candidate condition, the mean of positivity of movements was .45 (*SD* = .61), which indicates that the number of positive movement is greater than the number of negative movements. These results show that the number of local movements during the message-receipt reflects information in the message. H1.2 was supported by the McGreevy data. These results also provide evidence for validity of the computer mouse technique.

Strength of Information and the Effect of the Number of Local Movements

Regarding the relationship between weights of information in the message and belief trajectories during message receipt, H1.3 was proposed:

> H1.3: Belief trajectories in the message-receipt phase will reflect the weights of the pieces of information in the message.

In one of her pilot studies, McGreevy (1996) asked participants to indicate the importance of hobbies and personality characteristics for success or failure in college (p. 55). Importance levels were measured with a scale in which zero indicated the highest probability of failure and 10 indicated the highest probability of success. Based on these results, McGreevy selected hobbies and personality characteristics representing success that were not significantly different from each other. She also selected some hobbies and personality characteristics representing failure in college that were significantly different from those hobbies or characteristics representing success in college. McGreevy created sentences for the message with those hobbies or characteristics. Table 3.7 shows means and standard deviations of importance levels of hobbies and characteristics that were included in the message. In Table 3.7, hobbies and characteristics were listed according the order in the message in which they were presented in the experiment. H1.3 and Equation 1.7 predict that belief trajectories during the message-receipt phase should reflect the amount and the order of weights of pieces of information in Table 3.7.

Observed belief trajectories showed that participants did not make local movements in response to every piece of information. There are 32 sentences and 13 groups of pieces of information in the similar-candidate condition and 31 sentences and 13 groups of pieces of information in the different-candidate condition (see pp. 16-20). However, the number of local movements was not equal to the number of groups of pieces of information and varied among participants (M = 11.17, SD = 6.67, N = 78; there was no statistically significant difference between the similar-candidate and the different-candidate condition). It seems that some participants had local movements after processing multiple pieces of information. Instead of weights for individual pieces of information, average weights of groups of pieces of information were used to predict belief trajectories.

The messages in the McGreevy study had two parts: The first part described Candidate 1 and the second part described Candidate 2. The average importance of characteristics is 8.03 for Candidate 1 and 8.07 for Candidate 2 in the similar-candidate condition, and 5.05 for Candidate 1 and 8.07 for Candidate 2 in the different-candidate condition. The message for Candidate 2 is the same in both conditions.

The number of sentences and the number of groups of pieces of information about Candidate 1 and Candidate 2 were balanced. There were 17 sentences for Candidate 1 (7 grouped pieces of information) and 15 sentences for Candidate 2 (7 grouped pieces of information) in the similar-candidate condition; 16 sentences for Candidate 1 (6 grouped pieces of information) and 15 sentences for Candidate 2 (7 grouped pieces of information) in the different-candidate condition. Therefore, it is assumed that the amount of belief change in the first half of local movements of a trajectory represents belief change in the response to information about Candidate 1. That is:

$$\Delta P_{H1} = \Delta P_{\frac{N}{2}(0)} = \sum_{i=1}^{\frac{N}{2}} w_i P_{M_i} \ , \qquad (3.2)$$

where ΔP_{H1} represents the amount of belief change in the first half of local movements. Greater ΔP_{H1} indicates greater favorability toward Candidate 2, and *N* is the total number of local movements in the message-receipt phase. Because the average weight of information about Candidate 1 is greater for the similar-candidate condition than for the different-candidate condition, ΔP_{H1} is expected to be greater for different-candidate condition than the similar-candidate condition.

On the other hand, the amount of belief change in response to messages for Candidate 2 is expected not to be different between two conditions because the message is the same in both conditions. Also, because the average weight of information about Candidate 2, 8.07, is close to the average weight of information about Candidate 1 in the similar-candidate condition, 8.03, the absolute amount of belief change in response to the message for Candidate 2 in the similar-candidate condition is not expected to be different from the absolute amount of belief change in response to the message for Candidate 1 in the similar-candidate condition. The amount of belief change in response to information about Candidate 2 is measured by the amount of belief change by the second half of local movements. That is:

$$\Delta P_{H2} = \Delta P_{N(\frac{N}{2})} = \sum_{i=\frac{N}{2}}^{N} w_i P_{M_i} = \sum_{i=1}^{N} w_i P_{M_i} - \sum_{i=1}^{\frac{N}{2}} w_i P_{M_i} \ . \qquad (3.3)$$

A multivariate analysis of variance was conducted to test H1.3. The amount of belief change in the first half of local movements and the amount of belief change in the second half of local movements were predicted by candidate similarity and distraction (see Table 3.8 for means and standard deviations and Table 3.9 for the MANOVA analysis). The results show that the amount of negative belief change in the first half of the local movements was significantly greater in the similar-candidate condition (*M* = -18.30, *SD* = 19.86, *n* = 70) than in the different-candidate condition (*M* = .12, *SD* = 21.55, *n* = 70), $F(1, 66) = 14.50$, $p < .01$, and partial $\eta^2 = .18$, but the amount of belief change in the second half of the local movements was not significantly different between the two conditions (*M* = 27.99, *SD* = 22.31, *n* = 70 for the similar-candidate condition; *M* = 24.83, *SD* = 33.42, *n* = 70 for the different-candidate condition). These results are consistent with the prediction of H1.3.

The mean amount of belief change in the first half of local movements in the different-candidate condition was found to be about zero, .12. On the other hand, the average weight for hobbies and characteristics for Candidate 1 in the different-candidate condition was 5.05. The value 5.05 on 10-point scale suggests that those hobbies and characteristics of the candidate were neither perceived as indicators of failure nor of success, but provided neutral information. These results show that the amount of belief change in the first half of local movements in the different-candidate condition reflects the weights of pieces of information in the message.

To examine whether the absolute amount of belief change in response to the message for Candidate 2 is not different from the absolute amount of belief change in response to the message for Candidate 1 in the similar-candidate condition, a paired *t*-test was conducted. The results showed that the absolute amount of belief change in the second half of local movements (M = 29.69, SD = 19.93, n = 35) was greater than the absolute amount of belief change in the first half of local movements (M = 22.48, SD = 14.80, n = 35), $t(34) = 2.01$, $p \leq .05$, two-tailed. Even though the average weights are similar between information for Candidate 1 and information for Candidate 2, the information presented later induced greater belief change. This result is not consistent with the prediction of H1.3 but suggests a recency effect. H1.3 was partially supported.

The above results provide some evidence for validity of the computer-mouse technique. Results of H1.2 show that the number of positive and negative pieces of information in the message appears as a cause of the belief trajectories. Moreover, results of H1.3 suggest that the weights of information in the message were represented in belief trajectories obtained by the computer-mouse technique.

Patterns of Belief Change during the Post-Message Phase

A spatial-spring linkage model of cognitive forces (Kaplowitz et al., 1983) predicted oscillatory and damping patterns of belief change during judgment.

Patterns of Belief Change in Micro Local Movements: Oscillatory and Damping Patterns

Oscillatory and damping patterns of belief change in micro local movements were hypothesized in H2.1.1, and H2.1.2.

> H2.1.1: During judgment, a local movement is more likely to be followed by a local movement whose direction is opposite to the direction of the preceding one.

H2.1.2: During judgment, the absolute amount of belief change by a local movement is smaller than the absolute amount of belief change of the proceeding local movement.

Equation 1.11 summarizes H2.1.1, and H2.1.2.

$$\Delta P_{i(i-1)} = l_i \Delta P_{(i-1)(i-2)}; -1 < l_i < 0;\ i \geq 2, \tag{1.8}$$

where l_i is a constant for the ***i***-th local movement. In order to test the above equations, the amount of belief change by micro local movement is regressed on the amount of belief change by the previous micro local movement. That is,

$$\Delta P_{2(1)} = l_1 \Delta P_{1(0)}, \tag{3.4}$$

$$\Delta P_{3(2)} = l_2 \Delta P_{2(1)}, \tag{3.5}$$

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$$\Delta P_{N(N-1)} = l_{(N-1)} \Delta P_{(N-1)(N-2)}. \tag{3.6}$$

Hypothesis 2.1.1 and 2.1.2 predict that $-1.00 < l_i < 0$. First, the amount of belief change by a local movement from the previous belief, $\Delta P_{i(i-1)}$, was obtained for all data sets. Then, $\Delta P_{i(i-1)}$ was regressed on $\Delta P_{(i-1)(i-2)}$. Regression analysis was done only if the sample size was greater than 20. The number of regression analyses was six for the McGreevy data, four for the Wang data, four for the criminal-sentencing data, and two for the tuition-increase data.

McGreevy data. Six regression analyses were conducted (the minimum N = 26). Among the six regression analyses, only one regression analysis, regression of the 6th

micro local movement on the 5th micro local movement, showed a statistically significant negative effect (l_5 = -0.96, p < .01; see Table 3.10 for the regression results). In the other regression cases, no statistically significant relationship was found in the amount of belief change between two consecutive micro movements. Neither an oscillatory nor a damping pattern was supported by the McGreevy data.

Wang data. Four regression analyses were conducted (the minimum N = 22; see Table 3.11 for the regression results). Results for the Wang data showed a strong oscillatory pattern in micro local movements. Regression coefficients in all four-regression cases showed statistically significant negative effects (l_1 = -1.03, p < .01; l_2 = -0.70, p < .01; l_3 = -0.73, p < .01**;** l_4 = -0.50, p < .01), which indicates oscillatory patterns of belief trajectories. H2.1.1 was supported. However, the regression coefficient of l_1 (= -1.03) indicates that the amount of belief change by the 2nd micro movement is a little bit greater than the1st micro movement, which is somewhat inconsistent with the damping pattern. Coefficients from other four regression cases were found between -1.00 and 0, which indicates a damping pattern of belief trajectories. H2.1.2 was generally supported by the Wang data.

Criminal-sentencing data. Four regression analyses were conducted (the minimum N = 33; see Table 3.12 for the regression results). In the criminal-sentencing data, neither l_1 nor l_2 was statistically significant. Neither an oscillatory pattern nor a damping pattern was found for micro movements in the criminal-sentencing data. H2.1.1 and H2.2.2 were not supported by the criminal-sentencing data.

Tuition-increase data. Two regression analyses were conducted (the minimum N = 29; see Table 3.13 for the regression results). In the tuition-increase data, both regression coefficients were negative and statistically significant and found between -1.00 and 0 (l_1 = -.51, $p < .01$; l_2 = -.37, $p < .1$), which indicates oscillatory and damping patterns of belief trajectories. The tuition-increase data generally support H2.1.1 and H2.1.2.

In sum, results from regression analysis with micro local movements provide strong supporting evidence for an oscillatory pattern in the Wang data and the tuition-increase data, and but not in the McGreevy data and the criminal-sentencing data.[8]

Damping Pattern: Decrease of Absolute Amount of Belief Change

A damping pattern can be assessed by examining whether the absolute amount of belief change by local movements decreases as the decision approaches the final judgment. To test for a damping pattern of belief change, the absolute amounts of belief change by the last two micro movements were compared and analyzed with a repeated-measures analysis of variance. Only cases that have at least two micro local movements were included for the analysis.

McGreevy data. A repeated-measures analysis of variance (N = 54) was conducted on the absolute amount of belief change from the previous belief by ordinal time, candidate similarity, and distraction (see Table 3.14 for means and standard deviations and Table 3.15 for the repeated-measures analysis of variance results). Ordinal time was a repeated measure and consisted of two time points, the local movement before the final local movement and the final local movement. The absolute amount of belief change was significantly greater for the final movement (M = 34.87; SD = 27.55) than for the movement before the final movement (M = 14.34; SD = 19.38), $F(1, 50) = 37.12$, $p < .01$, and partial η^2= .43. This result indicates that the absolute amount of belief change increased rather than decreased at the end of judgment. Belief trajectories did not show a damping pattern. H2.1.2 was not supported by the McGreevy data.

Wang data. A repeated-measures analysis of variance (N = 44) was conducted on the absolute amount of belief change from the previous belief by ordinal time, individuation, and distraction (see Table 3.16 for means and standard deviations and Table 3.17 for the repeated-measures analysis of variance results). Ordinal time consisted of two time points, the local movement before the final local movement and the final local movement. The absolute amount of belief change of the final movement (M = 30.41; SD = 33.73) is not significantly different from the absolute amount of belief change of the movement before the final movement (M = 26.12; SD = 26.30), $F(1, 40) = .60$, *ns.* Belief trajectories did not show a damping pattern.

Criminal-sentencing data. A repeated-measures analysis of variance (N = 48) was conducted for the absolute amount of belief change by ordinal time, source credibility and grouped individual message discrepancy (see Table 3.18 for means and standard deviations and Table 3.19 for repeated-measures analysis of variance results). Ordinal time consisted of two time points, the local movement before the final local movement and the final local movement. The absolute amount of belief change was significantly smaller for the final movement (M = 4.27; SD = 3.83) than for the movement before the final movement (M = 2.61; SD = 2.25), $F(1, 42) = 5.46$, $p \leq .05$, partial $\eta^2 = .12$. This result suggests that belief trajectories are damped over time. Unlike the McGreevy data and Wang data, a damping pattern was found in the criminal-sentencing data. H2.1.2 was supported by the criminal-sentencing data.

Tuition-increase data. A repeated-measures analysis of variance (N = 56) was conducted on the absolute amount of belief change by ordinal time, source credibility and manipulated message discrepancy (see Table 3.20 for means and standard deviations and Table 3.21 for repeated-measures analysis of variance results). Ordinal time consisted of two time points, the local movement before the final local movement and the final local movement. The absolute amount of belief change linearly increased as a function of ordinal time, $F(1, 59) = 33.22$, $p < .01$, partial $\eta^2 = .36$ (M = 6.23 and SD =3.27 for the movement before the final movement; M = 8.01 and SD =2.76 for the final movement). The absolute amount of belief change increased in the last two micro movements, which is contrary to the expected damping pattern. The results also showed that the absolute amount of belief change in the last two micro movements increased as message discrepancy increased, $F(1, 59) = 6.82$, $p < .05$, and partial $\eta^2 = .10$.

In sum, a damping pattern in belief trajectory was not found in the McGreevy's study, the Wang study, and the tuition-increase issue but was found in the criminal-sentencing issue.

Patterns of Belief Change in Macro Local Movements: Damping Patterns

For the damping pattern in macro local movements, H2.2 and Equation 1.14 were proposed:

H2.2: During judgment, the amount of belief change of a macro local movement will be smaller than the amount of belief change of the proceeding macro of local movement.

Hypothesis 2.2 can be summarized as the following equation:

$$\Delta\tilde{P}_{i(i-1)} = \tilde{l}_i \Delta\tilde{P}_{(i-1)(i-2)}; -1.00 < \tilde{l}_i < 0; i \geq 2, \quad (1.11)$$

where $\tilde{l}_i$ is a constant for *i*-th macro local movement. Like micro movement cases, the amount of belief change by a macro local movement was regressed on the amount of belief change by the previous macro local movement. That is,

$$\Delta\tilde{P}_{2(1)} = \tilde{l}_1 \Delta\tilde{P}_{1(0)}, \tag{3.7}$$

$$\Delta\tilde{P}_{3(2)} = \tilde{l}_2 \Delta\tilde{P}_{2(1)}, \tag{3.8}$$

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$$\Delta\tilde{P}_{N(N-1)} = \tilde{l}_{(N-1)} \Delta\tilde{P}_{N-1(N-2)}. \tag{3.9}$$

H2.2 predicts that $-1.00 < \tilde{l}_i < 0$. The amount of belief change by a macro local movement, $\Delta\tilde{P}_{i(i-1)}$, was analyzed in all data sets. Variables were not transformed. Regression analyses were conducted when the sample size was more than 20. As a result, the number of regression analyses was two for the McGreevy data, three for the Wang data, one for the criminal-sentencing data, and one for the tuition-increase data.

McGreevy data. Two regression analysis were conducted (the minimum N = 25; see Table 3.22 for the regression analyses). In the McGreevy data, regression coefficients in both regression cases are significantly smaller than 0 but close to -1.00 ($\tilde{l}_1$ = -.93, p < .01; $\tilde{l}_2$ = -.99, p < .01). Evidence is not strong enough to support a damping pattern. H2.2 was not supported by the McGreevy data.

Wang data. Three regression analyses were conducted (the minimum N = 23; see Table 3.23 for the regression analyses). Results from the Wang data show that one of the regression coefficients is less than -1.00 ($\tilde{l}_1$ = -1.54, p < .01) even though the other two coefficients are found between -1.00 and 0 ($\tilde{l}_2$ = -.71, $p < .01$; $\tilde{l}_3$ = -.77, $p < .01$). Decrease in the absolute amount of belief change by macro local movements was found in two out of three macro local movements. H2.2 was only partially supported in the Wang data.

Criminal-sentencing data. One regression analysis was conducted (see Table 3.24 for the regression analysis). Results from the criminal-sentencing data showed that the regression coefficients were statistically significant and between -1.00 and 0 ($\tilde{l}_1$ = -.45, $p < .01$). Absolute amounts of belief change by macro local movements were found to decrease over time. H2.2 was supported for the criminal-sentencing data.

Tuition-increase data. As a highly involving issue, there were not many macro movements in the tuition-increase data. Seven cases (7%) were fount to have no macro movements; 72 cases (74%) had one macro movement; 17 (14%) cases had two macro movements; and one cases had 8 macro movements (N = 97, M = 1.18, SD = .85). Only one regression analysis was conducted (N = 18; see Table 3.25 for the regression analysis). In the tuition-increase data, the coefficient of the regression, $\tilde{l}_1$, was not statistically significant. No systematic relationship between the first macro local movement and the second macro local movement was found. H2.2 was not supported by the tuition-increase data.

In sum, H2.2 was supported by the criminal-sentencing data and partially supported by the Wang data. However, H2.2 was not supported by the McGreevy data or the tuition-increase data.

Cognitive Responses and Local Movement during the Post-Message Phase

Message Type and the Number of Local Movements

Regarding the relationship between message type (univalent versus mixed-valence) and the number of local movements during the post-message phase, H3.1.1 was proposed:

H3.1.1: During the post-message phase, the ratio of the number of positive local movements to the number of negative local movements is greater for positively univalent messages than for mixed-valence messages.

McGreevy data. To test H3.1.1, first positivity of movements in the post-message phase was obtained using the formula in Equation 3.1. Then an ANOVA was conducted for positivity of movements by candidate similarity and distraction for the post-message phase (see Table 3.26 for means and standard deviations and Table 3.27 for the ANOVA results). The message given in the similar-candidate condition was considered a mixed-valence message and the message given in the different-candidate condition was considered a univalent message.

Results showed that positivity of movements in the post-message phase was greater in the different-candidate condition (a univalent message) than the similar-candidate condition (a mixed-valence message), $F(1, 74) = 4.88$, $p < .05$, partial $\eta^2 = .13$. In the univalent message condition, the number of positive movements was not much different from the number of negative movements (the mean of positivity of movements is -.05) whereas in the mixed-valence message condition, the number of positive movements was greater than to the number of negative movements (the mean of positivity of movements is .45). This result suggests that individuals had more positive belief changes, which is assumed to be from self-generated positive thoughts, in response to a positively univalent message whereas they made an equal number of positive and negative belief changes during judgment in response to a mixed-valence message. Message type (univalent versus mixed-valence) showed an effect on local movements in belief trajectories during the post-message phase as well as during the message-receipt phase (H1.2).

Results also show an interaction between candidate similarity and distraction (F[1, 74] = 4.45, $p < .05$, partial $\eta^2 = .06$). Positivity of movements in the different-candidate condition was significantly greater than positivity the similar-candidate condition only when participants were distracted by noise (F[1, 39] = 10.11, $p < .05$, partial $\eta^2 = .21$; see Table 3.26). This interaction was not expected. Further investigation is needed to account for this interaction.

Wang data. In Wang's study, the no-individuation condition had a univalent message whereas the no-individuation condition had a mixed-valence message. Because higher numbers mean more favorability toward the Caucasian applicant, the message in the no-individuation condition is positively univalent. H3.1.1 predicts that the ratio of the number of positive local movements to the number of negative local movements is greater in no-individuation condition than in the individuation condition. Instead of the ratio, positivity of movements was used (see Equation 3.1).

An ANOVA was conducted for positivity of movements by individuation and distraction (see Table 3.28 for means and standard deviations and Table 3.29 for ANOVA results). Results showed that positivity of movements was greater in the no-individuation condition ($M = .55$; $SD = .48$) than in the individuation condition ($M = -.28$; $SD = .40$), $F(1, 74) = 56.97$, $p < .01$, and partial $\eta^2 = .48$. In response to a positively univalent message, a greater number of positive local movements than negative local movements was generated whereas in response to a mixed-valence message, the number of negative local movements was greater than the number of positive local movements. The absolute value of positivity of movements was smaller in the individuation condition (mixed-valence message) than in the no-individuation condition (univalent message condition). This result supports H3.1.1.

With the compute mouse technique and local movement framework, belief changes during judgments were reflected as predicted. Result on the relationship between message type and the number of local movements in belief trajectories during the post-message phase provides supporting evidence about validity of local movement framework.

Message Type and the Total Number of Local Movements

Regarding the types of message and the total number of local movements, H3.1.2 was proposed:

> H3.1.2: During the post-message phase, the number of local movements is greater for mixed-valence messages than for univalent messages.

The McGreevy data was used to test H3.1.2. In McGreevy's study, the number of pieces of information, the number of sentences in the text, is 32 in the similar-candidate condition and 31 in the different-candidate condition. Therefore, the number of local movements in the message-receipt phase is expected to be similar between the two conditions. However, in the post-message phase, a greater number of local movements is expected in the similar-candidate condition than in the different-candidate condition. The message in the similar-candidate condition is mixed-valence and more difficult than the message in the different-candidate condition, which is univalent. McGreevy measured the perceived difficulty of the decision and found that the decision in the similar-candidate condition was perceived to be more difficult than the decision in the different-candidate condition, $F(1, 97) = 43.88$, $p < .01$ (McGreevy, 1996, p. 169).

A repeated-measures analysis of variance was conducted to test this hypothesis (see Table 3.30 for means and standard deviations and Table 3.31 for ANOVA results). The total numbers of micro local movements in both phases were transformed before the analysis to meet the distributional assumptions (Hanushek & Jackson, 1977). The total number of micro local movements was analyzed in terms of phases, candidate similarity, and distraction. Results show that a statistically significant interaction between phase and candidate similarity, $F(1, 74) = 12.49$, $p < .01$, and partial $\eta^2 = .14$. To examine the interaction between phase and candidate similarity, an ANOVA was conducted for the total number of micro local movements by candidate similarity and distraction in each phase. Results shows that candidate similarity has a statistically significant effect on the total number of micro local movements in the post-message phase, $F(1, 74) = 13.58$, $p < .01$, and partial $\eta^2 = .16$, but not in the message-receipt phase, $F(1, 74) = 1.07$, *ns*, and partial $\eta^2 = .01$. As predicted, the total number of local movements was not different between the univalent message condition and the mixed-valence message condition during the message-receipt phase but was found to be greater in the mixed-valence message condition than the univalent message condition during the post-message phase. Results showed that during the message-receipt phase, the number of belief changes measured by local movements corresponded to the number of pieces of information, but during the post-message phase, the number of belief changes was affected by the difficulty of the message. H2.3.2 was supported by the McGreevy data.

Message Type and Final Belief Change

Regarding the mediating role of the number of local movements between message type and the final decision, H3.1.3 was proposed:

H3.1.3: The effect of message type (univalent versus mixed-valence) on the final decision is mediated by the number of positive and the number of negative local movements.

McGreevy data. Hypothesis 3.1.3 can be represented by a causal model, in which the number of positive and the number of negative local movement mediates the effect of the type of message on final decision. First, the final decision was obtained from final position. Final position, P_N, was expected to be either 0 or 100. In 72 (92%) of the 78 cases, final positions were found within 5 points of 0 or 100. For the six other cases, if a final position was within 25 points from 0, the final decision was categorized as Candidate 1. If a final position was within 25 points from 100, the final decision was categorized as Candidate 2. Otherwise, final positions were categorized as neutral. Because the final decision is a dichotomous variable, the mediating role of local movements was tested by stepwise logistic regression in which the final decision was regressed only on candidate similarity at the first step and then regressed on both candidate similarity and the number of positive and negative local movements at the second step. If the numbers of positive and negative local movements mediate the effect of candidate similarity on the final decision, the effect of candidate similarity on the final decision at the first step should be significantly less at the second step because of the effect of numbers of positive and negative local movements on the final decision.

Table 3.32 is the cross-tabulation of final decision by candidate similarity in the

McGreevy data. Three cases were found to be neutral. Without the neutral cases, a chi-square test shows that there was a significant difference among the different groups, $\chi^2(1, N = 75) = 4.01$, $p \leq .05$ (two-tailed test). As expected, in the different-candidate condition, more participants chose Candidate 2 (80.56%, $n = 29$) over Candidate 1 (19.44%, $n = 7$). In the similar-candidate condition, the number of participants who chose Candidate 2 (58.97%, $n = 23$) was greater than the number of participants who chose Candidate 1 (41.03%, $n = 16$). In the similar-candidate condition, the percent difference between participants who chose Candidate 2 and participants who chose Candidate 1 was 61.11%, whereas the difference was 17.95% in the different-candidate condition.

Table 3.33 shows results of the stepwise logistic regression. Neutral cases were included in the analysis. When candidate similarity was the only exogenous variable, candidate similarity showed a statistically significant effect on the final decision, B = 1.06 ($p \leq .05$). However, when the number of positive and negative movements were added as exogenous variables, both the effect of the number of positive movements, B = 1.16 ($p < .01$), and the effect the number of negative movements, B = -1.18 ($p < .01$), were statistically significant but the effect of candidate similarity became non-significant (B = .72, *ns*). With the result for Hypothesis 3.1.1, the result from the stepwise regression analysis suggests that the type of message exerts its effect on the final decision through the number of positive and negative movements.

Wang data. Like in the McGreevy data, final decision, a dichotomous variable, was predicted by message type (i.e., individuation) and the number of positive and the number of negative movements in the Wang data. Results showed that the African

American applicant was preferred to the Caucasian applicant in the individuation condition whereas the Caucasian applicant was preferred to the African American applicant in the no-individuation condition, χ^2 (1, N = 66) = 44.27, $p < .01$ (see Table 3.34). Results from a stepwise logistic regression of the final decision on individuation and the numbers of positive and negative movements showed that the effect of individuation still had a significant effect (B = 1.73, $p < .01$, N = 66) even when the number of positive movements (B = 3.30, $p \leq .05$) and the number of negative movements (B = -3.42, $p \leq .05$) on the final decision were controlled (see Table 3.35 for the stepwise logistic regression results). This result showed that the type of message had both direct and indirect effects on the final judgment.

In sum, the McGreevy data shows that the type of message exerts its effect on the final decision through the number of local movement whereas the Wang data shows that the type of message has an effect on the final decision both directly and indirectly through the number of local movements. Hypothesis 3.1.3 was only partially supported.

Cognitive Responses and the Number of Local Movements

Regarding the relationship between cognitive responses and local movements, H3.2.1 was proposed:

> H3.2.1: There will be a positive relationship between the number of positive local movements and the number of positive thoughts, and between the number of negative local movements and the number of negative thoughts.

In the criminal-sentencing data and the tuition-increase data, after participants made their final judgments, they were asked to list the thoughts they had during the decision task. Correlation analyses were conducted between the number of positive thoughts and the number of positive movements and between the number of negative thoughts and the number of negative movements.

Criminal-sentencing data. For the analysis, four relevant variables were transformed to the same power (see Appendix C for transformation method and skewness before and after transformation). The correlation between the number of positive thoughts about severe sentencing and the number of positive movements was .38 (N = 93; $p < .01$, one-tailed test). However, the correlation between the number of negative thoughts about severe sentencing and the number of negative movement was not statistically significant (N = 93, r = .01, *ns*). Only the correlation between the number of positive thoughts and the number of positive movements was consistent with the prediction. H3.2.1 was partially supported by the criminal-sentencing data.

Tuition-increase data. For the analysis, four relevant variables were transformed to the same power (see Appendix C for transformation method and skewness before and after transformation). The correlation between the number of positive thoughts about a tuition increase and the number of positive movements was .15 (N = 97, $p < .10$, one-tailed test). The correlation between the number of negative thoughts about tuition increase and the number of negative movements is not statistically significant (N = 97, r = .06, *ns*). H3.2.1 was not supported by the tuition-increase data.

In both data sets, the number of positive local movements was found to be correlated with the number of positive thoughts. However, there was no statistically significant correlation between the number of negative local movements and the number of negative thoughts in either data set. Systematic relationships between the number of local movements and the number of thoughts reported by participants were expected but were found only for the relationship between positive local movements and positive thoughts.

Effects of Cognitive Responses and Local Movements on Beliefs

Regarding effects of cognitive responses and local movements on beliefs, H3.2.2 was proposed:

> H3.2.2: The ratio of the effect of the number of positive thoughts on beliefs to the effect of the number of negative thoughts on beliefs will be the same as the ratio of the effect of the number of positive local movements on beliefs to the effect of the number of negative local movements on beliefs.

Two stages of analysis were needed to test this hypothesis. In the first stage, the following two regression analyses were conducted to find the effect of the number of movements on beliefs and the effect of the number of thoughts on beliefs:

$$\Delta P_{N(0)} = g_0 + g_1 p_m + g_2 q_m + \zeta_1; \tag{3.10}$$

$$\Delta P_{N(0)} = b_0 + b_1 p_{th} + b_2 q_{th} + \zeta_2, \tag{3.11}$$

where p_m is the number of positive movements, q_m is the number of negative movements, p_{th} is the number of positive thoughts, q_{th} is the number of negative thoughts, *g*s and *b*s are regression coefficients, and ζ_1 and ζ_2 are error terms. For each regression analysis, the ratio between two regression coefficients was computed. From Equation 3.10,

$$R_m = \frac{g_1}{g_2}, \tag{3.12}$$

where R_m is the ratio of the effect of the number of positive local movements on belief to the effect of the number of negative local movements on belief.

From Equation 3.11,

$$R_{th} = \frac{b_1}{b_2}, \tag{3.13}$$

where R_{th} is the ratio of the effect of the number of positive thoughts on belief to the effect of the number of negative thought on belief.

In the second stage, a structural equation modeling analysis was conducted to test whether the difference between R_m and R_{th} was statistically significant. In the structural equation model, R_m was constrained to be equal to R_{th}. The following constrained model was tested:

$$\Delta P_{N(0)} = b_1 p_{th} + \hat{b}_2 q_{th} + \zeta_2, \tag{3.14}$$

where

$$\hat{b}_2 = \left(\frac{g_2}{g_1}\right) b_1. \tag{3.15}$$

The ratio between g_1 and g_2 was obtained from Equation 3.10 and imposed on Equation 3.14. Equation 3.11 is an unconstrained model and Equation 3.14 is a constrained model. If the constrained model fits the data as well as the unconstrained model does, the two ratios can be said not to be significantly different from each other.

Criminal-sentencing data. First, the two regression analyses were conducted: (1) final belief change was predicted by the number of positive local movements and the number of negative local movements (local movement model); (2) final belief change was predicted by the number of positive thoughts and the number of negative thoughts (cognitive response model). In both regression analyses, the independent variables were transformed to meet assumptions for regression analysis with the same power (see Appendix C for transformation method and skewness before and after transformation).

Table 3.36 shows the result of the two regression analyses. In the local movement model, the number of positive local movement was found to have a statistically significant effect on final belief change, $B = 8.24$, $SE = 1.53$, $\beta = .53$, $p < .01$, one-tailed, whereas the effect of number of negative thoughts was not a significant predictor, $B = -1.71$, $SE = 1.46$, $\beta = -.12$, *ns*. The ratio of the effect of the number of positive movements to the effect of the number of negative movements was -4.81.

In the cognitive response model, the number of positive thoughts was found to have a marginally significant effect on final belief change, $B = 2.23$, $SE = 1.71$, $\beta = 1.43$, $p < .10$, one-tailed. The effect of number of negative thoughts on beliefs was not significant, $B = -1.90$, $SE = 1.75$, $\beta = -.12$, *ns*. The ratio of the effect of the number of positive thoughts to the effect of the number of negative thoughts was -1.17.

A structural equation modeling analysis was conducted to see whether the constrained model would fit the data. To find estimates, the maximum likelihood method was used with unstandardized data (see Table 3.37 for covariances among variables in the model; Table 3.38 shows the results of the structural equation modeling analysis). The ratio of the effect of the number of positive movements to the effect of the number of negative movements, -4.81, was imposed on the restricted model. The structural coefficient was 2.87 ($SE = 1.48$, $p \leq .05$, one-tailed) for the effect of the number of positive thoughts on beliefs and -.60 ($SE = 0.31$, $p \leq .05$, one-tailed) for the effect of the number of negative thoughts on beliefs. The ratio of two coefficients for the constrained model is approximately equal to the imposed ratio. The constrained model was found to fit the data well. The constrained model's minimum fit function chi-square was found to be not significant, χ^2 ($df = 1$) = .58, *ns*. Other measures of goodness of fit also showed that the constrained model fits the data: The root mean square error of approximation < 0.01, normed fit index = .96, and the comparative fit index = 1.00. Because the unconstrained model is just identified, which fits the data perfectly by definition, the statistical significance of the constrained model's minimum fit function chi-square indicates whether the constrained model fits the data as well as the unconstrained model does. Results showed that the constrained model is good as the unconstrained model, which indicates that the ratios between effects of local movements and the effects of thoughts on final beliefs are not significantly different from each other. Results from the criminal-sentencing data support H3.2.2.

Tuition-increases data. Like the criminal-sentencing data, two regression analyses were conducted: (1) final belief change was predicted by the number of positive local movements and the number of negative local movements (local movement model); (2) final belief change was predicted by the number of positive thoughts and the number of negative thoughts (cognitive response model). Table 3.39 shows the result of the two regression analyses. In the local movement model, the number of positive local movement was found to have a statistically significant effect on final belief change, B = 6.47, SE = .67, β = .70, $p < .01$, one-tailed, whereas the effect of number of negative thoughts was marginally significant, B = -1.13, SE = .73, β = -.12, $p < .10$, one-tailed. The ratio of the effect of the number of positive movements to the effect of the number of negative movements was -5.70.

In the cognitive response model, the number of positive thoughts was found to have a statistically significant effect on final beliefs, B = 2.00, SE = .92, β = .24, $p \leq .05$, one-tailed. The effect of number of negative thoughts on beliefs was not significant, B = -

.70, *SE* = .73, β = -.11, *ns*. The ratio of the effect of the number of positive thoughts to the effect of the number of negative thoughts was -2.86.

A structural equation modeling analysis was conducted to see whether the constrained model would fit the data. To find estimates, the maximum likelihood method was used with unstandardized data (see Table 3.40 for covariances among variables in the model; Table 3.41 shows the results of the structural equation modeling analysis). The ratio of the effect of the number of positive movements to the effect of the number of negative movements, -5.70, was imposed to the restricted model. The structural coefficient was 2.24 (*SE* = .72, $p < .01$, one-tailed) for the effect of the number of positive thought on beliefs, and -.39 (*SE* = 0.13, $p < .01$, one-tailed) for the effect of the number of negative thought on beliefs. The ratio of two coefficients for the constrained model is approximately equal to the imposed ratio. The constrained model's minimum fit function chi-square was found to be not significant, χ^2 ($df = 1$) = .18, *ns*, which indicates that the constrained model fits the data well. Other measures of goodness of fit also showed that the constrained model fits the data: The root mean square error of approximation < 0.01, normed fit index = .99 and the comparative fit index = 1.00. Results showed that the constrained model is as good as the unconstrained model, which indicates that the ratios between effects of local movements and the effects of thoughts on final beliefs are not significantly different from each other. Results from the tuition-increase data support H3.2.2.

Both data sets showed similarities between the effect of local movements on beliefs and the effect of thoughts on beliefss. These similarities could result from the fact that both local movements in belief trajectories measured by the computer mouse technique and thoughts reported by the thought-listing techniques measure cognitive responses during judgment.

The Effect of Message Discrepancy on Beliefs during Judgment

Message Discrepancy, Cognitive Responses and Local Movements

Regarding the relationship between message discrepancy and the number of local movements, H4.1.1 was proposed:

> H4.1.1: Assuming the message discrepancy is positive, as message discrepancy increases, the ratio of the number of positive local movements to the number of negative local movements will decrease.

Criminal-sentencing data. Positivity of movements (see Equation 3.1) was used instead of the ratio of the number of positive local movements to the number of negative local movements. Positivity of movements was regressed on individual message discrepancy and source credibility to test the hypothesis (see Table 3.42 for the regression results). Results showed that message discrepancy did not show a statistically significant effect on positivity in the number of local movements ($B = .004$, *ns*). H4.1.1 was not supported by the criminal-sentencing data.

Previous studies (Brock, 1967; Toy, 1982) found that message discrepancy has an effect on the number of positive thoughts and the number of negative thoughts. The effect of message discrepancy on positivity of thoughts was examined. Positivity of thoughts was computed by the following equation:

$$Positivity_{thoguhts} = \log(m+1) - \log(n+1), \qquad (3.16)$$

where m is the number of positive movements and n is the number of negative movements. Individual message discrepancy was found to have a statistically significant negative effect on positivity of thoughts in the criminal-sentencing data ($B = -.01$, $p < .05$, see Table 3.43 for the regression results). This result indicates that as message discrepancy increases, the number of negative thoughts about the message position increases, which is consistent with Toy (1982).

Tuition-increase data. An ANOVA was conducted on positivity of movements by linear and quadratic message discrepancy and source credibility (see Table 3.44 for means and standard deviations and Table 3.45 for the ANOVA analysis). Neither linear nor quadratic message discrepancy had a significant effect on positivity of movements . However, an interaction effect between source credibility and quadratic message discrepancy was found to be statistically significant, $F(1, 91) = 7.26$, $p < .01$, and partial $\eta^2 = .07$. To specify the effect of quadratic message discrepancy on initial belief change for each level of source credibility, positivity of movements were predicted by linear and quadratic message discrepancy for each level of source credibility (see Table 3.46 for the ANOVA analyses). Results showed that in the low source credibility condition, as message discrepancy increased, positivity of movements increased and then decreased, $F(1, 91) = 6.42$, $p < .01$, and partial $\eta^2 = .12$. Positivity of movements was greater for the moderately discrepant message than the extremely discrepant message, which is consistent with the hypothesis. H4.1.1 was partially supported by the tuition-increase data.

The effect of message discrepancy on positivity of thoughts were also examined to see whether the pattern found in previous studies (Brock, 1967; Toy, 1982) would be observed in the tuition-increase data. Results showed that message discrepancy did not have an effect on positivity of thoughts in the tuition-increase data (see Table 3.47 for means and standard deviations and Table 3.48 for the ANOVA analysis).

Message discrepancy was expected to have a negative effect on positivity of movements. The results were mixed. In the criminal-sentencing data, message discrepancy had no significant effect on positivity of movements. However, in the tuition-increase data, positivity of movements was found to be greater for the moderately discrepant message than for the extremely discrepant message.

Message Discrepancy and Initial Belief Change

Regarding the relationship between message discrepancy on the amount of belief change of the first local movement, initial belief change, H4.1.2 was proposed:

> H4.1.2: The greater the message discrepancy, the greater the belief change of the first micro local movement in the direction advocated by the message.

The belief change of the first micro local movement, $\Delta P_{1(0)}$, is used for initial belief change. The criminal-sentencing data and the tuition-increase data were used to test the effect of message discrepancy on initial belief change.

Criminal-sentencing data. A regression analysis was conducted to test H 4.1.2. In the regression analysis, initial belief change was regressed on linear and quadratic individual message discrepancy, source credibility, the interaction between the linear individual message discrepancy and source credibility, and the interaction between quadratic individual message discrepancy and source credibility (see Table 3.49 for correlations among the exogenous variables and Table 3.50 for the regression results). The effect of quadratic individual message discrepancy and the interaction effect between quadratic individual message discrepancy and source credibility were not hypothesized for initial belief change but were incorporated in the regression equation because it allows for a comparison of the results for initial belief change with the results for final belief change. For this analysis, only cases with at least one local movement were included (N= 81).

The regression showed a statistically significant effect of linear message discrepancy on initial belief change (B = .18, SE = .06, p < .01). As message discrepancy increased, initial belief change linearly increased. Results showed the interaction between source credibility and linear message discrepancy was marginally significant (B = .22, SE = .12, p = .06) and quadratic individual message discrepancy was also marginally significant, p < .10. Table 3.51 shows results from regression analyses for initial belief change on linear individual message discrepancy for low and high source credibility conditions. For the low source credibility condition, linear individual message discrepancy was marginally significant (B = .07, SE = .04, p = .07) but quadratic individual message discrepancy was statistically significant (B = -.01, SE = .04, p < .01). On the other hand, for the high source credibility condition, only linear individual message discrepancy was statistically significant (B = .29, SE = .12, p < .01). Figure 10 shows a nonmonotonic relationship between message discrepancy and initial belief change for the low source credibility condition; as message discrepancy increases, the amount for initial belief change increases and then decreases for the low source credibility condition. Results from the criminal-sentencing data only partially supported H4.1.2.

Tuition-increase data. An ANOVA was conducted on initial belief change by linear and quadratic message discrepancy and source credibility (see Table 3.52 for means and standard deviations, and Table 3.53 for ANOVA results). The mean of initial belief change was 4.73%, which was significantly different from the mean of initial position (t = 17.24, df = 89, p < .01). Initial positions about the tuition increase were measured at the beginning of the experiment and 98 out of 99 participants reported zero increase as their initial positions. Results showed that quadratic message discrepancy had a marginally significant effect (F[1, 84] = 2.94, p < .10, partial η^2 = .03), and a statistically significant interaction effect with source credibility (F[1, 84] = 4.68, p < .01, partial η^2 = .05). To specify the effect of quadratic message discrepancy on initial belief change for each level of source credibility, ANOVAs were conducted for the low and the high source credibility conditions (see Table 3.54 for the ANOVA results). The results showed that in the low source credibility condition, the amount of initial belief change increased and then decreased, F(1, 42) = 4.73, p < .01, and partial η^2 = .10. Figure 11 shows a nonmonotonic relationship between message discrepancy and initial belief change for the low source credibility condition. A linear relationship between message discrepancy and the amount of initial belief change was expected but a nonmonotonic relationship between the two variables was found. Results from the tuition-increase data did not support H4.1.2.

Message Discrepancy and Final Belief Change

Regarding the effect of message discrepancy on final beliefs, H4.1.3 was proposed:

> H4.1.3: As message discrepancy increases, the amount of final belief change will increase up to a certain point and then decrease.

The belief change of the final micro local movement, $\Delta P_{N(0)}$, is used for final belief change. H4.1.3 predicts an inverted U-shaped nonmonotonic effect of message discrepancy on final belief change. The criminal-sentencing data and the tuition-increase data were used to test the effect of message discrepancy on final belief change.

Criminal-sentencing data. A regression analysis was conducted to test H4.1.3. In the regression analysis, final belief change was regressed on linear and quadratic individual message discrepancy, source credibility, the interaction between the linear individual message discrepancy and source credibility, and the interaction between quadratic individual message discrepancy and source credibility (see Table 3.55 for the regression results). Quadratic individual message discrepancy was included as a predictor in order to capture the proposed nonmonotonic effect of message discrepancy on final belief change. A quadratic function is one of the simplest forms for nonmonotonic relationship.

The results showed that the effect of linear message discrepancy was statistically significant ($B = .20$, $SE = .05$, $p < .01$) and the effect of quadratic message discrepancy was marginally significant ($B = -.01$, $SE = .005$, $p = .81$). The interaction between source credibility and linear message discrepancy was statistically significant ($B = .29$, $SE = .11$, $p < .01$).

To examine different effect of message discrepancy on final belief change between low and high source credibility, regression analyses were conducted for each level of source credibility separately (see Table 3.56 for the regression results). Results showed a contrasting pattern in terms of the effect of linear and quadratic message discrepancy on final belief change between the low and the high source credibility condition. For the low source credibility condition, the effect of the linear message was not statistically significant but quadratic message discrepancy was statistically significant

(B = -.01, SE = .004, p < .01). For the high source credibility condition, only the effect of linear message discrepancy was statistically significant (B = .35, SE = .10, p < .01).

Figure 11 represents differences in final belief change by individual message discrepancy and source credibility. In Figure 11, final belief change increases monotonically as message discrepancy increases for the high credibility condition. However, for the low credibility condition, final belief change shows a nonmonotonic pattern. An inverted *U*-shaped nonmonotonic pattern of the relationship between message discrepancy and final belief change was found only for the low credibility condition. H4.1.3 was partially supported by the criminal-sentencing data.

Tuition-increase data. An ANOVA was conducted on final Belief Change by linear and quadratic message discrepancy and source credibility (see Table 3.57 for means and standard deviations and Table 3.58 for ANOVA results). The overall mean of final belief change for all cases was 7.13%, which is significantly different from the initial position (t = 22.25, df = 89, p < .01). Results showed that linear message discrepancy had statistically significant positive effect on final belief change, $F(1, 84)$ = 5.65, partial η^2 = .06, and $p \leq .05$. A nonmonotonic effect of message discrepancy on final belief change was expected but a linear increasing pattern was found between message discrepancy and final belief change (see Figure 12). Results from the tuition-increase data did not support H4.1.3.

Change of Effect of Message Discrepancy on Beliefs over Time

Regarding change of effect of message discrepancy on beliefs during judgment, H4.1.4 was proposed:

H4.1.4: Assuming message discrepancy is positive, the effect of message discrepancy on beliefs decreases over time during judgment.

Criminal-sentencing data. To test Hypothesis 4.1.4, a repeated-measures analysis of variance was conducted (see Table 3.59 for means and standard deviations of initial and final belief change by source credibility and individual message discrepancy, and Table 3.60 for the repeated-measures analysis of variance results). In the analysis, belief change from the initial position was the dependent variable, linear and quadratic individual message discrepancy and source credibility were independent variables, and ordinal time was the repeated measure. Ordinal time consists of two time points: time of the first local movement and time of the final local movement. A decrease of the effect of message discrepancy on beliefs was expected between the first local movement and the final local movement.

Results showed that neither the linear nor quadratic effect of message discrepancy on belief change was significant between the two time points. Results show a marginally significant three-way interaction effect among ordinal time, source credibility and quadratic message discrepancy, $F(1, 75) = .33$, $p = .07$, and partial $\eta^2 = .04$. The effect of quadratic message discrepancy in the low source credibility condition was stronger in the final local movement ($B = -.012$, $SE\ B = .004$; $\beta = -.466$, $p = .004$) than in the first local movement ($B = -.007$, $SE\ B= .003$; $\beta = -.350$, $p = .034$). Observed nonmonotonic relationships between message discrepancy and belief change in the low source credibility condition indicates that moderately discrepant messages have a stronger effect on beliefs than extremely discrepant messages (see Figure 10 and Figure 11). Therefore, the increase of the nonmonotonic effect of message discrepancy indicates the decrease of the effect of extremely discrepant messages on beliefs, which is consistent with the prediction of H4.1.4. H4.1.4 was partially supported by the criminal-sentencing data.

Tuition-increase data. To test H4.1.4, a repeated-measures analysis of variance was conducted for Belief Changes by ordinal time, linear and quadratic message discrepancy, and source credibility (see Table 3.52 for means and standard deviations of initial belief change, Table 3.57 for means and standard deviations of final belief change, and Table 3.58 for the repeated-measures analysis of variance results). H4.1.4 predicts that the effect of message discrepancy on beliefs decreases over time. More specifically, H4.1.4 predicts that the linear (positive) effect of message discrepancy decreases over time but the nonmonotonic effect of message discrepancy increases over time.

Results showed that the effect of linear message discrepancy on beliefs increased over time but the effect was marginally significant, $F(1, 84) = 2.89$, $p = .09$, and partial $\eta^2 = .03$. A three-way interaction among ordinal time, source credibility and quadratic message discrepancy was found to be statistically significant, $F(1, 84) = 7.71$, $p \leq .05$, and partial $\eta^2 = .08$. A repeated-measures analysis of variance for each level of source credibility (see Table 3.62 for the results) showed that the interaction between ordinal time and quadratic message discrepancy was statistically significant in the low source credibility condition ($F[1, 42] = 5.63$, $p \leq .05$, partial $\eta^2 = .12$), but not in the high credibility condition ($F[1, 42] = 2.17$, *ns*, and partial $\eta^2 = .05$). For the low source credibility condition, the effect of quadratic message discrepancy was found to be statistically significant only for initial Belief Change ($F[1, 42] = 4.73$, $p \leq .05$, and partial $\eta^2 = .57$), but not for final Belief Change ($F[1, 42] = .09$, *ns*, and partial $\eta^2 < .01$). In contrast to the quadratic effect, the effect of linear message discrepancy on beliefs was not statistically significant for the first local movement (*F*[1, 42] = .2.75, *ns*, and partial η^2 = .06), but was statistically significant for the final local movement (*F*[1, 42] = .4.61, *p* ≤ .05, and partial η^2 = .10).

These results showed that for messages from less credible source, the quadratic effect of message discrepancy decreased over time but the linear effect of message discrepancy increased, which is opposite to H4.1.4. H4.1.4 was not supported by the tuition-increase data. The results also showed that the amount of final belief change (*M* = 4.73, *SD* = 2.60) was greater than the amount of initial belief change (*M*.= 7.13, *SD* = 3.14), *F*(1, 84) = .51.99, *p* ≤ .05, and partial η^2 = .38.

The Effect of Source Credibility on Beliefs during Judgment

Source Credibility, Cognitive Responses and Local Movements

Regarding the relationship between source credibility and the number of local movements, H4.2.1 was proposed:

> H4.2.1: Assuming that message discrepancy is positive, for less involving issues, the ratio of positive local movements to the number of negative local movements will be greater in a message from a high than a low credibility source. However, for highly involving issues, the ratio of positive local movements to the number of negative local movements will not differ between messages from a high and a low credibility source.

H4.2.1 was tested by the criminal-sentencing data and the tuition-increase data. Compared to the tuition-increase data, the criminal-sentencing data is less involving. Two separate regression analysis were conducted.

Criminal-sentencing data. The regression analysis for Hypothesis 4.1.1 was used to test Hypothesis 4.2.1. Positivity of movements was regressed on individual message discrepancy and source credibility. Because the criminal-sentencing issue is relatively less involving, source credibility is likely to have an effect on positivity of movements for this issue. Results showed that source credibility did not have statistically significant effect on positivity of movements , $B = -.02$, *ns* (see Table 3.42 for regression results). Positivity in the numbers of movements in belief trajectories were not different between high and low source credibility conditions. This result is not consistent with H4.2.1.

Source credibility also did not show a statistically significant effect on positivity of thoughts (see Table 3.41 for regression results). This result is not consistent with Cook (1969) and Hass (1982).

Tuition-increase data. As a highly involving issue, it was expected that positivity of movements was not much influenced by source credibility. An ANOVA was conducted on positivity of movements by source credibility and message discrepancy. Results showed that positivity of movements was marginally greater for the high source credibility condition ($M = .88$; $SD = .44$) than for the low source credibility condition ($M = .73$; $SD = .49$), $F(1, 97) = .2.82$, $p < .10$, and partial $\eta^2 = .03$ (see Table 3.44 for means and standard deviations and Table 3.45 for ANOVA results). The results from the tuition increase issue are not consistent with H4.2.1. Even though the issue is personally involving, source credibility was found to have a marginal effect on the number of micro movements in belief trajectories.

For the tuition-increase issue, positivity of thoughts was not affected by source credibility (see Table 3.47 for means and standard deviations and Table 3.48 for ANOVA results).

Source Credibility and Initial Belief Change

Regarding the relationship between source credibility on the amount of belief change of the first local movement, initial belief change, H4.2.2 was proposed:

> H4.2.2: Controlling for message discrepancy, the amount of belief change by the first local movement from a message with a high credibility source will not differ from the same message from a low credibility source.

Criminal-sentencing data. The regression analysis for Hypothesis 4.1.2 was used to test Hypothesis 4.2.2. Initial belief change was regressed on linear and quadratic individual message discrepancy, source credibility, the interaction between the linear individual message discrepancy and source credibility, and the interaction between quadratic individual message discrepancy and source credibility (see Table 3.50 for regression results). Results from the regression analysis showed that the effect of source credibility was statistically significant ($B = 4.41$, $SE = 1.66$, $p \leq .05$). Results also showed that source credibility increased the effect of linear message discrepancy on initial belief change (marginally significant, $B = .22$, $SE = .12$, $p = .06$). The effect of linear message discrepancy on initial belief change is .07 ($SE = .04$, $p = .07$) in the low source credibility condition and .29 ($SE = .12$, $p \leq .05$) in the high source credibility condition. In contrast to H4.2.2, source credibility did have an effect on beliefs at the beginning of judgment. H4.2.2 was not supported by the criminal-sentencing data.

Tuition-increase data. An ANOVA was conducted on belief change by the first micro local movement by source credibility and message discrepancy (see Table 3.52 for means and standard deviations and Table 3.53 for ANOVA results). As a highly involving issue, source credibility was not expected to have an effect on initial belief change for the tuition-increase data. Results showed that the effect of source credibility was not significant, $F(1,84) = 1.46$, *ns*. This result is consistent with H4.2.2.

Source Credibility and Final Belief Change

Regarding to the effect of source credibility on final beliefs, H4.2.3 and H4.2.4 were proposed:

H4.2.3: For less involving issues, the amount of final belief change will be greater for a message from a high than a low credibility source. However, for highly involving issues, there will be no difference in the amount of final belief change between messages from a high and a low credibility source.

H4.2.4: As source credibility increases, the effect of message discrepancy on final beliefs increases.

H4.2.3 was tested by the two data-sets. For the criminal-sentencing issue, which is less involving, significant effect of source credibility on final belief change was expected, but for the tuition-increase issue, which is more involving, no difference in the amount of final belief change between messages from a high and a low credibility source was expected.

Criminal-sentencing data. The regression analysis used to test Hypothesis 4.1.3 was used to test Hypothesis 4.2.3 and Hypothesis 4.2.4. Final belief change was regressed on linear and quadratic individual message discrepancy, source credibility, the interaction between the linear individual message discrepancy and source credibility, and the interaction between quadratic individual message discrepancy and source credibility. As a relatively less involving issue, source credibility was expected to have an effect on final belief change.

Results of the regression analysis showed that source credibility had a positive effect on final belief change ($B = 4.31$, $SE = 1.52$, $p < .01$) (see Table 3.55 for regression results). The message from a highly credible source ($M = 8.78$; $SD = 9.62$) induced greater belief change than the message from a less credible source ($M = 4.75$; $SD = 4.59$).

Results also showed that source credibility had a significant interaction effect with linear message discrepancy on final belief change ($B = .29$, $SE = .11$, $p < .01$). The effect of message discrepancy on final Belief Change was greater for the high credibility condition ($B = .35$, $SE = .10$, $p < .01$) than the low credibility condition ($B = .06$, *ns*). These results are consistent with H4.2.3 and H4.2.4.

Tuition-increase data. An ANOVA was conducted on final belief change by message discrepancy and source credibility (see Table 3.57 for means and standard deviations and Table 3.58 for ANOVA results). As a highly involving issue, source credibility was not expected to have an effect on final belief change for the tuition-increase data. Results showed that the final belief change was greater for the message from highly credible source ($M = 7.72$; $SD = 3.00$) than for the message from less credible source ($M = 6.53$; $SD = 2.99$), $F(1, 84) = 3.10$, $p = .08$, and partial $\eta^2 = .08$. Even though the issue was personally involving, source credibility only had a marginal effect on the final belief change. H4.2.3 was not supported by the tuition-increase data.

Change of Effect of Source Credibility on Beliefs over Time

Regarding change of the effect of source credibility on beliefs over time, H4.2.5 was proposed:

H4.2.5: For less involving issues, the effect of source credibility on beliefs increases over time during judgment. However, for highly involving issues, no significant change in the effect of source credibility is expected.

Criminal-sentencing data. H4.2.5 was tested by the repeated-measures analysis of variance used to test Hypothesis 4.1.4. The amount of belief change was explained by ordinal time (the point of the initial and the final local movement), individual message discrepancy and source credibility (see Table 3.59 for means and standard deviations by source credibility and individual message discrepancy for initial and final belief change and Table 3.60 for the repeated-measures analysis of variance results). Results from the repeated-measures analysis of variance showed that source credibility had an effect on overall beliefs, $F(1, 75) = 12.87$, $p < .01$, and partial $\eta^2 = .15$, but the effect of source credibility on beliefs did not significantly differ between initial and final local movement, $F(1, 75) = .01$, *ns*.

Tuition-increase data. A repeated-measures analysis of variance was conducted for beliefs by ordinal time, message discrepancy and source credibility (see Table 3.52 for means and standard deviations in initial belief change, Table 3.57 for means and standard deviations in final belief change and Table 3.61 for the repeated-measures analysis of variance results). The effect of source credibility on beliefs was significantly different between initial belief change and final belief change, $F(1, 84) = 7.45$, $p \leq .05$, and partial $\eta^2 = .08$. The mean difference in the amount of belief change between high and low source credibility was greater in the final local movement (= 1.11) than in the first local movement (= -.55). This result suggests that the effect of source credibility increases over time.

Increase of the effect of source credibility was expected for a less involving issue but not expected for a highly involving issue like tuition increase. However, increase of the effect of source credibility was found even for a highly involving issue. Results from the tuition-increase data did not support H4.2.5.

With four data-sets, twenty hypotheses about dynamic belief change during judgment were tested. Results of hypothesis testing are summarized in Table 3.63.

CHAPTER V

Discussion

In this chapter, the theoretical rationale and the method of the study are first summarized. Second, significance of the findings, limitations of the study, and questions for the future study are discussed.

Summary of the Study

The time course of belief change during judgment is an important aspect of the process of belief change that has not been systematically explored. The time course of belief change during judgment provides information about the dynamic aspects of the cognitive system, the structural properties of the cognitive system, cognitive responses during judgment, and the effect of distal variables on beliefs. This study investigates the time course of belief change during judgment to enhance our understanding of the process of belief change and of cognitive systems. Based on theories and findings from previous studies, hypotheses were developed about the time course of belief changes, which were tested with four data sets from three previous studies (Fink et al., 2002; McGreevy, 1996; Wang, 1993).

Studies of belief change during judgment were reviewed. Although there are several theories that have implications for belief change during judgment (e.g., post-decisional cognitive dissonance theory; the self-generated attitude change model), a spatial-spring model of cognitive force (Kaplowitz et al., 1983) is a model that most explicitly aims at describing and explaining the time course of belief change during judgment. The model has two basic assumptions about cognitive structure. First, concepts are located in a cognitive space and belief change is equivalent to motion of a concept in a cognitive space. Second, concepts in a cognitive system are linked with each other and the linkages are spring-like. These two assumptions and the associated laws of motions lead to a mathematical model for the motion of a concept in cognitive space as a result of the impact of a message. The model predicts possible oscillatory patterns of motion of a concept. With an assumption that cognitive systems have a sufficiently strong damping force, the motion of a concept is predicted to show oscillatory and damping patterns. The model suggests that when a person receives persuasive messages, he or she may experience several belief changes during judgment. The direction of belief change is expected to alternate and the amount of belief change in each direction is expected to decrease over time.

In Fink et al.'s (2002) study, McGreevy's (1996) study, and Wang's (1993) study, a computer mouse technique was used to measure instantaneous belief change for each individual. The computer mouse technique provided individual belief trajectories. Due to the unexpected irregularities and complexity of belief trajectories, analyses in those studies were limited to some overall aspects of the belief trajectories such as the difference between the maximum and the minimum positions or the number of changes in direction.

Belief trajectories obtained by the computer mouse technique show repetitions of a stay and a move, which is assumed to reflect the participant's micro belief change during judgment. In this dissertation, belief trajectories were divided into sets of a stay and a move, labeled local movements. By analyzing local movements, micro aspects of belief trajectories were analyzed. Hypotheses were developed for the following aspects of micro belief change during judgment:

- patterns of belief change during the message-receipt phase in response to different message structures (univalent versus mixed-valence messages);
- patterns of belief change during the post-message phase in response to different message structures;
- the number of micro belief changes during the post-message phase;
- the relationship between cognitive responses and the number of local movements,
- the effect of message discrepancy on beliefs at different time points during judgment;
- the effect of source credibility on beliefs at different time points during judgment;
- the effect of message discrepancy and source credibility on the number of positive and negative local movements.

Data from studies that used the computer mouse technique to measure belief change during judgment (Fink et al., 2002; Kaplowitz et al., 1983; McGreevy, 1996; Wang, 1993) were reanalyzed. In McGreevy's (1996) study (N = 102), participants were asked to choose one of the two candidates for college admission based on messages about the candidates. The message given to participants consisted of either information about two high-quality candidates (the mixed-valence message) or information about one high-quality candidate and one low-quality candidate (the univalent message). In addition, participants were placed either in a noisy room or in a quiet room to create different levels of distraction. Participants were asked to indicate their positions about candidates both during the message-receipt phase and the post-message phase. Participants' position was recorded at least every 24 ms.

In Wang's (1993) study (N = 66), participants listened to messages about an African American candidate and a Caucasian candidate for college admission and asked to choose one candidate. In the message, the African American candidate was described either stereotypically (no-individuation condition) or in an individuated way (individuation condition). Information about the Caucasian candidate was the same in both conditions. In addition, participants were placed either in a noisy room or in a quiet room for different levels of distraction. Participants were asked to indicate their position about candidates after receiving the message. Participants' position about candidates was recorded at least every 33 ms.

In Fink et al.'s (2002) study (N = 99), participants were given messages about two issues, a criminal-sentencing scenario and a tuition increase scenario, and asked to indicate their positions about these two issues. For the criminal-sentencing issue, participants received a message about a judge's sentence to a defendant who allegedly committed armed robbery. The participants also received the text of the speech the judge supposedly delivered in sentencing the defendant. The judge's criminal sentence varied to create different levels of message discrepancy. The judge was described as either not respected in the state or as one of the most respected judges in the state, which created different levels of source credibility.

For the tuition-increase issue, the message was a statement that was allegedly written by a member of the state legislature. The proposed amount of tuition increase in the message varied to create small, moderate, and extreme discrepancy messages. The legislator, the hypothetical writer of the statement about the tuition increase, was described either as one whose knowledge of the issues and willingness to be fair to students were often questioned (low source credibility) or as one who was praised by student groups (high source credibility). Compared to the criminal-sentencing issue, the tuition-increase issue was more personally involving to participants because participants were college students. Participants' position was recorded by computer at least every 77 ms.

These three studies produced four sets of belief trajectories. For each belief trajectory, local movements were identified with a pre-specified algorithm with carefully chosen constraints.

Summary and Interpretation of Results

Patterns of Belief Change during Judgment

Patterns of belief change during the message-receipt phase. For the patterns of belief change during the message-receipt phase, three hypotheses were proposed. First, *U*-shaped or inverted *U*-shaped patterns of belief change are expected for mixed-valence messages, whereas unidirectional (monotonic) patterns of local movements are expected for univalent messages (H1.1). This hypothesis was tested with the McGreevy data and was supported by the data. In the mixed-valence message condition (the similar-candidate condition), belief trajectories showed *U*-shaped patterns and the quadratic effect of the time was dominant (with a strong effect, partial $\eta^2 = .54$), whereas in the univalent message condition (the different-candidate condition), the (positive) linear effect of the time was dominant (with a strong effect, partial $\eta^2 = .50$). These findings suggest that the valence and the sequence of information in the message have an effect on micro belief change while the recipient receives a message. Beliefs of the recipients changed during the message-receipt phase in accordance to the valence of information in the message.

Patterns of belief change during the message-receipt phase between the univalent message condition and the mixed-valence message condition was also tested in terms of the number of positive and the number of negative local movements. It was expected that positivity of movements during the message-receipt phase will be greater for positively univalent messages than for the mixed-valence messages (H1.2). Positivity of movements is a logarithmic transformation of the ratio of the number of positive movements to the number of negative movements (see Equation 3.1). This hypothesis was tested with the McGreevy data and supported. In response to a positively univalent message (the different-candidate condition), positive local movements outnumbered negative local movements, whereas in the mixed-valence message condition (the similar-candidate condition), the number of the positive local movements was not significantly different from the number of negative local movements. The effect size of message type on positivity of movements was somewhat small (partial $\eta^2 = .13$). This finding also shows that while receiving message recipients experience belief changes according to the valence and the amount of information in the message.

Beliefs are a function of importance or weight of information (Anderson, 1971). Weights of information in a message were expected to be reflected in the amount of belief change by local movements in a belief trajectory (H1.3). Results showed that belief trajectories reflected average weights of pieces of information for each candidate. The first half of belief trajectories was found to reflect the average weights of pieces of information about the first candidate, and the second half of belief trajectories was found to reflect the average weights of pieces of information about the second candidate. McGreevy data supported H1.3. In addition, because the average weights of pieces of information about the first candidate and the second candidate in the similar-candidate condition was close, the absolute amount of belief change was expected not to be different between the first half and the second half of belief trajectories. However, it was found that the absolute amount of belief change was greater in the second half than in the first half of belief trajectories.

Previous studies on order effects have reported mixed results. Some studies have found that early information on an issue has a stronger impact on beliefs than later information, which is a primacy effect; others have found that later information exerts the stronger impact, which is a recency effect. Others have found that order of presentation has no effect (Hovland et al., 1957). Anderson and Farkas (1973) presented participants with a series of paragraphs about some United States Presidents and measured participants' beliefs about statesmanship at four different time points. They found that the most recent information had the greatest impact on beliefs, which indicates a recency effect. Results from the present study also support a recency effect.

Patterns of belief change during the post-message phase. Under some not too restrictive assumptions, the spatial-spring model of cognitive force predicts oscillatory patterns of belief change during judgment. The oscillatory patterns of belief change during judgment after receiving messages (H2.1.1) were tested with four sets of belief trajectories (Fink et al., 2002: criminal- sentencing issue, Fink et al., 2002: tuition-increase issue; McGreevy, 1996; Wang, 1993).

For the Wang data and the tuition-increase data, oscillatory patterns were found to be statistically significant. For the Wang data, the effect size was strong (R^2 ranges between .39 to .68). For the tuition-increase data, the effect size is somewhat small (R^2 ranges between .12 to .38). However, for the McGreevy data and in the criminal-sentencing data, oscillatory patterns of belief change were not statistically significant, which suggests that beliefs are not likely to oscillate for every micro belief change. Oscillatory patterns of belief change were found in one of the dichotomous decisions and one of the continuous decisions. Thus, the oscillatory patterns of belief change suggested by the spatial-spring model were only partially supported. Further investigation is needed to explain inconsistencies among results from different data sets.

The spatial-spring model also predicts that a damping pattern will be found in the time course of belief change during judgment. It was expected that the absolute amount of belief change in local movements will decrease over time (H2.1.2). Results from the criminal-sentencing data showed that the absolute amount of belief change significantly decreased over time with a somewhat small effect (partial $\eta^2 = .12$). However, contrary to the hypothesis, a statistically significant increase in the absolute amount of belief change by a local movement at the end of belief trajectory was found in the McGreevy data (with a somewhat strong effect, partial $\eta^2 = .43$) and the tuition-increase data (with a moderate effect, partial $\eta^2 = .36$). In the Wang data, the increase was not statistically significant.

The lack of a damping pattern found in the McGreevy data and the Wang data could be explained by the decision issues. In both the McGreevy data and the Wang data, the decision involved choosing one of two alternatives, which is dichotomous decision.

In dichotomous decisions, decision makers are forced to move to one of two ends of the position scale. When they have decided, decision makers should be at one of the two ends of the scale, which is likely to occur at the final movement. Therefore, the absolute amount of Belief Change by the final movement is more likely to be greater than for other previous movements. On the other hand, there is no such constraint in a continuous decision. In one continuous decision, the criminal-sentencing issue, the expected damping pattern was found, but in the other continuous decision, the tuition-increase issue, the opposite pattern was found. The pattern found in the tuition-increase issue may suggest that if the decision is highly involving, individuals may have a significant change at the end of judgment. The spatial-spring model predicts that the cognitive system generates an underdamped oscillatory trajectory when a damping force is within a certain range (see pp. 10-11). The observed patterns that are different from predictions by the spatial-spring model could result from failure of assumptions about the damping force. Further investigation is needed to explain different patterns between the criminal-sentencing data and the tuition-increase data.

Local movements and cognitive responses during the post-message phase. During the post-message phase, the number of positive micro belief changes, or local movements, was expected to be greater than the number of negative micro belief changes in response to positively univalent messages, whereas the number of positive micro belief changes was expected not to be different from the number of negative micro belief changes in response to mixed-valence messages (H3.1.1). This hypothesis was tested with the McGreevy data and the Wang data and supported by both data sets. A greater number of positive local movements than the number of negative local movements was found in the univalent message condition (the different-candidates condition in the McGreevy data; the no-individuation condition in the Wang data), whereas the numbers of positive and negative local movements were not different in the mixed-valence condition (the similar-candidate condition in the McGreevy data; the individuation message condition in the Wang data). The size of effect of message type on positivity of movements was somewhat small in the McGreevy data (partial $\eta^2 = .13$) and somewhat strong in the Wang data (partial $\eta^2 = .48$). This observed relationship between message type and the number of local movements in belief trajectories during the post-message phase provides another piece of evidence about the validity of the measurement process using the computer mouse technique and the local movement framework.

It was expected that in response to mixed-valence messages, people have more micro belief changes than to the univalent messages during the post-message phase (H3.1.2). A decision is more difficult for the mixed-valence message than for the univalent message. Therefore, more cognitive responses and micro belief changes were expected in response to a mixed-valence message than a univalent message. This hypothesis was tested with the McGreevy data and supported by the data. The total number of local movements was not different in the message-receipt phase in both the univalent-message condition (the different-candidates condition) and the mixed-valence message condition (the similar-candidates condition). However, in the post-message phase, the total number of local movements was found to be greater in the mixed-valence message condition than in the univalent message condition (with a somewhat small effect, partial $\eta^2 = .16$). This finding suggests that people may generate more cognitive responses and experience more micro belief changes during judgment for more difficult issues.

According to the cognitive response approach, cognitive responses mediate the effect of messages on beliefs. Assuming local movements reflect cognitive responses during judgments, it was hypothesized that the effect of message type (univalent versus mixed-valence messages) on the final decision is mediated by the number of positive and the number of negative local movements (H3.1.3). This hypothesis was tested by the McGreevy data and the Wang data. In the McGreevy data, statistical evidence was found for an indirect effect of the message type on the final decision through the number of positive and the number of negative local movements. In the Wang data, message type was found to have both direct and indirect effects on the final decision. In the indirect effect, the effect of the message type on the final decision was exerted through the number of positive and the number of negative movements. Findings for the McGreevy data and the Wang data suggest that local movements in belief trajectories seem to reflect cognitive responses that recipients generate during judgment.

Assuming that cognitive responses have an effect on the recipients' belief during judgment and that those belief changes can be represented by local movements in belief trajectories, a positive relationship between the number of positive local movements and the number of positive thoughts, and between the number of negative local movements and the number of negative thoughts were expected (H3.2.1). This hypothesis was tested with the criminal-sentencing data and the tuition-increase data. In the criminal-sentencing data, a positive correlation was found between the number of positive local movements using the computer mouse technique and the number of positive thoughts that recipients reported after judgment (r = .38). However, no significant correlation was found between the number of negative local movements and the number of negative thoughts. In the tuition-increase data, the correlation between the number of positive local movements and the number of positive thoughts was found to be marginally significant (r = .15) and the correlation between the number of negative local movements and the number of negative thoughts was not significant.

This lack of systematic relationships between the number of local movements and the number of self-reported thoughts may be attributed to three factors. First, micro belief changes during judgment may not be caused by cognitive responses during judgment. Second, assuming that micro belief changes during judgment are caused by cognitive responses during judgment, local movements in the belief trajectories may not validly measure micro belief change during judgment. Third, self-reported thoughts after judgment may not validly measure cognitive responses during judgment because of inaccurate memory and influence of the final decision on recall. The McGreevy (1996) data and the Wang (1993) data provide evidence for the validity of belief trajectories as a measure of micro belief change (see results of H1.1, H1.2, H1.3, H3.1.1, and H3.1.2). However, it is unclear which measure is responsible for the lack of systematic relationships between the number of local movements and the number of self-reported thoughts. Further investigation is needed to explore the cause of the lack of systematic relationships between these two measures.

Assuming local movements in belief trajectories represent micro belief change due to cognitive responses during judgment, some similarities between weights of cognitive responses on beliefs and weights of local movements on beliefs were expected

(H3.2.2). This hypothesis was tested with the criminal-sentencing data and the tuition-increase data. In both the criminal-sentencing data and the tuition-increase data, the results showed the ratio of the effect of the number of positive local movements on beliefs to the effect of the number of negative movements on beliefs was not significantly different from the ratio of the effect of the number of positive thoughts on beliefs to the effect of the number of negative thoughts on beliefs. This finding supports the idea that local movements in belief trajectories measures micro belief change due to cognitive responses during judgment.

Message Discrepancy, Source Credibility, and Dynamics of Judgment

How do message discrepancy and source credibility influence belief systems? This question was investigated by examining the effect of message discrepancy and source credibility on beliefs at different time points during judgment, and by examining the effect of message discrepancy and source credibility on cognitive responses. Hypotheses were tested with the criminal-sentencing data and the tuition-increase data.

Message discrepancy, cognitive responses, and local movement. Based on the studies on the relationship between message discrepancy and counterarguments (Brock, 1967; Toy, 1982), it was expected that as message discrepancy increases, positivity of movements decreases, given that message discrepancy is positive (H4.1.1). This hypothesis was tested with the criminal-sentencing data and the tuition-increase data. In the criminal-sentencing data, message discrepancy did not have a significant effect on positivity of movements. The hypothesis was not supported. However, message discrepancy was found to have a negative effect on the number of thoughts. As message discrepancy increased, positivity of thoughts decreased ($\beta = .14$; see Table 3.43). This finding is generally consistent with Toy (1982).

In the tuition-increase data, a nonmonotonic relationship between message discrepancy and positivity of movements was found when the source of the message was less credible (with a somewhat small effect, partial $\eta^2 = .12$). In particular, when the source of the message was less credible, positivity of movements was higher for the moderately discrepant message than the extremely discrepant message. This result suggests that extremely discrepant messages induced more negative belief changes during judgment than moderately discrepant messages did. Unlike the criminal-sentencing data, a negative effect of message discrepancy on positivity of thoughts was not found in the tuition-increase data.

In summary, message discrepancy showed a negative effect on positivity of thoughts in the criminal-sentencing data and some negative effect on positivity of movements in the tuition-increase data. Even though the pattern was not consistent between the two data sets, the results from both studies generally suggest that extremely discrepant messages may generate a greater number of counterarguments and induce more negative belief changes during judgment. The results have implications for the dynamic effect of message discrepancy on beliefs. Assuming generating counterarguments takes time and counterarguments decrease the effect of messages on beliefs, the amount of belief change by a discrepant message after generating counterarguments could be less than the amount of belief change at the beginning of judgment. If so, the effect of message discrepancy on beliefs could decrease over time.

Further investigation is needed to explain differences in patterns of positivity of movements by message discrepancy

Message discrepancy and initial belief change. According to the Spinozan procedure model (Gilbert et al., 1990), people initially accept both true and false information as true. Therefore, it was expected that the greater message discrepancy, the greater belief change at the beginning of the judgment (H4.1.2). This hypothesis was tested with the criminal-sentencing data and the tuition-increase data. Using the criminal-sentencing data, the hypothesis had mixed results. When the source of the message was highly credible, initial belief change linearly increased as message discrepancy increased, which is generally consistent with the hypothesis ($\beta = .38$; see Table 3.51). However, when the source of the message was less credible, the amount of belief change was greatest for a moderately discrepant message ($\beta = .30$; see Table 3.51). Results from the tuition-increase data also showed a nonmonotonic relationship between message discrepancy and initial belief change for the message advocated by a less credible source (with a small effect size, partial $\eta^2 = .10$).

Both data sets showed that when the source of a message is less credible, the amount of belief change at the beginning of judgment was greater for moderately discrepant messages than extremely discrepant messages. In Fink et al.'s (2002) experiment, after participants finished reading the message, they were asked to indicate belief position with the computer mouse. Belief position while reading the message was not measured and there was a time interval after reading the message and before indicating belief change. It is possible that participants generated cognitive responses and experienced belief changes in response to different levels of discrepant message while reading the message but those belief changes were not reported. Unexpected nonmonotonic effects of messages discrepancy on the initial local movement were found in the low source credibility condition but the format of the experiment suggests that initial belief change of belief trajectories may not indicate belief change at the beginning of judgment.

Message discrepancy and final belief change. Based on two mathematical models regarding the effect of message discrepancy on beliefs (Fink et al., 1983; Laroche, 1977), an inverted *U*-shaped nonmonotonic effect of message discrepancy on final belief change was predicted (H4.1.3). This hypothesis was tested with the criminal-sentencing data and the tuition-increase data. In the criminal-sentencing data, the effect of message discrepancy on final belief change was different for the high credibility message condition and the low credibility message condition. For the high credibility message, the amount of final belief change linearly increased as message discrepancy increased ($\beta = .50$; see Table 3.56). However, for the low credibility message, the amount of final belief change was greater in the moderately discrepant message condition than in the extremely discrepant message condition. The expected nonmonotonic pattern was found only in the low credibility condition ($\beta = .20$; see Table 3.56).

The nonmonotonic relationship between message discrepancy and belief position for the low source credibility condition, which was found in the criminal-sentencing data, had also been found in previous studies (Aronson et al., 1963; Bochner & Insko, 1966). The nonmonotonic relationship between message discrepancy and final belief change for messages from a less credible source is consistent with Laroche's model. Lacroche's model predicts that when other factors are constant, as the degree of source credibility increases, the relationship between message discrepancy and the amount of belief change changes from nonmonotonic (inverted *U*-shaped) to nonlinear monotonic increasing, to linear increasing. For the high credibility condition, a linear pattern is more likely to be found. The observed pattern in final belief change was generally consistent with the findings from previous studies.

For the tuition-increase data, results showed that as message discrepancy increased, final belief change linearly increased with a somewhat small effect (partial η^2 = .16). This monotonic increasing pattern was not expected and different from the pattern found in the criminal-sentencing data. Both Laroche's model and Fink et al.'s model predict that as message discrepancy increases, the weight of message discrepancy on beliefs exponentially decreases. As a result, the amount of belief change monotonically increases until message discrepancy reaches a certain amount. After that amount of message discrepancy, beliefs starts to show decreasing pattern as message discrepancy increases. The amount of message discrepancy for the maximum belief change varies depending on other factors such as source credibility. One possible explanation for the lack of a nonmonotonic relationship in the tuition-increase data may be that the message position for the extreme message discrepancy, a 22% tuition increase, did not reach the amount of message discrepancy that could induce the maximum beliefs. Monotonic increasing pattern of beliefs by message discrepancy has been found in other studies (Fink et al, 1983; Kaplowitz et al., 1986; Kaplowitz et al., 1991). Further investigation is needed to explain discrepancy in observed patterns between two issues.

The dynamic effect of message discrepancy on beliefs. Based on studies of message discrepancy and counterarguments, it was predicted that the effect of message discrepancy on beliefs was not constant but dynamic. More specifically, the effect of message discrepancy on beliefs was predicted to decrease during judgment (H4.1.4). This hypothesis was tested with the criminal-sentencing data and the tuition-increase data. In the criminal-sentencing data, both at the beginning of judgment and at the end of judgment, a nonmonotonic relationship, an inverted *U*-shape, between message discrepancy and beliefs was found for the message from a less credible source. However, the nonmonotonic effect of message discrepancy on beliefs was found to be somewhat stronger at final belief change than at initial belief change. It indicates that the effect of extremely discrepant messages on beliefs may decrease over time.

Results from the tuition-increase data showed that for a message from a less credible source, the linear effect of message discrepancy on beliefs became stronger over time, whereas the nonmonotonic effect of message discrepancy on beliefs became weaker. These observed patterns were opposite to predicted patterns. On this point, no explanation is proposed for how an extremely discrepant message with a low source credibility affects beliefs when the issue is highly involving. Further investigation is needed to explain the pattern found in the tuition-increase data.

Source credibility, cognitive responses and local movements. Based on studies on source credibility and cognitive responses (Cook, 1969; Hass, 1981), it was predicted that positivity of movements will be greater in a message from a high than a low credibility source when the issue is less involving but positivity of movements will not differ between messages from a high and a low credibility source when the issue is highly involving (H4.2.1). This hypothesis was tested with the criminal-sentencing data and the tuition-increase data. The results showed an opposite pattern. For the less involving issue, the criminal-sentencing issue, positivity of movements was not different for the message from the high and the low credibility source. On the other hand, for the more involving issue, the tuition-increase issue, positivity of movements was somewhat greater in a message from a highly credible source than a less credible source (marginally significant with a small effect, partial $\eta^2 = .03$).

In the criminal-sentencing data, the message from a highly credible source induced greater belief change than the message from a less credible source (H4.2.3). Results from the criminal-sentencing data suggest that beliefs may be determined not by quantity of positive and negative cognitive responses but by the relative strength of positive and negative cognitive responses.

The results from the tuition increase data suggest that even though a message is highly involving, source credibility may have an effect on the number of micro belief changes during judgment. Source credibility did not have a significant effect on the number of thoughts in either the more involving or less involving issue. This result is not consistent with Cook (1969) or Hass (1982).

Source credibility and initial belief change. Applying the Spinozan procedure model (Gilbert et al., 1990), source credibility was expected to have no effect on initial belief change (H4.2.2). This hypothesis was tested with the criminal-sentencing data and the tuition-increase data. In criminal-sentencing data, however, source credibility did have a significant effect on beliefs at the beginning of judgment ($\beta = .27$; see Table 3.50). Also, the results showed that source credibility increased the effect of message discrepancy on initial belief change.

Inconsistent with the hypothesis, the results show that people use information about the source from the beginning of the judgment period. In Fink et al.'s (2002) study, belief changes at the very beginning of judgment might not be recorded because the imperfect measurement procedures of the experiment. Belief change by the source credibility may have occurred while receiving information about the source or before the participants started to indicate their positions.

For the tuition-increase data, the effect of source credibility on beliefs at the beginning of the judgment was not significant, which is generally consistent with H4.2.2.

Source credibility and final belief change. Based on Petty et al. (1981), it was predicted that for less involving issues, the amount of final belief change will be greater for a message from a high than a low credibility source, whereas for highly involving issues there will be no difference in the amount of final belief change between messages from a high versus a low credibility source (H4.2.3). Also, based on Laroche (1977) and Fink et al. (1983), it was predicted that as source credibility increases, the effect of message discrepancy on final belief change increases (H4.2.4). These hypotheses were tested with the criminal-sentencing data and the tuition-increase data. For the criminal-sentencing issue, a low involving issue, a significant effect of source credibility on final belief change ($\beta = .27$; see Tab3.50) and a significant interaction effect between source credibility and message discrepancy on final belief change ($\beta = .20$; see Tab3.50) were found. The amount of belief change at the end of judgment was greater for the message from a high credibility source than from a low credibility source. The positive effect of message discrepancy on final belief change was greater for the message from a high credibility source than a low credibility source. These results are consistent with the prediction and with previous studies.

For the tuition issue, which is more involving, no effect of source credibility on final belief change was expected. However, results showed that source credibility had a positive effect on final belief change (marginal significance with a small effect size, partial $\eta^2 = .04$). Inconsistent with the prediction, even though the issue was highly involving, people used information about the source for the judgment. In the tuition-increase data, the effect of message discrepancy did not differ between a message from a highly credible source and a message from a less credible source.

The dynamic effect of source credibility on beliefs. Based on the role of cognitive responses in message processing and belief change, the effect of source credibility on beliefs was expected to increase over time during judgment for less involving issues (e.g., criminal sentencing), but not to change for highly involving issues (e.g., tuition increase) (H4.2.5).

In the criminal-sentencing data, the results showed that source credibility had significant positive effect on beliefs both at the beginning and the end of judgment. The effect of source credibility was not different between at the beginning and the end of judgment. This result suggests that source credibility may exert its effect on beliefs only once at the beginning of the judgment and the amount of belief change by source credibility at the beginning of the judgment remains during the judgment.

On the other hand, the effect of source credibility on beliefs was found to increase over time in the tuition-increase data. The difference in belief change for a message from a high versus a low credibility source was greater at the end of judgment than at the beginning of judgment. The greater effect of source credibility was expected for a less involving issue but was found for a highly involving issue. The results suggest not only that source credibility has an effect on beliefs for a highly involving issue but also that source credibility exerts a stronger effect on beliefs at the later phase of judgment. However, why an increase of the effect of source credibility on beliefs was found for a highly involving issue remains in question. Further investigation is needed.

Significance of the Findings, Limitations of the Study, and Directions for Future Research

Measurement of Belief Change during Judgment

The computer mouse technique. Since the early age of persuasion study, researchers have been interested in message recipients' beliefs change as a function of time (e.g., Brehm & Wicklund, 1970; Kaplowitz et al., 1983; Tesser, 1978; Walster, 1964). Those studies have made significant contributions on understanding the role of time on belief change by finding dynamic patterns of belief change during judgment. However, those studies had methodological limitations. Except for Brehm and Wicklund's (1970) study, people typically indicated their positions only once at an assigned time point and the observed positions of the group of people were compared to positions of another group of people who indicated their positions at a different time point (between-participant design with cross-sectional data). With this design, individuals' belief change over time was not observed but only inferred from observed differences among groups at different time points.

Another limitation of the early studies lies in the small number of time points for measurement of the message recipient's position. For example, in Walster (1964), beliefs were measured immediately, 4 minutes, 15 minutes, and 90 minutes after the first decision. Walster found a decrease of attractiveness of a chosen alternative, which was interpreted as regret, in the 4-minute delay condition, but she found a later increase in attractiveness for the chosen alternative, which was interpreted as dissonance reduction. However, it is not clear whether there were other belief reversals between the 4-minute delay and the 15 minute delay, or after 15-minute delay. To find possible belief reversals, more measurements over time are needed.

Another limitation can be found in the enforcement of a uniform time period for judgment to individuals. Individuals may take different time periods for judgment and cognitive processing. In Walster's study, it might be possible that some people were experiencing regret but some people were experiencing dissonance reduction in the 4-minute delay condition.

To overcome limitations of eariler studies, a new measurement system was developed by Fink, Kaplowitz and their colleagues, and independently by Vallacher, Nowak, and Kaufman. The new technique, using a computer mouse, provided belief trajectories. With those belief trajectories, details of belief change during judgment are observed. Theories about dynamic belief change were tested with those belief trajectories, which provided strong evidence for the dynamic character of human judgment (Fink, Kaplowitz, & Hubbard, 2002; McGreevy, 1996; Vallacher, Nowak, & Kaufman, 1996; Wang, 1993). On the other hand, belief trajectories obtained by the computer mouse technique appeared to be irregular and also showed substantial individual differences. Because of lack of regularities and individual differences, only some overall aspects of belief trajectories were analyzed in previous studies.

Local movement framework. The present study proposed a measurement framework for belief trajectories. Each belief trajectory was decomposed into local movements, which were assumed to represent micro belief change during judgment. The local movement framework made it possible to analyze both overall aspects and the micro aspects of belief trajectories.

With the local movement framework, the validity of the computer mouse technique was tested. In the McGreevy data, six time points were chosen based on local movements to see whether the pattern of belief change during judgment reflects the structure of the messages during the message-receipt phase. The observed belief trajectories and local movements were found to reflect the order and the valence of information in the given message (see the results for H1.1, H1.2, and H1.3). Also, all hypotheses for the pattern of belief change during the post-message phase in response to different types of messages (H3.1.1 and H3.1.2) were supported by the observed pattern of local movements of belief trajectories. These results provide evidence not only for theoretical predictions but also for the validity of the measurement process. The reliable and valid portion of the belief measurement generated from the computer mouse technique was large enough to reveal systematic relationships between belief change and relevant variables.

Belief trajectories provide not only information about the course of belief change during judgment but also about the cognitive responses during judgment. Traditionally cognitive responses have been measured by the thought-listing technique. Unlike the thought-listing technique, local movements of belief trajectories can measure the amount of positive and negative cognitive responses on-line, which is free from the influence of the final judgment. The present study found evidence for belief trajectories as measures of the amount of positive and negative cognitive responses (H3.1.1 and H3.1.2). However, expected systematic relationships between belief trajectories and thoughts reported by the participants were not found except for the relationship between the number of positive local movements and the number of positive thoughts (H3.1.3). On the other hand, the number of local movements of belief trajectories and the number of thoughts showed some similarities in effects on beliefs, which provides another piece of evidence for belief trajectories as measures of cognitive responses (H3.2.2). However, the lack of systematic relationships between belief trajectories and thoughts reported by the participants should be investigated in future research.

Belief trajectories provide information about the process of belief change, which can be used to resolve issues of human judgment. For example, belief trajectories may be used to observe the anchoring effect that was found by Tversky and Kahneman (1974). In typical anchoring studies (e.g., Tversky & Kahneman, 1974), participants were asked to make a comparative judgment with an arbitrary number, and then they were asked to make an absolute numerical judgment. It was found that the absolute numerical judgment was influenced by the given arbitrary number. To explain the anchoring phenomenon, Tversky and Kahneman (1974) suggested that the anchor serves as a starting point for adjustment. In a more detailed explanation, Jacowitz and Kahneman (1995) argued that judges adjust their estimates from the anchored value in the appropriate direction and this adjustment process terminates at the nearest upper or lower boundary of a range of acceptable values, which is generally insufficient for accurate estimation. This adjustment process may be observed when belief trajectories are examined. Also, belief trajectories may be used to identify the role of motivation in judgment. Belief trajectories may be different when participants are highly motivated versus when they are not.

The reliability and validity of the measurement here were not fully known. As explained in the method section, there could be two kinds of error in the measurement process using the computer mouse technique: (1) an error of non-reporting belief change (i.e., no computer mouse movement when a belief has changed), and (2) an error of false reporting (i.e., computer mouse movement when a belief has not changed). In the first case, the number of belief changes will be underestimated. It is unknown how much the number of belief changes was underestimated in the measurement process. Development of methods to assess the reliability of the measurement using the computer mouse technique is needed. Also, more effective instructions and techniques to minimize both kinds of error in reporting instantaneous belief change are needed.

For the message-receipt phase of the McGreevy data, six data points over time were used. However, because of the required minimum number of local movements, the number of cases for analysis dropped from 78 to 62. Applying the local movement framework requires more cases. New methods may be needed to analyze belief trajectories with a small number of local movements.

Theoretical Implications and Limitations

The present study proposed hypotheses about patterns of belief change during judgment, and the role of message discrepancy, source credibility, and involvement on belief change during judgment. Those hypotheses were tested with belief trajectories measured by the computer mouse technique. The results of this dissertation have significant implications for existing theories of belief change, but also have generated new questions for future research.

Dynamic belief change. Postdecisonal dissonance theory (Festinger & Walster, 1964), the self-generated attitude change model (Tesser, 1978) and the spatial-spring model (Kaplowitz et al., 1983) predict dynamic belief change. Those theories argue that during judgment belief change may occur without external forces. The present study confirmed the idea that processes of belief change are dynamic rather than static. During judgment, significant micro belief changes were observed in all four data-sets. Micro belief change during judgment also showed systematic patterns depending on particular message variables. Specifically, the structure of the message was reflected in micro belief change during the message-receipt phase (H1.1, H1.2, and H1.3) and the difficulty of message (H3.1.1 and H3.1.2), the levels of message discrepancy (H4.1.1 for the tuition-increase issue), and the levels of source credibility (H4.2.1 for the tuition-increase issue) were reflected in micro belief change during the post-message phase.

The spatial-spring model (Kaplowitz et al., 1983) predicts oscillatory and damping patterns of belief change during judgment under certain conditions. Oscillatory and damping patterns were examined with micro belief change during judgment. In two of four data sets, the oscillatory pattern was found. However, in the other two data sets, the oscillatory pattern was not significant. The results suggest that a local movement is not necessarily followed by a micro belief change whose direction is opposite to the previous one. Individuals may experience two or more micro belief changes with the same direction before having a micro belief change that is opposite to the previous one. The finding also suggests that the degree of oscillation varies depending on issues.

However, why oscillatory patterns were found in two data sets, one with a dichotomous and one with a continuous decision, but not found in other two data sets, one with a dichotomous and one with a continuous decision, is unknown. This finding requires further investigation.

Damping patterns were found in one of the continuous decisions. When the decision is dichotomous or highly involving, damping patterns were not found. This result supported the spatial-spring model but also suggests specifying conditions for the damping patterns of belief change.

The findings of the study suggest that the patterns of belief change are more complicated than a sinusoidal pattern.

The effect of message discrepancy on beliefs. The study proposed and tested a model for the temporal variation of the effect of message discrepancy on beliefs during judgment: The effect of message discrepancy was expected to be linear and positive at the beginning of judgment but the effect was expected to decrease over time. In one data set (the criminal-sentencing data), evidence for the decrease of the effect of message discrepancy on beliefs was found even though it was relatively weak.

This finding provides valuable information about how message variables influence beliefs and may resolve some conflicting issues of the effect of message discrepancy. For example, some studies (Aronson et al., 1963; Bochner & Insko, 1966) have found a nonmonotonic relationship between message discrepancy and belief change whereas other have found a monotonically increasing function of message discrepancy on beliefs (Fink et al., 1983; Kaplowitz & Fink, 1991; Kaplowitz et al., 1986). The proposed model, which argues a decrease of the effect of message discrepancy on beliefs over time, suggests that the effect of message discrepancy on beliefs could be either nonmonotonic or monotonically increasing depending on the amount of initial belief change and the amount of decay of the effect of message discrepancy on beliefs. The different observations in previous studies may result from the different amount of initial belief change, which are mainly affected by message positions, and the amount of decay of the effect of message discrepancy on beliefs, which are mainly affected by decision time and counterarguments.

However, the effect of message discrepancy on beliefs shows different patterns depending on issue involvement. For a highly involving issue with low source credibility, message discrepancy initially had a nonmonotonic effect on beliefs but had a linear effect on beliefs at the end of judgment. This increasing pattern of the discrepancy effect for highly involving issues was not expected. In Fink et al.'s (2002) study, issue involvement was not manipulated. Two issues, the criminal-sentencing and the tuition-increase issue, differ on more than the level of issue involvement. The role of issue involvement on dynamic belief change should be more systematically investigated in future studies.

The role of source credibility on belief change. This study proposed and tested a dynamic model for the effect of source credibility on beliefs. The effect of source credibility on beliefs was hypothesized not to be static but to increase during judgment for messages about less involving issues. For a less involving issue, the effect of source credibility was found at the beginning of the judgment, and the difference in the amount of belief change between messages from a high versus a low credible sources remained at the end of judgment. On the other hand, for a highly involving issue, source credibility had no effect on belief at the beginning of the judgment but had a significant effect at the end of judgment.

Theories of belief change proposed two different ways that source credibility affects beliefs. One argument is that source information is processed independently of other pieces of information of the message, either as a cue (Chaiken et al., 1989; Petty et al., 1981) or as a message argument (Kruglanski & Tompson, 1999; Petty & Cacioppo, 1986). The other view is that source credibility has an effect on the weight of other pieces of information of the message (the information integration theory; Anderson, 1971). If source information exerts its effect independently, the effect of source credibility will be static. If source credibility exerts its effect by increasing or decreasing the effect of other pieces of information, as the message is processed, the effect of source credibility should increase or decrease. The finding in the criminal-sentencing data supports the former explanation. In the tuition-increase data, an increasing effect of source credibility on beliefs over time was observed, but whether source credibility exerts its effect continually during judgment is unclear because only two time points were used. Beliefs should be measured at least at three time points to test whether the effect of a variable appears continuous. Also, if micro belief changes had been measured in both the message-receipt phase and in the post-message phase, clearer evidence for the role of source credibility on belief change would have been adduced.

In the study, the effect of source credibility on beliefs was found not only for a less involving issue but also for a highly involving issue. This result is somewhat inconsistent with Petty, Cacioppo, and Goldman (1981). Kruglanski and Thompson (1999) found that when source information is more lengthy and more complex than message arguments, the effect of source credibility on beliefs can be greater for highly involving issues than for less involving issues. Kruglanski and Thompson argued that when message arguments are more difficult to process than source information, the effect of source credibility will be greater for less issue-involvement cases, and the effect of message arguments will be greater for high issue-involvement cases. However, when source information is more difficult to process than message arguments, the opposite pattern will appear.

In the present study, even though the source information was relatively short and simple and placed at the beginning of the message (high accessibility), the effect of source credibility was found for a highly involving issue. One explanation for this finding can be found in information integration theory (Anderson, 1971). This theory argues that source credibility has an effect on beliefs by increasing or decreasing the effect of information on beliefs. When the issue is highly involving, people tend to process more pieces of information and access more difficult information. If source credibility has an effect on the weight of message arguments, the effect of source credibility on beliefs can be found regardless of how many pieces of information are processed. The information integration theory predicts that the effect of source credibility can be found regardless of the level of involvement of the issue. Manipulation of issue involvement and examination of belief trajectories for both the message-receipt phase and the post-message phase can provide critical information about how source information is processed in high and low issue involvement conditions.

The cognitive response model of attitude change. To consider the dynamic effect of message discrepancy and source credibility on beliefs during judgment, the cognitive response model of attitude change (Greenwald, 1968; Petty et al., 1981) was used. The cognitive response model explains belief change as a result of cognitive responses that individuals generate during judgment. Findings of the current study have implications for the cognitive response model of attitude change.

The present study proposed that the effect of message discrepancy decreases due to the greater number of counterarguments in response to extremely discrepant messages. This pattern was tested with positive and negative micro belief changes during judgment. Positivity in the number of micro local movement was expected to be less for an extremely discrepant message than for a moderately discrepant message. This pattern was found only when the message was attributed to a less credible source and the issue of the message was more involving. For the criminal-sentencing data, a nonmonotonic relationship was found between message discrepancy and final belief change for the low source credibility condition, but there was no significant difference in the number of positive micro belief changes and the number of negative belief changes. This finding suggests that in some cases it is not the quantity of positive and negative cognitive responses but their strength that plays an important role in belief change.

The present study proposed that the effect of source credibility increases over time due to the greater number of positive cognitive responses for a message from a highly credible source and the greater number of negative cognitive responses for a message from a low credible source. It was found that when the issue of the message was highly involving, positivity in the number of micro belief changes was greater for the message from a highly credible source and the effect of source credibility increased over time. However, when the issue was less involving, even though the message from a highly credible source induced greater belief change than the message from a less credible source, the number of positive micro belief changes was not significantly different than the number of negative micro belief changes. These findings suggest that cognitive responses have an effect on beliefs, either through the quantity or strength of individual cognitive responses.

This dissertation investigated the time course of belief change during judgment and attempted to deepen our understanding the process of belief change by analyzing micro belief change in belief trajectories. Interesting patterns about belief change during judgment were found and new questions about the role of distal variables on belief change during judgment were found. More importantly, the study opened the door for systematic investigation about the time course of belief change that is believed to contain critical information about belief systems and human communication process.

Footnotes

[1] According to Halliday and Resnick (1974), "the velocity of a particle is the rate at which its Belief Changes with time" (p. 26), and "the magnitude of the instantaneous velocity is called the speed and is simply the absolute value of the instantaneous velocity" (p. 27).

[2] Individuals can experience belief change without being aware of the causes of that change (Bargh, 1994). In this case, cognitive responses can follow belief change to provide an explanation for it (e.g., misattribution behavior; Zillmann, 1978).

[3] Participants were also asked to indicate which candidate they thought was more suitable to college in a different question after completing the computer mouse measurement. However, participants' responses to the question were not found in the data set that the present analysis used.

[4] The criterion of one second for the short interval is chosen by two reasons. First, the number of cases with less than a one second interval is significantly greater than other intervals (the number of cases with the interval greater than one but less than two seconds is three; the number of cases with the interval greater than two but less than three seconds is one; the number of cases with the interval greater than three but less than four seconds is two; the number of cases with the interval greater than four but less than five seconds is four). Secondly, the length of intervals of the cases with less than one second is equally distributed in general.

[5] A computer program was written in the *C* computer language to extract key points from each trajectory. This program allows the use of different values for the maximum position difference and the minimum stay length. Appendix A provides the

flow chart of the algorithm of the computer program. In the flow chart, P_start is the starting point of a stay; P_end is the end point of a stay; StayLength is a time length; MAX_DIFF is the prescribed maximum position difference; MIN_STAY is the prescribed minimum time length for a stay (also see Appendix B for the code of the computer program)

[6] There are several studies that have multiple successive measurements (Brehm, & Wicklund, 1970; Fink et al., 2002; McGreevy, 1996; Vallacher et al., 1994; Wang, 1993). However, the validity of this kind of measurement has not been systematically investigated. One possible threat is the effect of previous measurements on later measurements. Research has shown that the desire for consistency is one motivator of our judgment and behavior (Festinger, 1957; Heider, 1958; Newcomb, 1953). Baumeister (1982) and Tedeschi and Rosenfeld (1981) found that the desire to appear consistent influences our behavior. If the consistency motivation affects the measurement process, participants may not report belief change or report less subsequent belief change after reporting their initial beliefs. This problem causes non-reporting error. Non-reporting error basically works against our hypotheses.

Instructions of the computer mouse technique may give participants a cue that participants should indicate belief reversals as good participants (demand characteristics; Orne, 1962; Orne & Whitehouse, 2000). However, in studies using the computer mouse technique (Fink et al., 2002; McGreevy, 1996; Wang, 1993) participants were placed in different experimental conditions that were unknown to them. Therefore, any systematic differences in belief trajectories between experimental conditions are hardly attributable to demand characteristics.

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[7] Participants were also asked to indicate their final decision in a different question after completing the computer mouse measurement. However, participants' responses to the question were not found in the data set that the present analysis used.

[8] The average number of micro movements per macro movement is another indicator of oscillatory pattern. The greater the average number of micro movement per macro movement, the lesser oscillation in belief trajectories. The average number of micro movements per macro movement is 2.10 in the McGreevy data (*SD* = 1.11, *N* = 72), 1.27 in the Wang data (*SD* = .60, *N* = 66), 1.56 in the criminal-sentencing data (*SD* = .89, *N* = 79), and 1.82 in the tuition-increase data (*SD* = .75, *N* = 90). These results suggest that once individuals have one or two attitudinally consistent thoughts (one or two positive thoughts or one or two negative thoughts), they are more likely to have thoughts that are attitudinally inconsistent with previous thoughts.

Table 1.1

Position Movement for the First Half of the Message-Receipt Phase of the Trajectory in Figure 3 (McGreevy, 1996)

Local Movement	Position at stay	Time for Stay (s)	Position after move	Belief Change	Speed (points/s)
1st Move	50.00	10.35	49.00	-1.00	13.89
2nd Move	49.00	3.41	46.30	-2.70	1.66
3rd Move	46.30	4.61	43.70	-2.60	1.36
4th Move	43.70	9.20	39.30	-4.40	2.42
5th Move	39.30	12.12	37.20	-2.10	1.89
6th Move	37.20	8.67	33.80	-3.40	1.30
7th Move	33.80	19.15	30.70	-3.10	1.54

Table 1.2

Position Movement for the Second Half of the Message-Receipt Phase of the Trajectory in Figure 3 (McGreevy, 1996)

Local Movement	Position at stay	Time for Stay (s)	Position after move	Belief Change	Speed (points/s)
1st Move	30.70	13.56	49.00	18.30	2.04
2nd Move	49.00	6.41	51.80	2.80	1.36
3rd Move	51.80	6.12	58.80	7.00	1.62
4th Move	58.80	1.01	60.70	1.90	0.60
5th Move	60.70	1.08	65.20	4.50	1.14
6th Move	65.20	3.62	67.50	2.30	0.93
7th Move	67.50	3.29	N/A	N/A	N/A

Table 1.3

Belief Changes in Fink and Kaplowitz and Their Colleagues' Studies[a]

		Issue					
		Criminal Sentencing	Tuition	College Admission (Wang Experiment 2)		College Admission (McGreevy)[b]	
Type of decision		Continuous	Continuous	Dichotomous		Dichotomous	
				Easy (Different candidate)	Difficult (Similar candidate)	Easy (No individuation)	Difficult (Individuation)
Sample size		99	91	31	36	50-51	47-51
Percentage changing direction at least once		72.7	59.3	77.4	97.2	64.7	76.5
Number of changes of direction	Adjusted geometric mean[c]	1.33	0.91	1.66	5.04	0.89	1.60
	25th percentile	0	0	1	3	0	1
	Median	1	1	2	5.5	1	2
	75th percentile	2	2	3	9	3	4
	Maximum[d]	7	11	14	14	12	18

[a] This table is part of Table 2.1 of Fink, Kaplowitz, and Hubbard (2002, p. 23).

[b] For McGreevy, the results reported in the table are only form the post-message phase.

[c] Let log(x + c) be the transformation used to create a functional form whose skew was approximately zero, where x is the variables of interest and c is a constant. Adjusted geometric mean = (antilog of the mean of transformed variable) – c. If c were zero, the adjusted geometric mean would equal the geometric mean.

[d] For this variable, the minimum was zero in all experiment.

Table 2.1

R-*square and Adjusted* R-*square Statistics for the Number of Movements by Candidate Similarity and Distraction, with Different Parameters of the Minimum Stay Length and the Maximum Position Difference, McGreevy Data*

Minimum Stay Length (s)	Maximum Difference	*R*-square	Adjusted *R*-square
Message-receipt phase			
1	1	0.08	0.03
	2	0.08	0.04
2	1	0.03	-0.01
	2	0.04	0.05
Post-message phase			
1	1	0.14	0.10
	2	0.11	0.07
2	1	0.18	0.14
	2	0.14	0.10

Note. N = 78. The dependent variable was transformed with $\log(x+5)$, where x is the target variable.

Table 2.2

Regression Analysis for Initial Belief Change by Individual Message Discrepancy and Source Credibility, with Different Values of the Maximum Belief Change, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Maximum Belief Change	*N*	R^2	Adj. R^2	*B*				
				C	*D*	*C* x *D*	D^2	*C* x D^2
.3 year	89	.13	.08	2.17	.16**	.17	-.005	-.008
1 year	86	.16	.11	3.17*	.15 **	.13	-.01^	-.01
2 year	85	.17	.12	3.33	.13*	.14	-.01*	-.01
2.3 year	83	.22	.17	4.27**	.16**	.21^	-.01^	-.005
2.5 year	81	.23	.18	4.3*	.17**	.24*	-.009^	-.004
2.7 year	81	.23	.18	4.41**	.18**	.23^	-.01^	-.005
3 year	79	.22	.17	4.74**	.17**	.21^	-.008	-.003
3.5 year	78	.24	.18	4.85**	.18**	.22^	-.007	-.003
4 year	76	.23	.17	4.28*	.17**	.25*	-.006	-.002
5 year	.69	.24	.18	3.95*	.17**	.26*	-.005	-.001

Note. In the regression analysis, initial belief change was regressed on linear and quadratic individual message discrepancy, *D* and D^2, source credibility, *C*, the interaction between the linear individual message discrepancy and source credibility, *C* x *D*, and the interaction between the quadratic individual message discrepancy and source credibility, *C* x D^2.

^$p < .10$. *$p \leq .05$. **$p < .01$.

Table 2.3

Statistics in the ANOVA for Initial Belief Change by Source Credibility and Message Discrepancy, with Different Values of the Maximum Belief Change, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Maximum Belief Change	*N*	R^2	Adj. R^2	*F*		
				C	*D*	*C* x *D*
.3 %	93	.09	.03	2.35	2.45^	.16
1%	92	.04	-.02	.32	1.45	.11
2%	91	.08	.02	.12	1.21	2.24
2.3%	91	.10	.04	.38	1.65	2.75^
2.5%	91	.10	.05	.68	1.67	2.97^
2.7%	91	.11	.06	.83	1.60	3.37*
3%	90	.14	.08	1.46	1.78	4.40*
4%	90	.13	.08	2.77	1.24	4.01*
5%	83	.10	.04	3.00	2.24	.81

Note. In the ANOVA, initial belief change was explained by source credibility, *C*, message discrepancy, *D*, and the interaction between source credibility and message discrepancy, *C* x *D*.

^$p < .10$. *$p \leq .05$.

Table 3.1

Data Sets for Hypotheses

	Hypothesis	Data Set
H1.1	Sequence of information and sequence of local movements during the message-receipt phase	McGreevy (1996)
H1.2.	Message type and the ratio of the number of positive local movements to the number of negative local movements during the message-receipt phase	McGreevy (1996)
H1.3	Weights of information in the message and belief trajectories	McGreevy (1996)
H2.1.1	The oscillatory pattern for local movements	McGreevy (1996) Wang (1993) Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H2.1.2	The damping pattern for local movements	McGreevy (1996) Wang (1993) Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H2.2	The damping pattern for macro local movements	McGreevy (1996) Wang (1993)

		Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H3.1.1	Message type and the number of local movements	McGreevy (1996)
H3.1.2	Message type and the total number of local movements	McGreevy (1996) Wang (1993)
H3.1.3	Mediating role of the number of local movements between message type and the final decision	McGreevy (1996) Wang (1993)
H3.2.1	Cognitive responses and the number of local movements	Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H3.2.2	Effects of cognitive responses and local movements on beliefs	Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H4.1.1	Message discrepancy and local movements	Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H4.1.2.	Message discrepancy and initial belief change	Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H4.1.3	Message discrepancy and final belief change	Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H4.1.4	Change of effect of message discrepancy on beliefs	Fink et al. (2002): Criminal Fink et al. (2002): Tuition

H4.2.1	Source credibility and the ratio of local movements	Fink et al. (2002): Criminal and Fink et al. (2002): Tuition
H4.2.2	Source credibility and initial belief change	Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H4.2.3	Source credibility and final belief change	Fink et al. (2002): Criminal and Fink et al. (2002): Tuition
H4.2.4	The moderating role of source credibility on the effect of message discrepancy on final beliefs	Fink et al. (2002): Criminal Fink et al. (2002): Tuition
H4.2.5	Change of effect of source credibility on beliefs	Fink et al. (2002): Criminal

Table 3.2

Belief Change from the Initial Position by Ordinal Time of Local Movements, Candidate Similarity, and Distraction in the Message-Receipt Phase, McGreevy Data

Ordinal Time	Candidate Similarity	Distraction	Mean	Standard Deviation	*n*
The first local movement	Similar	Distraction	-9.72	18.63	15
		No Distraction	-11.57	18.48	14
	Different	Distraction	-6.03	8.1	19
		No Distraction	-0.81	14.4	14
1st quartile-local movement	Similar	Distraction	-27.11	13.63	15
		No Distraction	-22.15	18.65	14
	Different	Distraction	-10.45	16.47	19
		No Distraction	-2.5	24.4	14
Mid-point local movement	Similar	Distraction	-17.62	25.92	15
		No Distraction	-20.85	16.75	14
	Different	Distraction	-0.64	21.61	19
		No Distraction	1.7	19.01	14
3rd quartile-point local movement	Similar	Distraction	5.96	19.84	15
		No Distraction	-0.54	20.86	14
	Different	Distraction	25.8	13.3	19
		No Distraction	14.86	26.78	14
Final movement	Similar	Distraction	7.09	25.86	15
		No Distraction	11.06	24.71	14

Different	Distraction	28.42	12.34	19
	No Distraction	19.35	35.46	14

Note. *N* = 62. Only cases that have at least 5 movements were used.

Table 3.3

Repeated-Measures Analysis of Variance for Belief Change from the Initial Position by Ordinal Time of Local Movements, Candidate Similarity, and Distraction in the Message-Receipt Phase, McGreevy Data

	df	*F*	Partial η^2	Observed Power
		Between participants		
Candidate Similarity (S)	1	23.21**	.29	1.00
Distraction (D)	1	.05	< .01	.06
S x D	1	< .01	< .01	.05
Between-group error	58	(791.34)		
		Within participants		
Time(T) (Linear)	1	58.96**	.50	1.00
T (Quadratic)	1	31.25**	.35	1.00
T (Cubic)	1	26.85**	.32	1.00
T (Quartic)	1	3.39^	.06	.44
Error	58	(568.32)		
T(Linear) x S	1	.57	.01	.12
T (Quadratic) x S	1	4.40*	.07	.54
T (Cubic) x S	1	.54	.01	.11
T (Quartic) x S	1	.01	< .01	.05
Error	58	(241.77)		
T(Linear) x D	1	1.50	.03	.23

T (Quadratic) x D	1	.01	< .01	.05
T (Cubic) x D	1	4.87*	.08	.58
T (Quartic) x D	1	.03	< .01	.05
Error	58	(213.32)		
T(Linear) x S x D	1	1.53	.03	.23
T (Quadratic) x S x D	1	.53	.01	.11
T (Cubic) x S x D	1	.05	< .01	.06
T (Quartic) x S x D	1	.25	< .01	.08
Error	58	(239.43)		

Note. $N = 62$. Time factor consists of five variables: Position after the first movement, 1st quartile-point position, mid-point position, 3rd quartile-point position and final position. The parenthesized values represent mean square error. . Observed power was computed using alpha = .05.

^$p < .10$. *$p \leq .05$. **$p < .01$.

Table 3.4

Effects of Ordinal Time of Local Movements for the Similar-Candidate and the Different -Candidate Conditions in the Message-Receipt Phase, McGreevy Data

Time	*df*	*F*	Partial η^2	Observed Power
		Similar candidate		
Linear	1	19.97**	.42	.99
Quadratic	1	32.95**	.54	1.00
Cubic	1	13.62**	.33	.95
Quartic	1	1.78	.06	.25
Error (Linear)	28	(647.59)		
Error (Quadratic)	28	(204.53)		
Error (Cubic)	28	(267.67)		
Error (Quartic)	28	(196.97)		
		Different candidate		
Linear	1	45.83**	.59	1.00
Quadratic	1	6.40*	.17	.69
Cubic	1	14.07**	.31	.95
Quartic	1	2.00	.06	.28
Error (Linear)	32	(520.20)		
Error (Quadratic)	32	(263.25)		
Error (Cubic)	32	(184.99)		
Error (Quartic)	32	(263.78)		

Note. *N* = 62. The time factor consists of five variables: Position after the first movement, 1st quartile-point position, mid-point position, 3rd quartile-point position and final position. The parenthesized values represent mean square error. . Observed power was computed using alpha = .05.

$^{*}p \leq .05$. $^{**}p < .01$.

Table 3.5

Positivity of Movements by Candidate Similarity and Distraction in the Message-Receipt Phase, McGreevy Data

Candidate Similarity	Distraction	Mean	Standard Deviation	*n*
Similar	Distraction	-.07	.71	20
	No Distraction	.03	.55	21
Different	Distraction	.44	.55	21
	No Distraction	.45	.69	16

Note. N = 78. Positivity of movements is computed as $\log(p+1)-\log(q+1)$, where p is the number of positive movements and q is the number of negative movements.

Table 3.6

Analysis of Variance for Positivity of Movements by Candidate Similarity and Distraction in the Message-Receipt Phase, McGreevy Data

Source	*df*	*F*	Partial η^2	Observed Power
Similarity (S)	1	10.71**	.13	.90
Distraction (D)	1	.14	< .01	.07
S x D	1	.11	< .01	.06
Within-group error	74	(.39)		

Note. N = 78. Values enclosed in parentheses represent mean square error. Observed power was computed using alpha = .05. The model's R^2 = 0.13 (Adjusted R^2 = 0.09).

**p < .01.

Table 3.7

Importance Level for Hobbies and Personality Characteristics of Those Individuals Thought to be Successful in College (McGreevy, 1996, Pilot Data 1C)

Hobby/Personality Characteristic	Mean	*SD*
Candidate 1 in the similar-candidate condition		
Intelligent (Impressive academic record and SAT) [2]	8.75	1.07
Debate Team [4]	7.57	1.43
Student government [6]	7.71	1.38
Captain of a sports team [8]	7.05	1.32
Hardworking [10]	9.05	0.92
Determined [10]	8.48	1.33
Volunteers [12] [15]	7.24	1.14
Disciplined [16]	8.38	1.24
Average Mean	8.03	
Candidate 2 in the similar-candidate condition		
Intelligent [2]	8.75	1.07
Captain of a sports team [4]	7.05	1.32
Debate Team [4]	7.57	1.43
Student government [6]	7.71	1.38
Volunteers [10][11]	7.24	1.14
Confident [14]	8.19	1.03
Motivated [14]	8.86	0.85

Responsible [14]	8.90	1.22
Disciplined [16]	8.38	1.24
Average Mean	8.07	
Candidate 1 in the different-candidate condition		
Average GPA and SAT [2]		
Skis [4]	5.19	1.08
Snow boards [4]	4.90	1.18
Skateboards [5]	4.90	1.34
Tennis [7]	5.48	0.98
Mountain bikes [7]	5.71	0.90
Shy [8]	4.33	1.24
Is artistic [8]	5.57	1.08
Plays electric guitar [9]	5.33	0.97
Plays acoustic guitars [9]	5.48	0.98
Rock band [10]	4.14	1.35
Three part-time jobs [12]	4.57	1.69
Average Mean	5.05	

N = 21. The data were from Table 3 and Table 4 in McGreevy (1996).

Table 3.8

Belief Change by Time Period of Local Movements, Candidate Similarity, and Distraction in the Message-Receipt Phase, McGreevy Data

Ordinal Time	Candidate Similarity	Distraction	Mean	Standard Deviation	*n*
Belief change by the first half of local movements	Similar	Distraction	-17.60	23.17	19
		No Distraction	-19.13	15.77	16
		Total	-18.30	19.86	35
	Different	Distraction	-3.44	21.01	20
		No Distraction	4.88	22.07	15
		Total	.12	21.55	35
	Total	Distraction	-10.34	22.94	39
		No Distraction	-7.51	22.37	31
		Total	-9.09	22.57	70
Belief change by the second half of local movements	Similar	Distraction	26.95	19.95	19
		No Distraction	29.23	25.46	16
		Total	27.99	22.31	35
	Different	Distraction	33.32	23.49	20
		No Distraction	13.52	41.52	15
		Total	24.83	33.42	35
	Total	Distraction	30.21	21.79	39
		No Distraction	21.63	34.53	31
		Total	26.41	28.25	70

Table 3.9

MANOVA for Belief Change by Time Period, Candidate Similarity, and Distraction in the Message-Receipt Phase, McGreevy Data

Source	*df*	*F*	Partial η^2	Observed Power
	Belief change by the first half of local movements			
Candidate similarity, C	1	14.50**	.18	.96
Distraction, D	1	.46	.01	.10
C x D	1	1.70	.03	.25
Between-group error	66	(433.26)		
	Belief change by the second half of local movements			
Candidate similarity, C	1	.48	.01	.11
Distraction, D	1	1.70	.03	.25
C x D	1	.97	.01	.16
Between-group error	66	(780.34)		

**$p < .01$.

Table 3.10

Regression Analysis for the Amount of Belief Change by a Micro Movement on the Amount of Belief Change by the Previous Micro Movement in the Post-Message Phase, McGreevy Data

Independent Variable	*N*	*B*	*SE B*	β	R^2 (Adjusted R^2)
		2nd micro movement			
1st micro movement	54	-.18	.15	-.17	.03 (.01)
		3rd micro movement			
2nd micro movement	43	-.27	.23	-.18	.03 (.01)
		4th micro movement			
3rd micro movement	40	-.42	.24	-.27	.07 (.05)
		5th micro movement			
4th micro movement	32	-.03	.23	.03	.001 (-.03)
		6th micro movement			
5th micro movement	27	-.96**	.19	-.72	.51 (.49)
		7th micro movement			
6th micro movement	26	-.12	.16	-.24	.06 (.002)

**$p < .01$.

Table 3.11

Regression Analysis for the Amount of Belief Change by a Micro Movement on the Amount of Belief Change by the Previous Micro Movement, Wang Data

Independent Variable	*N*	*B*	*SE B*	β	R^2 (Adjusted R^2)
		2nd micro movement			
1st micro movement	44	-1.03**	.16	-.70	.49 (.47)
		3rd micro movement			
2nd micro movement	36	-.70**	.15	-.63	.39 (.38)
		4th micro movement			
3rd micro movement	28	-.73**	.10	-.82	.68 (.66)
		5th micro movement			
4th micro movement	22	-.50**	.13	-.65	.42 (.38)

$^{**}p < .01$.

Table 3.12

Regression Analysis for the Amount of Belief Change by a Micro Movement on the Amount of Belief Change by the Previous Micro Movement, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Independent Variable	*N*	*B*	*SE B*	β	R^2 (Adjusted R^2)
		2nd micro movement			
1st micro movement	48	-.12^	.07	-.24	.06 (-.04)
		3rd micro movement			
2nd micro movement	33	.22	.17	.22	.05(.02)

^$p < .10$. **$p < .01$.

Table 3.13

Regression Analysis for the Amount of Belief Change by a Micro Movement on the Amount of Belief Change by the Previous Micro Movement, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Independent Variable	*N*	*B*	*SE B*	β	R^2 (Adjusted R^2)
		2nd micro movement			
1st micro movement	65	-.51**	.08	-.62	.38 (.37)
		3rd micro movement			
2nd micro movement	29	-.37^	.19	-.35	.12 (.09)

^$p < .10$. **$p < .01$.

Table 3.14

Absolute Amount of Belief Change from the Previous Movement, by the Last Two Movements, Candidate Similarity, and Distraction in the Post-Message Phase, McGreevy Data

Variable	Candidate Similarity	Distraction	Mean	Standard Deviation	*n*
Belief change by the movement before the final movement	Similar	Distraction	19.02	17.06	16
		No Distraction	15.70	26.76	18
		Total	17.26	22.45	34
	Different	Distraction	8.42	12.18	12
		No Distraction	10.79	10.96	8
		Total	9.37	11.47	20
	Total	Distraction	14.48	15.84	28
		No Distraction	14.19	22.93	26
		Total	14.34	19.38	54
Belief change by the final movement	Similar	Distraction	41.80	21.31	16
		No Distraction	37.58	32.92	18
		Total	39.57	27.74	34
	Different	Distraction	27.42	29.65	12
		No Distraction	26.09	21.12	8
		Total	26.89	25.96	20
	Total	Distraction	35.64	25.75	28
		No Distraction	34.05	29.86	26

	Total	34.87	27.55	54

Table 3.15

Repeated-Measures Analysis of Variance for the Absolute Amount of Belief Change from the Previous Belief, by the Last Two Movements, Candidate Similarity, and Distraction in the Post-Message Phase, McGreevy Data

	df	*F*	Partial η^2	Observed Power
		Between participants		
Candidate Similarity (S)	1	3.32^	.06	.43
Distraction (D)	1	.16	.00	.07
S x D	1	.14	.00	.07
Between-group error	50	(834.22)		
		Within participants		
Movement (M)	1	37.12**	.43	1.00
M x S	1	.51	.01	.11
M x D	1	.08	.00	.06
M x S x D	1	.04	.00	.05
Error (M)	50	(306.61)		

Note. $N = 54$. Movement consists of the movement before the final movement and the final movement. The parenthesized values represent mean square error. Observed power was computed using alpha = .05.

^$p < .10$. *$p \leq .05$. **$p < .01$.

Table 3.16

Absolute Amount of Belief Change from the Previous Belief, by the Last Two Movements, Individuation, and Distraction, Wang Data

Variable	Individuation	Distraction	Mean	Standard Deviation	*n*
Belief change by the movement before the final movement	Individuation	Distraction	29.81	30.88	16
		No Distraction	19.58	18.83	13
		Total	25.22	26.26	29
	No individuation	Distraction	28.71	29.83	9
		No Distraction	26.56	25.41	6
		Total	27.85	27.21	15
	Total	Distraction	29.41	29.89	25
		No Distraction	21.78	20.66	19
		Total	26.12	26.30	44
Belief change by the final movement	Individuation	Distraction	38.50	35.48	16
		No Distraction	29.80	36.85	13
		Total	34.60	35.71	29
	No individuation	Distraction	11.94	17.10	9
		No Distraction	37.89	37.30	6
		Total	22.32	28.93	15
	Total	Distraction	28.94	32.45	25
		No Distraction	32.35	36.15	19
		Total	30.41	33.73	44

Table 3.17

Repeated-Measures Analysis of Variance for the Absolute Amount of Belief Change from the Previous Belief, by the Last Two Movements, Individuation, and Distraction, Wang Data

	df	*F*	Partial η^2	Observed Power
		Between participants		
Individuation (I)	1	.415	.010	.096
Distraction (D)	1	.101	.003	.061
I x D	1	1.887	.045	.268
Between-group error	40	(1160.13)		
		Within participants		
Movement (M)	1	.60	.01	.12
M x I	1	1.52	.04	.22
M x D	1	.87	.02	.15
M x I x D	1	1.25	.03	.19
Error (M)	40	(674.29)		

Note. N = 44. Movement consists of the movement before the final movement and the final movement. The parenthesized values represent mean square error. Observed power was computed using alpha = .05.

^$p < .10$. *$p \leq .05$. **$p < .01$.

Table 3.18

Absolute Amount of Belief Change from the Previous Belief, by the Last Two Movements, Source Credibility, and Individual Message Discrepancy, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	Source Credibility	Individual Message Discrepancy	Mean	Standard Deviation	*n*
Belief change by the movement before the final movement	Low	Small	4.17	3.06	6
		Moderate	3.10	.54	6
		Extreme	3.54	3.51	8
		Total	3.60	2.69	20
	High	Small	3.84	2.77	8
		Moderate	5.05	4.18	11
		Extreme	5.19	6.12	9
		Total	4.75	4.46	28
	Total	Small	3.98	2.78	14
		Moderate	4.36	3.46	17
		Extreme	4.41	4.98	17
		Total	4.27	3.83	48
Belief change by the final movement	Low	Small	2.25	1.06	6
		Moderate	1.92	.99	6
		Extreme	1.88	1.09	8
		Total	2.00	1.01	20
	High	Small	3.51	2.30	8

		Moderate	2.92	3.55	11
		Extreme	2.79	2.21	9
		Total	3.05	2.76	28
	Total	Small	2.97	1.93	14
		Moderate	2.57	2.91	17
		Extreme	2.36	1.78	17
		Total	2.61	2.25	48

Table 3.19

Repeated-Measures Analysis of Variance for the Absolute Amount of Belief Change from the Previous Belief, by the Last Two Movements, Source Credibility, and Individual Message Discrepancy, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

	df	*F*	Partial η^2	Observed Power
		Between participants		
Source credibility (C)	1	112.43	.73	.36
Discrepancy (linear, D)	1	2.68	.06	.05
Discrepancy (Quadratic, D^2)	1	.00	< .01	.05
C x D	1	.01	< .01	.08
C x D^2	1	.25	.01	.07
Between-group error	42	(9.90)		
		Within participants		
Movement (M)	1	5.46*	.12	.63
M x C	1	.00	< .01	.05
M x D	1	.37	.01	.09
M x D^2	1	.03	< .01	.05
M x C x D	1	.46	.01	.10
M x C x D^2	1	.22	.01	.07
Error (M)	42	(11.14)		

Note. $N = 48$. Movement consists of the movement before the final movement and the final movement. The parenthesized values represent mean square error. Observed power was computed using alpha = .05.

*$p \leq .05$. **$p < .01$.

Table 3.20

Absolute Amount of Belief Change from the Previous Belief, by the Last Two Movements, Candidate Similarity, and Distraction, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	Source Credibility	Individual Message Discrepancy	Mean	Standard Deviation	*n*
Belief change by the movement before the final movement	Low	9 %	3.77	1.53	13
		15 %	6.11	3.45	8
		30 %	7.80	4.14	11
		Total	5.74	3.50	32
	High	9 %	6.36	2.58	8
		15 %	6.64	3.83	13
		30 %	6.99	2.43	12
		Total	6.70	3.01	33
	Total	9 %	4.76	2.32	21
		15 %	6.43	3.61	21
		30 %	7.38	3.30	23
		Total	6.23	3.27	65
Belief change by the final movement	Low	9 %	6.39	2.22	13
		15 %	6.52	2.50	8
		30 %	8.94	2.87	11
		Total	7.30	2.73	32

	High	9 %	8.08	2.24	8
		15 %	9.11	2.54	13
		30 %	8.68	3.11	12
		Total	8.71	2.64	33
	Total	9 %	7.03	2.33	21
		15 %	8.13	2.78	21
		30 %	8.80	2.93	23
		Total	8.01	2.76	65

Table 3.21

Repeated-Measures Analysis of Variance for the Absolute Amount of Belief Change from the Previous Belief by the Last Two Movements, Source Credibility, and Individual Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

	df	*F*	Partial η^2	Observed Power
			Between participants	
Source credibility (C)	1	2.50	.04	.34
Discrepancy (linear, D)	1	6.82*	.10	.73
Discrepancy (Quadratic, D^2)	1	.00	.00	.05
C x D	1	2.75	.04	.37
C x D^2	1	.28	.00	.08
Between-group error	59	(13.85)		
			Within participants	
Movement (M)	1	33.22**	.36	1.00
M x C	1	.96	.02	.16
M x D	1	1.40	.02	.21
M x D^2	1	.11	< .01	.06
M x C x D	1	1.02	.02	.17
M x C x D^2	1	3.19^	.05	.42
Error (M)	59	(2.65)		

Note. $N = 65$. Movement consists of the movement before the final movement and the final movement. The parenthesized values represent mean square error. Observed power was computed using alpha = .05.

*$p \leq .05$. **$p < .01$.

Table 3.22

Regression Analysis for the Amount of Belief Change by a Macro Movement on the Amount of Belief Change by the Previous Macro Movement in the Post-Message Phase, McGreevy Data

Independent Variable	*N*	*B*	*SE B*	β	R^2 (Adjusted R^2)
		2nd macro movement			
1st macro movement	41	-.93**	.20	-.59	.35 (.33)
		3rd macro movement			
2nd macro movement	25	-.99**	.20	-.72	.52 (.50)

**p < .01.

Table 3.23

Regression Analysis for the Amount of Belief Change by a Macro Movement on the Amount of Belief Change by the Previous Macro Movement, Wang Data

Independent Variable	*N*	*B*	*SE B*	β	R^2 (Adjusted R^2)
		2nd macro movement			
1st macro movement	40	-1.54**	.14	-.88	.77 (.77)
		3rd macro movement			
2nd macro movement	31	-.71**	.10	-.80	.65 (.63)
		4th macro movement			
3rd macro movement	23	-.77**	.09	-.89	.78 (.78)

$^{**}p < .01$.

Table 3.24

Regression Analysis for the Amount of Belief Change by a Macro Movement on the Amount of Belief Change by the Previous Macro Movement, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Independent Variable	*N*	*B*	*SE B*	β	R^2 (Adjusted R^2)
		2nd macro movement			
1st macro movement	35	-.33**	.09	-.48	.23 (.21)

**$p < .01$.

Table 3.25

Regression Analysis for the Amount of Belief Change by a Macro Movement on the Amount of Belief Change by the Previous Macro Movement, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Independent Variable	*N*	*B*	*SE B*	β	R^2 (Adjusted R^2)
		2nd macro movement			
1st macro movement	18	-.16	.18	-.22	.05 (-.01)

Table 3.26

Positivity of Movements, by Candidate Similarity and Distraction in the Post-Message Phase, McGreevy Data

Candidate Similarity	Distraction	Mean	Standard Deviation	*n*
Similar	Distraction	-.18	.75	20
	No Distraction	.07	.62	21
Different	Distraction	.49	.59	21
	No Distraction	.09	.77	16

Note. $N = 78$.

Table 3.27

Analysis of Variance for Positivity of Movements, by Candidate Similarity and Distraction in the Post-Message Phase, McGreevy Data

Source	*df*	*F*	Partial η^2	Observed Power
Similarity (S)	1	4.88*	.13	.59
Distraction (D)	1	.26	< .01	.08
S x D	1	4.45*	.06	.55
Within-group error	74	(.46)		

Note. N = 78. Parenthesized value represents mean square error. Observed power was computed using alpha = .05. The model's R^2 = 0.12 (Adjusted R^2 = 0.09).

$*p \leq .05$.

Table 3.28

Positivity of Movements by Individuation and Distraction, Wang Data

Individuation	Distraction	Mean	Standard Deviation	*n*
Individuation	Distraction	-.30	.38	20
	No Distraction	-.25	.44	17
Stereotype	Distraction	.45	.60	15
	No Distraction	.65	.29	14

Note. N = 66.

Table 3.29

Analysis of Variance for Positivity of Movements by Individuation and Distraction, Wang Data

	df	*F*	Partial η^2	Observed Power
Individuation (I)	1	56.97**	.48	1.00
Distraction (D)	1	1.38	.02	.21
I x D	1	.49	.01	.11
Within-group error	62	(.19)		

Note. N = 66. Parenthesized value represents mean square error. Observed power was computed using alpha = .05. The model's R^2 = 0.49 (Adjusted R^2 = 0.46).

**p < .01.

Table 3.30

Total Number of Local Movements by Phases, Candidate Similarity, and Distraction, McGreevy Data

Phase	Candidate Similarity	Distraction	Mean	Standard Deviation	*n*
Message receipt phase	Similar	Distraction	2.70	.50	20
		No Distraction	2.49	.57	21
	Different	Distraction	2.67	.36	21
		No Distraction	2.74	.41	16
Post-message phase	Similar	Distraction	2.28	.44	20
		No Distraction	2.46	.41	21
	Different	Distraction	2.04	.35	21
		No Distraction	2.03	.40	16

Note. *N* = 78.

Table 3.31

Repeated-Measures Analysis of Variance for the Total Number of Micro Local Movements by Phases, Candidate Similarity, and Distraction, McGreevy Data

	df	*F*	Partial η^2	Observed Power
		Between participants		
Candidate Similarity (S)	1	2.17	.03	.31
Distraction (D)	1	< .01	< .01	.05
S x D	1	.09	< .01	.06
Between-group error	74	(.23)		
		Within participants		
Phase (P)	1	50.71**	.41	1.00
P x S	1	12.49**	.14	.94
P x D	1	1.43	.02	.22
P x S x D	1	3.38	.04	.44
Error (Phase)	74	(.16)		

N = 78.

Table 3.32

Final Decision by Candidate Similarity, McGreevy Data

		Preferred Candidate		
		Candidate 1	Candidate 2	Neutral
Candidate Similarity	Similar	16	23	2
	Different	7	29	1
Total		23	52	3

Note. N = 78. $\chi^2(2) = 4.36$, *ns*. Without neutral cases, N = 75, $\chi^2(1) = 4.01$, $p \leq .05$.

Table 3.33

Logistic Regression Analysis for Final Decision by Candidate Similarity, the Number of Positive Movements and the Number of Negative Movements in the Post-Message Phase, McGreevy Data

Variable	*B*	*SE B*	Exp (*B*)
Step 1			
Constant	.70	.76	.50
Candidate similarity	1.06*	.53	2.88
Step 2			
Constant	-.17	1.23	.84
Candidate similarity	.72	.64	2.06
The number of positive movements	1.16**	.45	3.19
The number of negative movements	-1.18**	.36	.31

Note. N = 78. –2 Log likelihood = 88.27, Cox-Snell R^2 = 0.05, and Nagelkerke R^2 = .08 for Step 1; –2 Log likelihood = 74.00, Cox-Snell R^2 = .22, and Nagelkerke R^2 = .31 for Step 2.

*$p \leq .05$. **$p < .01$.

Table 3.34

Final Decision by Individuation, Wang Data

		Preferred Candidate		
		Black	White	Neutral
Individuation	Individuation	33	4	0
	Stereotype	2	26	1
Total		35	30	1

N = 66. χ^2 (1) = 44.27, p < .01.

Table 3.35

Logistic Regression Analysis for Final Decision by Individuation, the Number of Positive Movements, and the Number of Negative Movements, Wang Data

Variable	*B*	*SE B*	Exp (*B*)
Step 1			
Constant	-.10	.44	.91
Individuation	2.33 **	.45	10.31
Step 2			
Constant	-.13	1.40	.88
Individuation	1.73**	.54	5.64
The number of positive movements	3.30*	1.47	27.09
The number of negative movements	-3.42*	1.55	.03

Note. N = 66. –2 Log likelihood = 39.76, Cox-Snell R^2 = 0.54, and Nagelkerke R^2 = .72 for Step 1; –2 Log likelihood = 31.56, Cox-Snell R^2 = 0.59, and Nagelkerke R^2 = .79 for Step 2.

*$p \leq .05$. **$p < .01$.

Table 3.36

Regression Analysis for Final Belief Change by the Number of Positive Movements and the Number of Negative Movements, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*B*	*SE B*	β
	Predicted by numbers of movements		
The number of positive movements	8.24**	1.53	.53
The number of negative movements	-1.71	1.46	-.12
	Predicted by numbers of thoughts		
The number of positive thoughts about severe sentencing	2.23^	1.71	.14
The number of negative thoughts about severe sentencing	-1.90	1.75	-.12

Note. $N = 93$. The first model's $R^2 = 0.25$ (Adjusted $R^2 = 0.23$); the second model's $R^2 = 0.05$ (Adjusted $R^2 = 0.03$). Independent variables were transformed to the same power (see Appendix C).

^$p < .10$, one-tailed. **$p < .01$, one-tailed.

Table 3.37

Covariance among Variables in the Structural Equation Model to Test H3.2.2, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

	Final belief change	The number of positive thoughts about severe sentencing	The number of negative thoughts about severe sentencing
Final belief change	59.95		
The number of positive thoughts about severe sentencing	.71	.25	
The number of negative thoughts about severe sentencing	-.63	-.083	.24

Note. *N* =93. All variables except final belief change were transformed to the same power (see Appendix C).

Table 3.38

Structural Equation Modeling Analysis for Final Belief Change by the Number of Positive Movements and the Number of Negative Movements, Constrained Model, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Exogenous variable	Coefficient	*SE* of coefficient	Standardized coefficient
The number of positive thoughts about severe sentencing	2.87*	1.48	.18
The number of negative thoughts about severe sentencing	-.60*	0.31	-.04

Note. *N* = 93. The endogenous variable is final belief change. χ^2 = .58, *df* = 1, *ns*. Root mean square error of approximation < .01; normed fit index = .96; comparative fit index = 1.00.

**p* ≤ .05, one-tailed.

Table 3.39

Regression Analysis for Final Belief Change by the Number of Positive Movements and the Number of Negative Movements, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*B*	*SE B*	β
	Predicted by numbers of movements		
The number of positive movements	6.47**	.67	.72
The number of negative movements	-1.13^	.73	-.12
	Predicted by numbers of thoughts		
The number of positive thoughts about tuition increase	2.00*	.92	.24
The number of negative thoughts about tuition increase	-.70	.73	-.11

Note. $N = 97$. The first model's $R^2 = 0.50$ (Adjusted $R^2 = 0.49$); the second model's $R^2 = 0.10$ (Adjusted $R^2 = 0.08$). Independent variables were transformed to the same power (see Appendix C).

^$p < .10$, one-tailed. *$p \leq .05$, one-tailed. **$p < .01$, one-tailed.

Table 3.40

Covariances among Variables in the Structural Equation Model to Test H3.2.2, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

	Final belief change	The number of positive thoughts about severe sentencing	The number of negative thoughts about severe sentencing
Final belief change	11.99		
The number of positive thoughts about severe sentencing	.43	.18	
The number of negative thoughts about severe sentencing	.41	-.11	.28

Note. *N* = 97. All variables except final belief change were transformed by taking its square root.

Table 3.41

Structural Equation Modeling Analysis for Final Belief Change by the Number of Positive Movements and the Number of Negative Movements, Constrained Model, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Exogenous variable	Coefficient	*SE* of coefficient	Standardized coefficient
The number of positive thoughts about tuition increase	2.24**	.72	.27
The number of negative thoughts about tuition increase	-.39**	.13	-.05

Note. N = 97. The endogenous variable is final belief change. χ^2 = .18, df = 1, *ns*. Root mean square error of approximation < .01; normed fit index = .99; comparative fit index = 1.00.

**p* < .01, one-tailed.

Table 3.42

Regression Analysis for Positivity of Movements on Individual Message Discrepancy and Source Credibility, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*B*	*SE B*	β
Constant	.36	.05	
Source Credibility (C)	-.02	.12	-.02
Individual Message Discrepancy (Linear, D)	.004	.004	.089
C x D	.01	.01	.12

Note. N = 93. The model's R^2 = .01 (Adjusted R^2 = -.03). Positivity of movements is computed as $\log(p+1)-\log(q+1)$, where p is the number of positive movements and q is the number of negative movements. All exogenous variables are mean corrected. The interaction term was created as the product of mean-corrected exogenous variables.

Table 3.43

Regression Analysis for Positivity of Thoughts on Individual Message Discrepancy and Source Credibility, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*B*	*SE B*	β
Constant	.29	.08	
Source Credibility (C)	.23	.16	.14
Individual Message Discrepancy (Linear, D)	-.01*	.01	-.23
C x D	-.0004	.01	-.03

Note. N = 93. The model's R^2 = .07 (Adjusted R^2 = .04). Positivity of thoughts is computed as $\log(p+1)-\log(q+1)$, where p is the number of positive thoughts and q is the number of negative thoughts. All exogenous variables are mean corrected. The interaction term was created as the product of mean-corrected exogenous variables.

$*p \leq .05$.

Table 3.44

Positivity of Movements by Source Credibility and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source Credibility	Message Discrepancy	Mean	Standard Deviation	*n*
Low	9 %	.88	.40	18
	15 %	.47	.51	15
	30 %	.81	.50	16
	Total	.73	.49	49
High	9 %	.69	.44	15
	15 %	.98	.38	17
	30 %	.96	.47	16
	Total	.88	.44	48
Total	9 %	.79	.42	33
	15 %	.74	.51	32
	30 %	.88	.49	32
	Total	.81	.47	97

Note. N = 97. Positivity of movements is computed as $\log(p+1)-\log(q+1)$, where p is the number of positive movements and q is the number of negative movements.

Table 3.45

Analysis of Variance for Positivity of Movements by Source Credibility and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source	*df*	*F*	Partial η^2	Observed Power
Source credibility (C)	1	2.82^	.03	.38
Discrepancy (Linear, D)	1	.76	.01	.14
Discrepancy (Quadratic, D^2)	1	1.21	.01	.19
C x D	1	2.27	.02	.32
C x D^2	1	7.26**	.07	.76
Between-group error	91	(.20)		

Note. N = 97. Positivity of movements is computed as $\log(p+1)-\log(q+1)$, where p is the number of positive movements and q is the number of negative movements. The model's R^2 = 0.13 (Adjusted R^2 = 0.09). The parenthesized value represents mean square error. . Observed power was computed using alpha = .05.

^$p < .10$. **$p < .01$.

Table 3.46

Analysis of Variance for Positivity of Movements for Low and High Source Credibility, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source	*df*	*F*	Partial η^2	Observed Power
		Low source credibility		
Discrepancy (Linear, D)	1	.19	< .01	.07
Discrepancy (Quadratic, D^2)	1	6.42*	.12	.70
Between-group error	46	(.22)		
		High source credibility		
Discrepancy (Linear, D)	1	2.98^	.06	.39
Discrepancy (Quadratic, D^2)	1	1.44	.03	.22
Between-group error	45	(.18)		

Note. N = 49 for the first model and N = 48 for the second model. Positivity of movements is computed as $\log(p+1)-\log(q+1)$, where p is the number of positive movements and q is the number of negative movements. The first model's R^2 = 0.13 (Adjusted R^2 = 0.09). The second model's R^2 = 0.09 (Adjusted R^2 = 0.05). The parenthesized values represent mean square error. Observed power was computed using alpha = .05.

^$p < .10$. *$p \leq .05$.

Table 3.47

Positivity of Thoughts by Source Credibility and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source Credibility	Message Discrepancy	Mean	Standard Deviation	*n*
Low	9 %	-.27	.80	18
	15 %	-.25	1.01	15
	30 %	-.36	.62	16
	Total	-.29	.80	49
High	9 %	-.40	.78	15
	15 %	-.42	.93	17
	30 %	-.58	.84	16
	Total	-.47	.84	48
Total	9 %	-.33	.78	33
	15 %	-.34	.95	32
	30 %	-.47	.73	32
	Total	-.38	.82	97

Note. N = 97. Positivity of thoughts is computed as $\log(p+1)-\log(q+1)$, where p is the number of positive thoughts and q is the number of negative thoughts.

Table 3.48

Analysis of Variance for Positivity of Thoughts by Source Credibility and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source	*Df*	*F*	Partial η^2	Observed Power
Source credibility (C)	1	1.07	.01	.18
Discrepancy (Linear, D)	1	.45	< .01	.10
Discrepancy (Quadratic, D^2)	1	.13	< .01	.07
C x D	1	.05	< .01	.06
C x D^2	1	< .01	< .01	.05
Between-group error	91	(.70)		

Note. N = 97. Positivity of thoughts is computed as $\log(p+1)-\log(q+1)$, where p is the number of positive thoughts and q is the number of negative thoughts. The model's R^2 = 0.02 (Adjusted R^2 = -0.04). The parenthesized value represents the mean square error. Observed power was computed using alpha = .05.

Table 3.49

Correlation Matrix of Exogenous Variables in H4.1.2, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

	Source Credibility (C)	Message Discrepancy (Linear, D)	C x D	Message Discrepancy (Quadratic, D^2)	C x D^2
C	1.00				
D	-.02	1.00			
C x D	-.01	-.12	1.00		
D^2	-.16	.24*	-.12	1.00	
C x D^2	.04	-.12	-.23*	-.08	1.00

Note. N = 81. Quadratic and interaction terms were created with mean-corrected exogenous variables.

*$p \leq .05$.

Table 3.50

Regression Analysis for Initial Belief Change by Individual Message Discrepancy and Source Credibility, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*B*	*SE B*	β
Constant	7.19**	.83	
Source Credibility (C)	4.41*	1.66	.27
Message Discrepancy (Linear, D)	.18**	.06	.32
C x D	.22^	.12	.20
Message Discrepancy (Quadratic, D^2)	-.01^	.01	-.19
C x D^2	.00	.01	-.05

Note. N = 81. The model's R^2 = .23 (Adjusted R^2 = .18). All exogenous variables are mean corrected.

^p < .10. *$p \leq$ .05. **p < .01.

Table 3.51

Regression Analysis for Initial Belief Change by Individual Message Discrepancy for Low and High Source Credibility, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*B*	*SE B*	β
	Low source credibility		
Constant	5.03	.53	
Message Discrepancy (Linear, D)	.07^	.04	.30
Message Discrepancy (Quadratic, D^2)	-.01*	.003	-.35
	High source credibility		
Constant	9.44	1.58	
Message Discrepancy (Linear, D)	.29*	.12	.38
Message Discrepancy (Quadratic, D^2)	-.01	.01	-.18

Note. n = 41 for the low source credibility condition; n = 40 for the high source credibility condition. The first model's R^2 = .14 (Adjusted R^2 = .10) and the second model's R^2 = .16 (Adjusted R^2 = .11).

^$p < .10$. *$p \leq .05$.

Table 3.52

Initial Belief Change by Source Credibility and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source Credibility	Message Discrepancy	Mean	Standard Deviation	*n*
Low	9 %	3.54	.91	18
	15 %	6.64	4.13	12
	30 %	5.29	3.61	15
	Total	4.95	3.22	45
High	9 %	5.00	2.03	14
	15 %	4.35	1.57	16
	30 %	4.21	1.82	15
	Total	4.50	1.80	45
Total	9 %	4.18	1.65	32
	15 %	5.33	3.11	28
	30 %	4.75	2.86	30
	Total	4.73	2.60	90

Table 3.53

Analysis of Variance for Initial Belief Change by Source Credibility and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

	df	*F*	Partial η^2	Observed Power
Source credibility (C)	1	1.46	.02	.22
Discrepancy (Linear, D)	1	.58	.01	.12
Discrepancy (Quadratic, D^2)	1	2.94^	.03	.40
C x D	1	4.00	.05	.51
C x D^2	1	4.68*	.05	.57
Between-group error	84	(6.20)		

Note. $N = 90$. The model's $R^2 = 0.14$ (Adjusted $R^2 = 0.08$). The parenthesized value represents the mean square error. Observed power was computed using alpha = .05. ^$p < .10$. *$p \leq .05$.

Table 3.54

Analysis of Variance for Initial Belief Change and Message Discrepancy for Low and High Source Credibility, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

	df	*F*	Partial η^2	Observed Power
		Low source credibility		
Discrepancy (Linear, D)	1	2.75^	.06	.37
Discrepancy (Quadratic, D^2)	1	4.73*	.10	.57
Between-group error	42	(9.14)		
		High source credibility		
Discrepancy (Linear, D)	1	1.38	.03	.21
Discrepancy (Quadratic, D^2)	1	.21	< .01	.07
Between-group error	42	(3.26)		

Note. N = 45 for the first model and N = 45 for the second model. The first model's R^2 = 0.16 (Adjusted R^2 = 0.12). The second model's R^2 = 0.04 (Adjusted R^2 = 0.01). The parenthesized values represent the mean square error. Observed power was computed using alpha = .05.

^$p < .10$. *$p \leq .05$.

Table 3.55

Regression Analysis for Final Belief Change by Individual Message Discrepancy and Source Credibility, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*B*	*SE B*	β
Constant	7.95**	.76	
Source Credibility (C)	4.31**	1.52	.28
Message Discrepancy (Linear, D)	.20**	.05	.37
C x D	.29**	.11	.27
Message Discrepancy (Quadratic, D^2)	-.01^	.005	-.18
C x D^2	.01	.01	.08

Note. $N = 81$. The model's $R^2 = 0.30$ (Adjusted $R^2 = 0.26$). The quadratic term is mean corrected after squaring mean-corrected individual message discrepancy.

^$p < .10$. **$p < .01$.

Table 3.56

Regression Analysis for Final Belief Change by Individual Message Discrepancy for Low and High Source Credibility, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*B*	*SE B*	β
	Low source credibility		
Constant	5.84**	.66	
Message Discrepancy (Linear, D)	.06	.04	.20
Message Discrepancy (Quadratic, D^2)	-.01**	.004	-.47
	High source credibility		
Constant	10.14**	1.37	
Message Discrepancy (Linear, D)	.35**	.10	.50
Message Discrepancy (Quadratic, D^2)	.00	.01	-.07

Note. N = 81. The fist model's R^2 = 0.20 (Adjusted R^2 = 0.15) and the second model's R^2 = 0.24 (Adjusted R^2 = 0.20). The quadratic term is mean corrected after squaring mean-corrected individual message discrepancy.

**p < .01.

Table 3.57

Final Belief Change by Source Credibility and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source Credibility	Message Discrepancy	Mean	Standard Deviation	*n*
Low	9 %	5.59	2.32	18
	15 %	6.39	3.25	12
	30 %	7.77	3.24	15
	Total	6.53	2.99	45
High	9 %	6.64	2.75	14
	15 %	8.38	2.89	16
	30 %	8.02	3.25	15
	Total	7.72	3.00	45
Total	9 %	6.05	2.53	32
	15 %	7.53	3.16	28
	30 %	7.90	3.19	30
	Total	7.13	3.04	90

Table 3.58

Analysis of Variance for Final Belief Change by Source Credibility and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

	df	*F*	Partial η^2	Observed Power
Source credibility (C)	1	3.10^	.04	.41
Discrepancy (Linear, D)	1	5.65*	.06	.65
Discrepancy (Quadratic, D^2)	1	.31	.00	.09
C x D	1	.28	.00	.08
C x D^2	1	1.00	.01	.17
Between-group error	84	(8.64)		

Note. N = 90. The model's R^2 = 0.12 (Adjusted R^2 = 0.06). The parenthesized value represents the mean square error. Observed power was computed using alpha = .05.

^p < .10. *$p \leq$ .05.

Table 3.59

Initial and Final Belief Change by Source Credibility and Individual Message Discrepancy, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Time	Source Credibility	Message Discrepancy	Mean	Standard Deviation	*n*
Initial Belief Change	Low	Small	3.97	3.02	15
		Moderate	5.40	4.80	11
		Extreme	5.20	2.91	15
		Total	4.80	3.51	41
	High	Small	4.28	5.02	13
		Moderate	10.56	7.41	15
		Extreme	14.04	15.51	12
		Total	9.56	10.55	40
	Total	Small	4.11	3.99	28
		Moderate	8.38	6.84	26
		Extreme	9.13	11.24	27
		Total	7.15	8.13	81
Final Belief Change	Low	Small	4.92	4.88	15
		Moderate	6.82	5.69	11
		Extreme	4.95	3.03	15
		Total	5.44	4.51	41
	High	Small	5.28	6.26	13
		Moderate	9.09	6.86	15

	Extreme	16.58	12.38	12
	Total	10.10	9.66	40
Total	Small	5.09	5.46	28
	Moderate	8.13	6.37	26
	Extreme	10.12	10.22	27
	Total	7.74	7.82	81

Note. For individual message discrepancy, the grouped individual message discrepancy was used.

Table 3.60

Repeated-Measures Analysis of Variance for the Amount of Belief Change by Movement, Source Credibility, and Individual Message Discrepancy, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

	df	*F*	Partial η^2	Observed Power
		Between participants		
Source credibility (C)	1	12.87**	.15	.94
Discrepancy (Linear, D)	1	5.96**	.07	.67
Discrepancy (Quadratic, D^2)	1	3.63*	.05	.47
C x D	1	.03^	.00	.05
C x D^2	1	8.52	.10	.82
Between-group error	75	(87.82)		
		Within participants		
Movement (M)	1	.05	< .01	.06
M x C	1	.01	< .01	.05
M x D	1	.33	< .01	.09
M x D^2	1	.75	.01	.14
M x C x D	1	.09	< .01	.06
M x C x D^2	1	3.29^	.04	.43
Error (M)	75	(11.86)		

Note. $N = 81$. Movement consists of the first movement and the final movement. The parenthesized values represent mean square error. Observed power was computed using alpha = .05.

^$p < .10$. *$p \leq .05$. **$p < .01$.

Table 3.61

Repeated-Measures Analysis of Variance for the Amount of Belief Change by Movement, Source Credibility, and Message Discrepancy, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source	*df*	*F*	Partial η^2	Observed Power
		Between participants		
Source credibility (C)	1	.23	<.01	.08
Discrepancy (Linear, D)	1	3.81	.04	.49
Discrepancy (Quadratic, D^2)	1	1.69	.02	.25
C x D	1	2.07	.02	.30
C x D^2	1	.29	<.01	.08
Between-group error	84	(10.35)		
		Within participants		
Movement (M)	1	51.99**	.38	1.00
M x C	1	7.45*	.08	.77
M x D	1	2.89^	.03	.39
M x D^2	1	.77	.01	.14
M x C x D	1	1.30	.02	.20
M x C x D^2	1	7.71*	.08	.78
Error (M)	84	(4.49)		

Note. $N = 90$. Movement consists of the first movement and the final movement. The parenthesized values represent mean square error. The parenthesized values represent mean square error. Observed power was computed using alpha = .05.

^$p < .10$. *$p \leq .05$. **$p < .01$.

Table 3.62

Repeated-Measures Analysis of Variance for the Amount of Belief Change by Movement and Message Discrepancy for Low and High Source Credibility, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Source	*df*	*F*	Partial η^2	Observed Power
Low source credibility				
		Between participants		
Discrepancy (Linear, D)	1	5.00*	.11	.59
Discrepancy (Quadratic, D^2)	1	1.28	.03	.20
Between-group error	42	(12.65)		
		Within participants		
Movement (M)	1	9.05**	.18	.84
M x D	1	.15	< .01	.07
M x D^2	1	5.63*	.12	.64
Error (M)	42	(4.92)		
High source credibility				
		Between participants		
Discrepancy (Linear, D)	1	.16	< .01	.07
Discrepancy (Quadratic, D^2)	1	.41	.01	.10
Between-group error	42	(8.05)		
		Within participants		
Movement (M)	1	55.33**	.57	1.00
M x D	1	4.21*	.09	.52

M x D^2	1	2.17	.05	.30
Error (M)	42	(4.06)		

Note. *N* = 90. Movement consists of the first movement and the final movement. The parenthesized values represent mean square error. Observed power was computed using alpha = .05.

^$p < .10$. *$p \leq .05$. **$p < .01$.

Table 3.63

Summary of Results of Hypothesis Testing

	Hypothesis	Data Set	Results
H1.1	For a sequential mixed-valence messages, a *U*-shaped or inverted *U*-shaped pattern of local movements (or a series of such patterns) occurs; for a univalent message, a unidirectional (monotonic) pattern of local movement occurs.	McGreevy (1996)	Supported.
H1.2.	During the message-receipt phase, the ratio of the number of positive local movements to the number of negative local movements in belief trajectories is greater for positively univalent messages than for mixed-valence messages.	McGreevy (1996)	Supported.
H1.3	Belief trajectories in the message-receipt phase will	McGreevy (1996)	Supported.

	reflect the weights of the pieces of information in the message.		
H2.1.1	During judgment, a local movement is more likely to be followed by a local movement whose direction is opposite to the direction of the preceding one.	McGreevy (1996)	Not supported.
		Wang (1993)	Supported.
		Fink et al. (2002): Criminal	Not supported.
		Fink et al. (2002): Tuition	Supported.
H2.1.2	During judgment, the absolute amount of belief change by a local movement is smaller than the absolute amount of belief change of the proceeding local movement.	McGreevy (1996)	Not supported.
		Wang (1993)	Not supported
		Fink et al. (2002): Criminal	Supported.
		Fink et al. (2002): Tuition	Not supported (opposite pattern found).

H2.2	During judgment, the amount of belief change of a macro local movement will be smaller than the amount of belief change of the proceeding macro of local movement.	McGreevy (1996)	Not supported.
		Wang (1993)	Partially supported (supported in two cases out of three).
		Fink et al. (2002): Criminal	Supported.
		Fink et al. (2002): Tuition	Not supported.
H3.1.1	During the post-message phase, the ratio of the number of positive local movements to the number of negative local movements is greater for positively univalent messages than for mixed-valence messages.	McGreevy (1996)	Supported.
		Wang (1993)	Supported.

H3.1.2	During the post-message phase, the number of local movements is greater for mixed-valence messages than for univalent messages.	McGreevy (1996)	Supported.
H3.1.3	The effect of message type (univalent versus mixed-valence) on the final decision is mediated by the number of positive and the number of negative local movements.	McGreevy (1996)	Supported.
		Wang (1993)	Partially supported.
H3.2.1	There will be a positive relationship between the number of positive local movements and the number of positive thoughts, and between the number of negative local movements and the	Fink et al. (2002): Criminal	Partially supported (only for positive thoughts and positive movements).

	number of negative thoughts.	Fink et al. (2002): Tuition	Not supported.
H3.2.2	The ratio of the effect of the number of positive thoughts on beliefs to the effect of the number of negative thoughts on beliefs will be the same as the ratio of the effect of the number of positive local movements on beliefs to the effect of the number of negative local movements on beliefs.	Fink et al. (2002): Criminal	Supported.
		Fink et al. (2002): Tuition	Supported.
H4.1.1	Assuming the message discrepancy is positive, as message discrepancy increases, the ratio of the number of positive local movements to the number of negative local movements will decrease.	Fink et al. (2002): Criminal	Not supported.
		Fink et al. (2002): Tuition	Partially supported (The pattern was found in the low source credibility condition).

H4.1.2.	The greater the message discrepancy, the greater the belief change of the first micro local movement.	Fink et al. (2002): Criminal	Partially supported (linear increase pattern in the high source credibility condition; nonmonotonic pattern in the low source credibility condition).
		Fink et al. (2002): Tuition	Not supported (no significant effect of message discrepancy in the high source credibility condition; nonmonotonic pattern in the low source credibility condition).

H4.1.3	As message discrepancy increases, the amount of final belief change will increase up to a certain point and then decrease.	Fink et al. (2002): Criminal	Partially supported (the pattern was found in the low source credibility condition).
		Fink et al. (2002): Tuition	Not supported (linear increase pattern was found).
H4.1.4	Assuming message discrepancy is positive, the effect of message discrepancy on beliefs decreases over time during judgment in the direction advocated by the message.	Fink et al. (2002): Criminal	Partially supported (Expected pattern found in the low credibility condition).
		Fink et al. (2002): Tuition	Not supported (opposite pattern found).

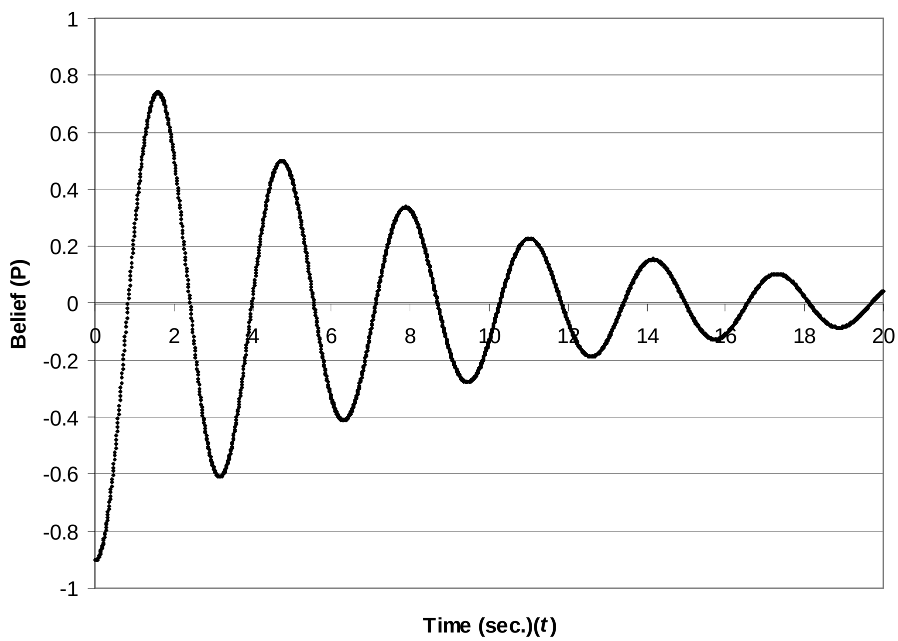
H4.2.1	Assuming that message discrepancy is positive, for less involving issues, the ratio of positive local movements to the number of negative local movements will be greater in a message from a high than a low credibility source. However, for highly involving issues, the ratio of positive local movements to the number of negative local movements will not differ between messages from a high and a low credibility source.	Fink et al. (2002): Criminal	Not supported.
		Fink et al. (2002): Tuition	Not supported (marginally significant effect of source credibility on positivity of movements).

H4.2.2	Controlling for message discrepancy, the amount of belief change by the first local movement from a message with a high credibility source will not differ from the same message from a low credibility source.	Fink et al. (2002): Criminal	Not supported (significant effect of source credibility on the amount of initial belief change; interaction effect with message discrepancy on initial belief change).
		Fink et al. (2002): Tuition	Supported (consistent with the null hypothesis).

H4.2.3	For less involving issues, the amount of final belief change will be greater for a message from a high than a low credibility source. However, for highly involving issues, there will be no difference in the amount of final belief change between messages from a high and a low credibility source.	Fink et al. (2002): Criminal	Supported.

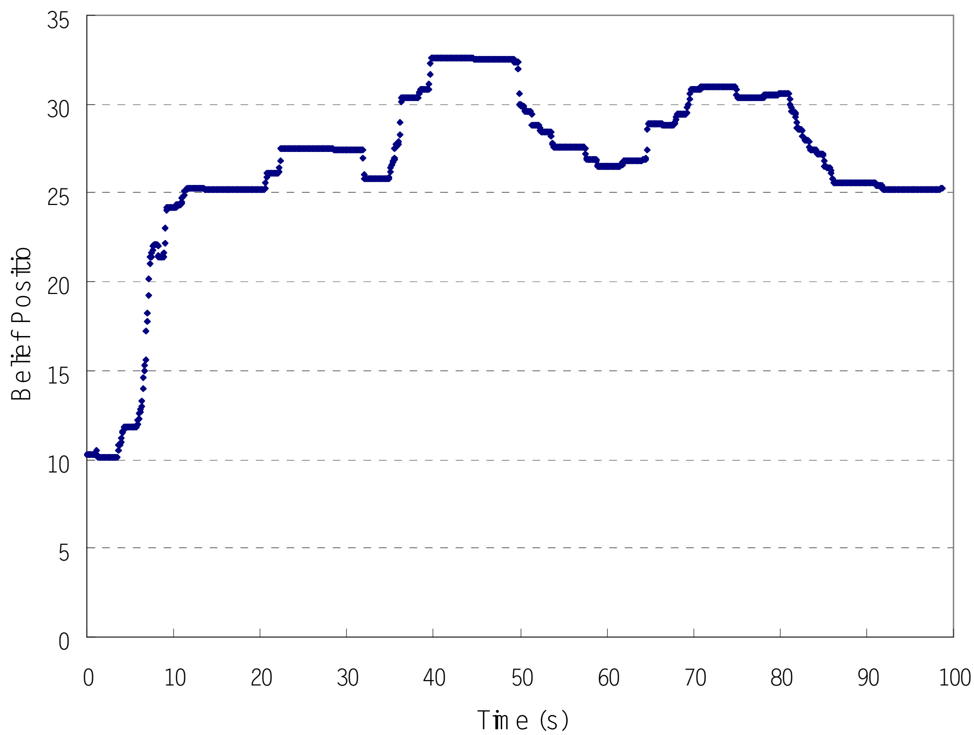
		Fink et al. (2002): Tuition	Not supported (opposite pattern was found: significant effect of source credibility on final belief change).
H4.2.4	As source credibility increases, the effect of message discrepancy on final beliefs increases.	Fink et al. (2002): Criminal	Supported.
		Fink et al. (2002): Tuition	Not supported.

H4.2.5	For less involving issues, the effect of source credibility on beliefs increases over time during judgment. However, for highly involving issues, no significant change in the effect of source credibility is expected.	Fink et al. (2002): Criminal	Not supported.
		Fink et al. (2002): Tuition	Not supported (linear effect increased).



Note. $P = e^{rt}(a_1 \sin \omega t + a_2 \cos \omega t)$; $r = -.125; a_1 = -.100; a_2 = -.900; \omega = 2.000$.

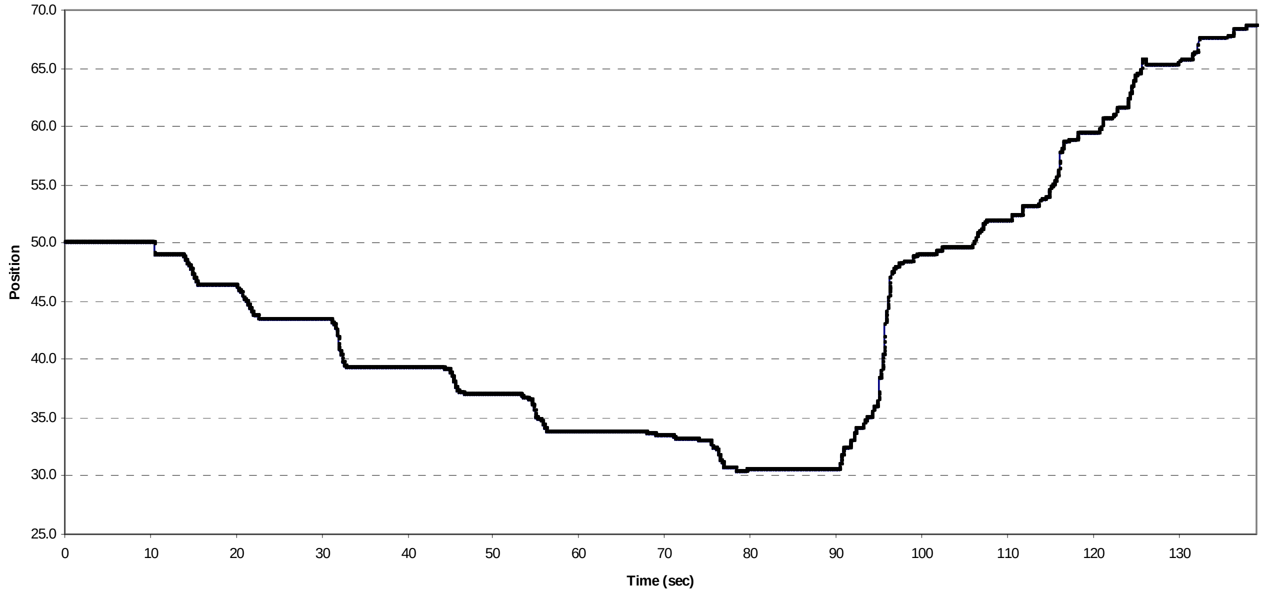
Figure 1. An example of an underdamped oscillatory trajectory of beliefs.



Note. This belief trajectory was found in the high source credibility and moderate message discrepancy condition.

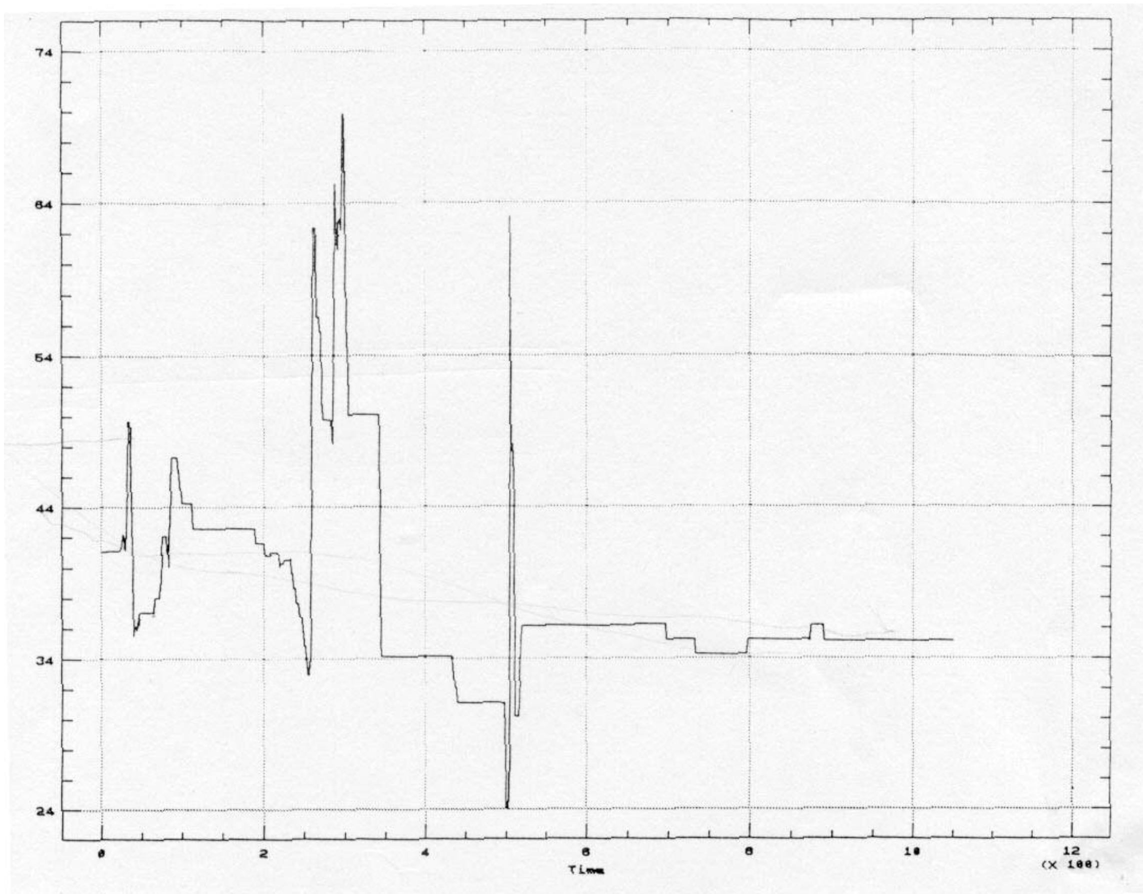
Figure 2. A belief trajectory during judgment obtained by a computer mouse technique

(Fink, Kaplowitz, & Hubbard, 2002).



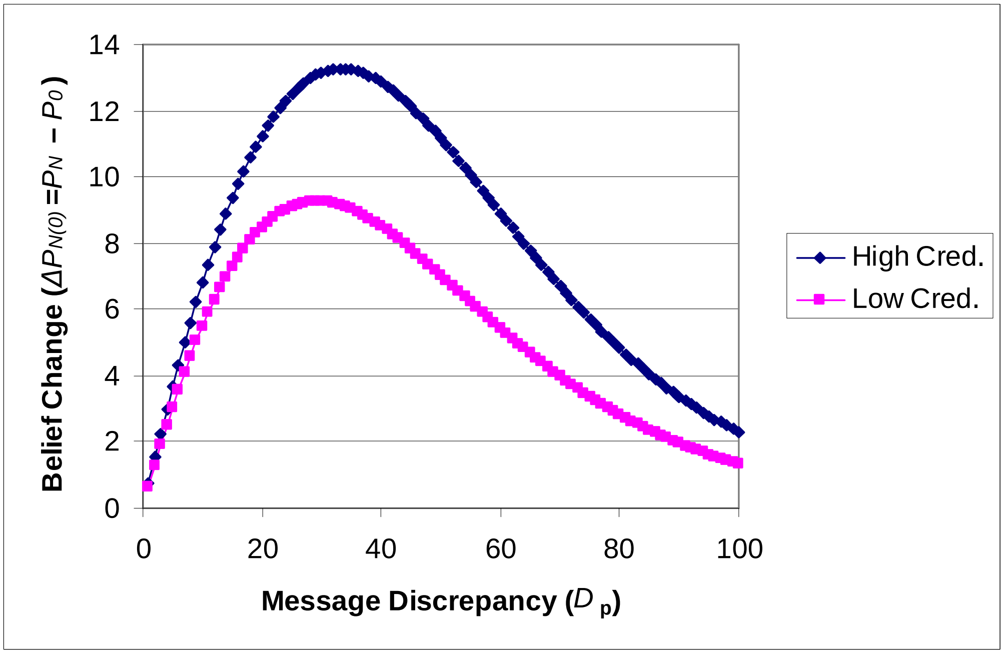
Note. Belief trajectory of Participant No. 65 (1 to 139.08 s.) in McGreevy (1996).

Figure 3. A belief trajectory during judgment in the similar candidate and no distraction condition (McGreevy, 1996).



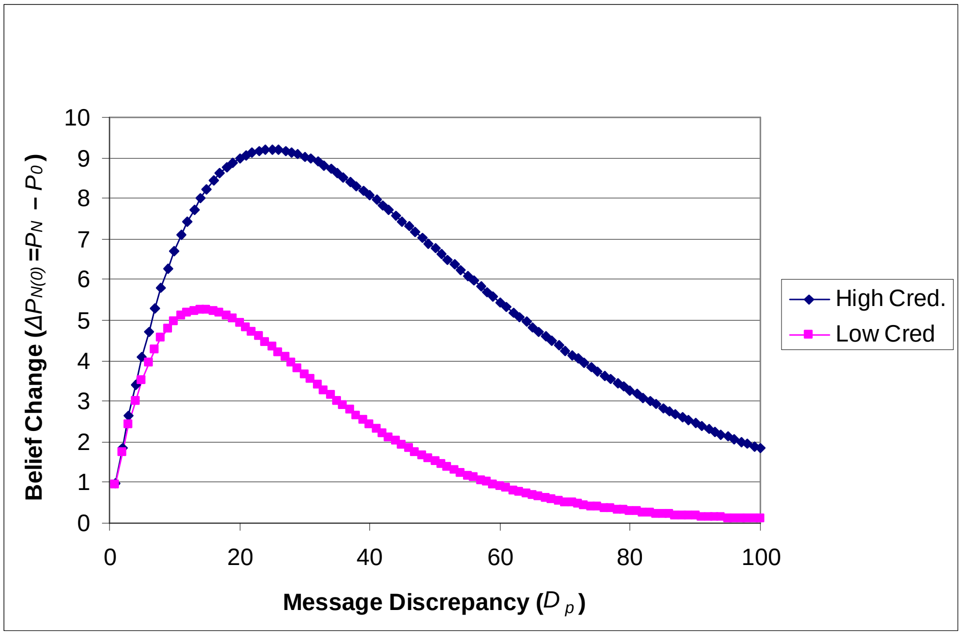
Note. *Y*-axis is attitude toward the target person (unit = pixel of the screen). *X*-axis is time (unit = 100 milliseconds).

Figure 4. Distance from target by time for subject judging positive target (Experiment 1) (from Vallacher, Nowak, & Kaufman, 1994, p. 25, reprinted).



Note. $\Delta P_{N(0)} = P_N - P_0 = \dfrac{(w_c C + w_T)e^{-kD_p}}{w_0 + (w_c C + w_T)e^{-kD_p}} D_p$; $w_0 = .2; w_c = .3; w_T = .4; C = 1$ for high credibility; $C = 0$ for low credibility.

Figure 5. Graph of Fink, Kaplowitz and Bauer’s (1983) model, parameters specified.



Note. $\Delta P_{N(0)} = P_N - P_0 = e^{-(-k_C \ln(C)+k_T)D_p} D_p ; -k_C \ln(C) + k_T > 0$; $k_c = .03; k_T = .04; C = 1$ for high credibility; $C = e^{-1}$ for low credibility.

Figure 6. Graph of Laroche's (1977) model, parameters specified.

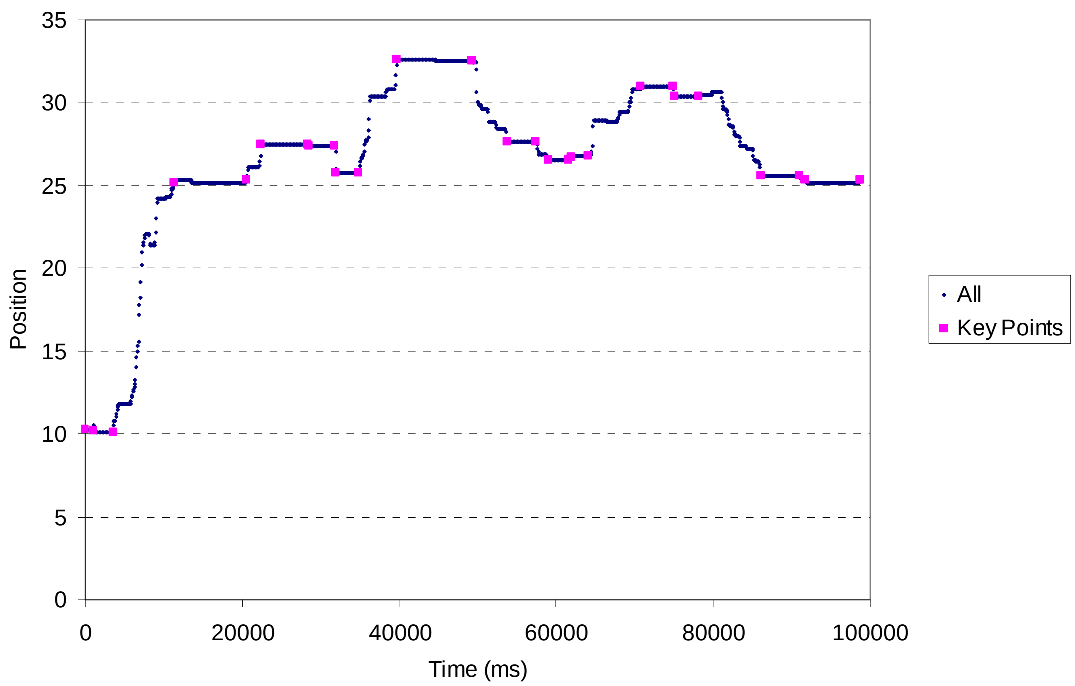
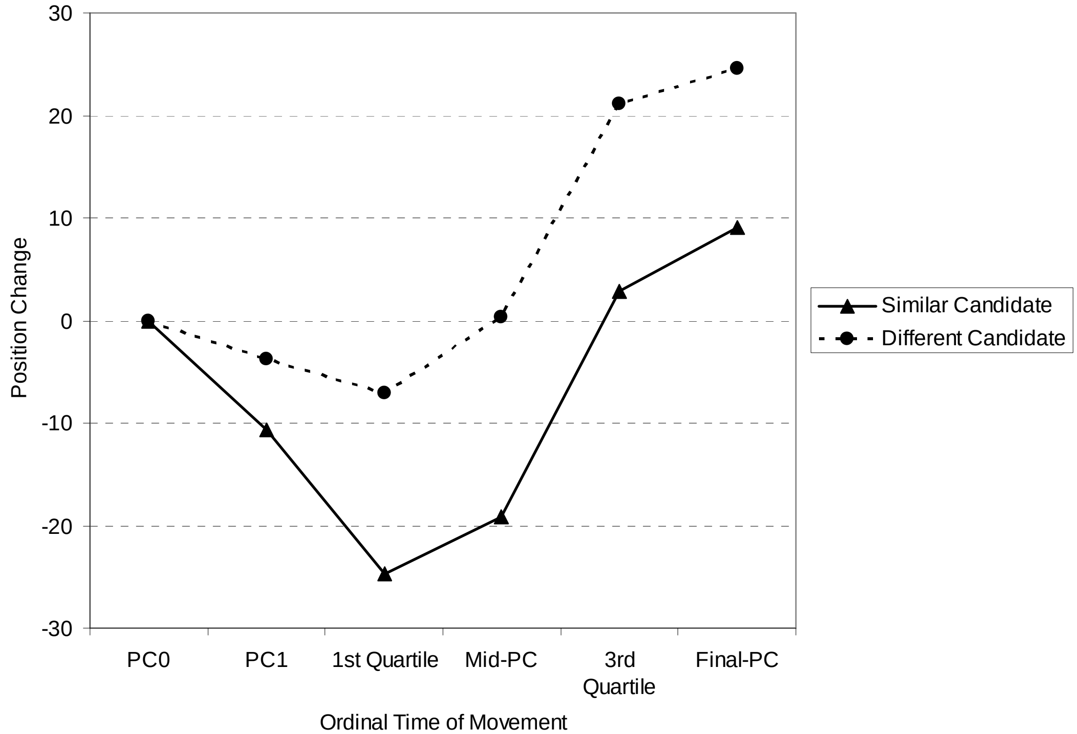


Figure 7. A belief trajectory and key points in the criminal-sentencing data (Fink, Kaplowitz, & Hubbard, 2002; minimum stay length = 2 s, maximum position difference = 0.1).



Note. N = 62. Only cases that have at least 5 movements were used. Values are averages for each condition at each time point.

Figure 8. Belief change from the initial position in 5 ordinal time points by candidate similarity in the message-receipt phase in the McGreevy data.

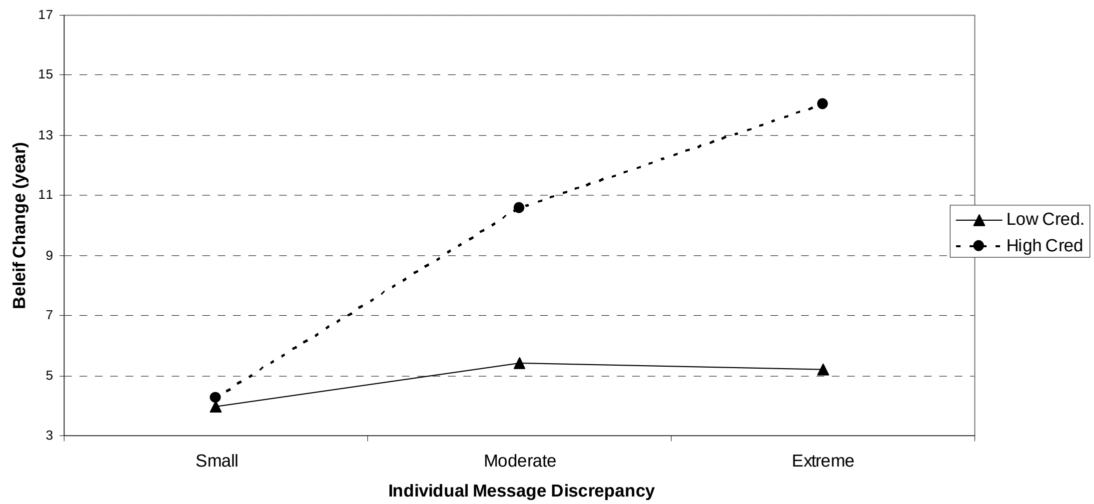


Figure 9. Initial belief change by source credibility and individual message discrepancy in the criminal-sentencing data (Fink, Kaplowitz, & Hubbard, 2002).

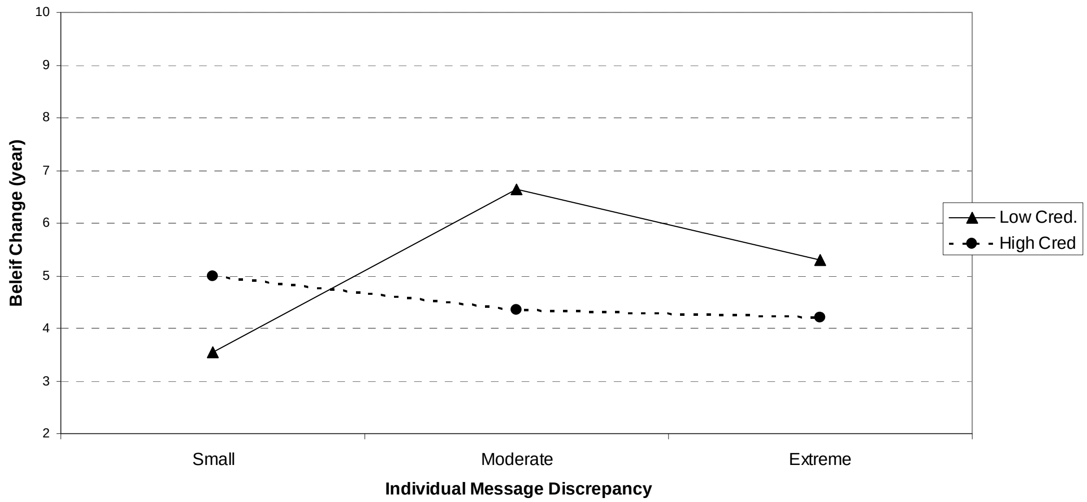


Figure 10. Initial belief change by source credibility and message discrepancy in the tuition-increase data (Fink, Kaplowitz, & Hubbard, 2002).

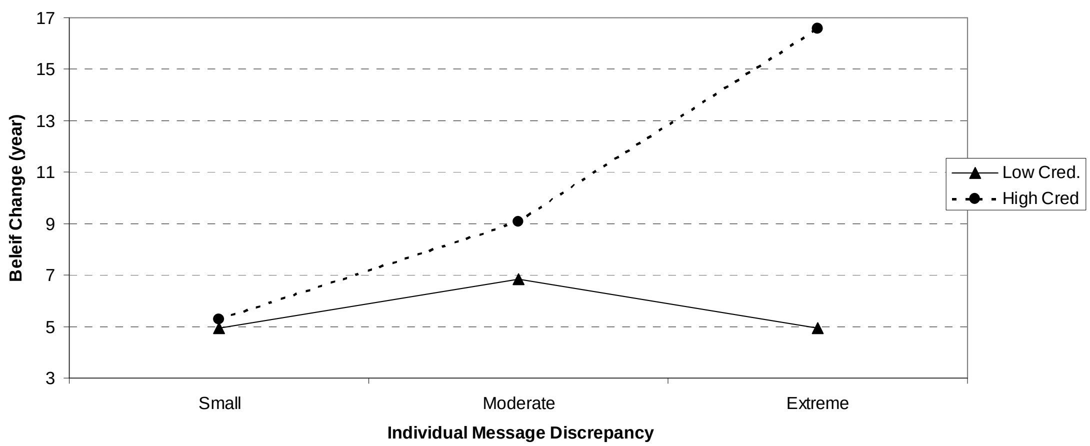


Figure 11. Final belief change by source credibility and message discrepancy in the criminal-sentencing data (Fink, Kaplowitz, & Hubbard, 2002).

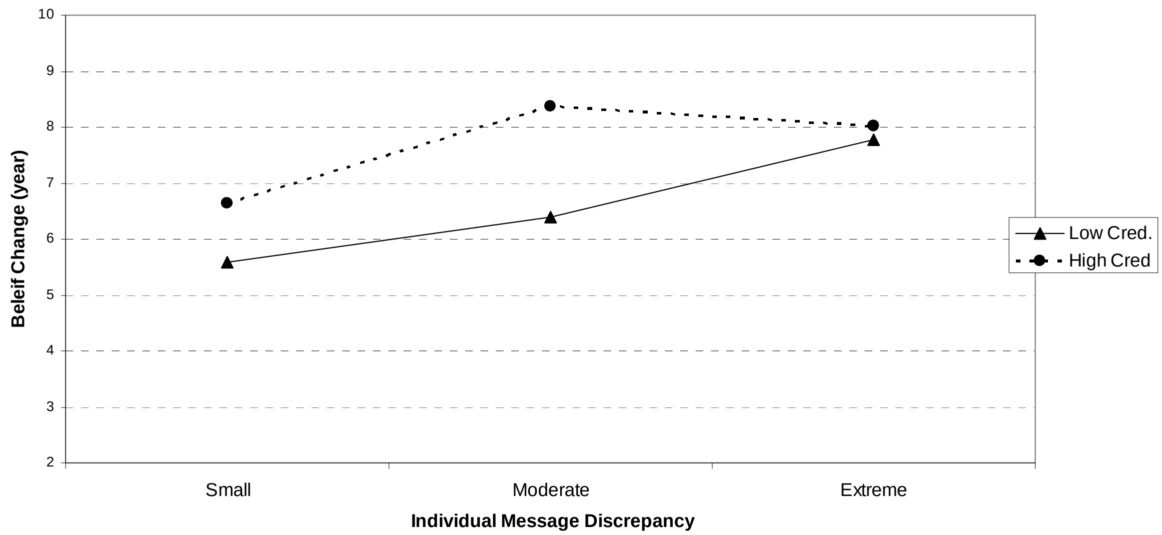
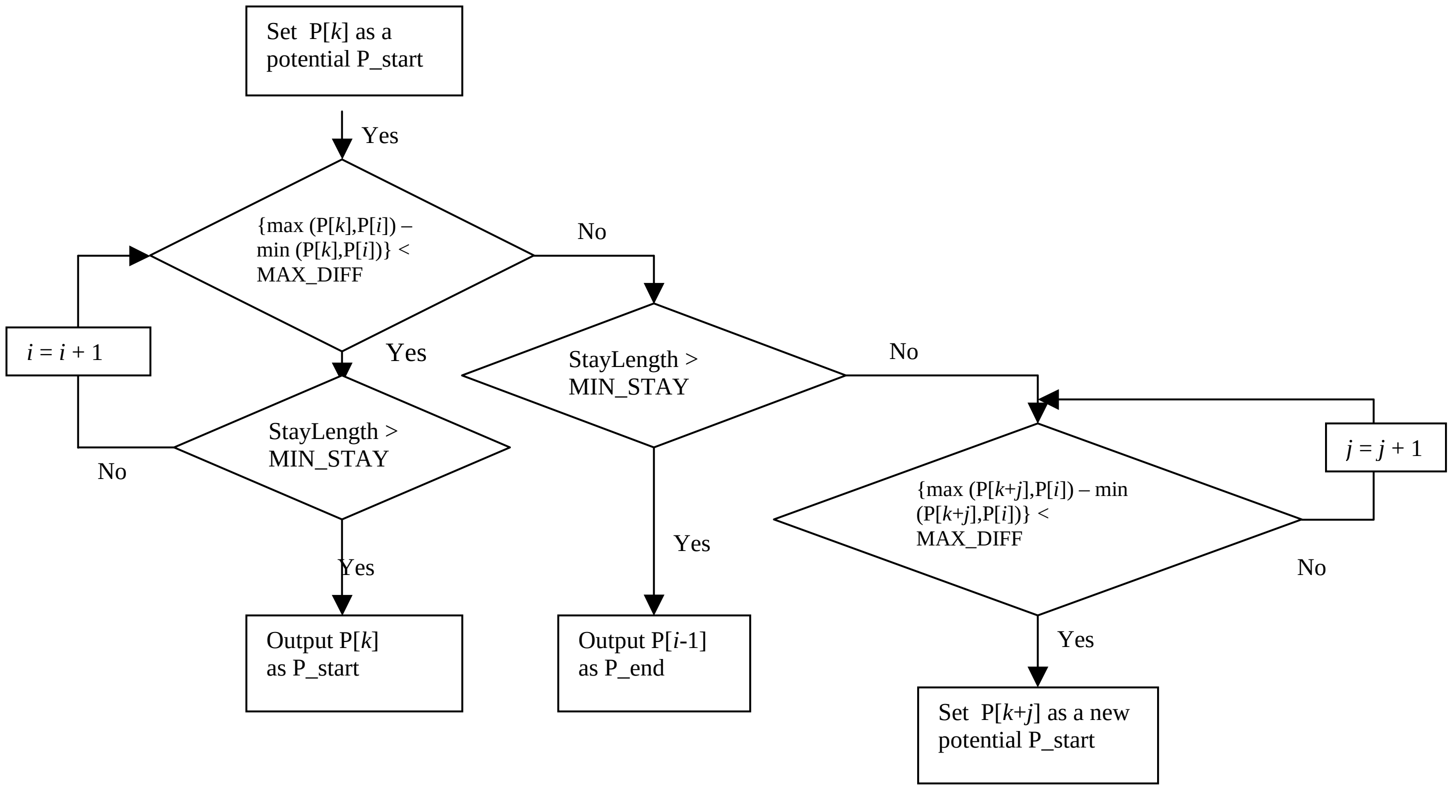


Figure 12. Final belief change by source credibility and message discrepancy in the tuition-increase data (Fink, Kaplowitz, & Hubbard, 2002).

APPENDIX A

Flow Chart for Extracting Key Points


Set P[k] as a potential P_start
Yes
{max (P[k],P[i]) – min (P[k],P[i])} < MAX_DIFF
No
i = i + 1
Yes
StayLength > MIN_STAY
No
StayLength > MIN_STAY
No
Yes
Yes
Output P[k] as P_start
Output P[i-1] as P_end
j = j + 1
{max (P[k+j],P[i]) – min (P[k+j],P[i])} < MAX_DIFF
No
Yes
Set P[k+j] as a new potential P_start

APPENDIX B

Computer Codes for Extracting Key Points

```
#include <stdio.h>
#include <stdlib.h>
#include <iostream.h>
#include <fstream.h>
#include <string.h>

int MIN_STAY = 25;
float MAX_DIFF = 1;

const int MCGREEVY = 0;
const int MCGREEVY_READ = 4;
const int MCGREEVY_THINK = 5;
const int STAN = 1;
const int WANG = 2;
const int NEW_WANG = 3;

// How to print boolean tags
bool TIME_PRINT = false;
bool PRINT_START_ONLY = false;
bool PRINT_PEAK_BOT_ONLY = false;
int FILE_TYPE = WANG;

bool firstPrinted = false;
bool isReading = true;
int phaseSep = -1;

void printUsage()
{
      cerr << "sec [-h] [-t] [-1] [-2] [-s #] [-d #] [-f <str>]
<filename>" << endl;
      cerr << "    [-h]       : help" << endl;
      cerr << "    [-t]       : print time (instead of position value)"
<< endl;
      cerr << "    [-1]       : print only starting values" << endl;
      cerr << "    [-2]       : print only peak/bottom starting values"
<< endl;
      cerr << "    [-s #]     : set minimum staylength [25]" << endl;
      cerr << "    [-d #]     : set maximum difference [1]" << endl;
      cerr << "    [-f <str>] : file format" << endl;
      cerr << "              <str>=\"m\"  --> McGreevy" << endl;
      cerr << "              <str>=\"mr\" --> Reading phase of McGreevy"
<< endl;
      cerr << "              <str>=\"mt\" --> Thinking phase of
McGreevy" << endl;
      cerr << "              <str>=\"s\"  --> Stan" << endl;
      cerr << "              <str>=\"w\"  --> Wang (DEFAULT)" << endl;
      cerr << "              <str>=\"wn\" --> Wang : new format" <<
endl;
      cerr << endl;
      cerr << "---------------------------------------------" << endl;
      cerr << "When you use \"mr\" as format, the last printed value is
"<< endl;
      cerr << "the finishing value of the reading phase. It is
printed"<< endl;
      cerr << "no matter what option you use (-1, -2)."<< endl;
      exit(0);
```

```
}

const int MAX_OUTPUT = 1024;
int nOut = 0;
float posOut[ MAX_OUTPUT ];
int tmOut[ MAX_OUTPUT ];

void store_output( float pos, int tm )
{
	posOut[ nOut ] = pos;
	tmOut[ nOut ] = tm;

	nOut++;
}

void print_output()
{
	int i, N;

	if ( !TIME_PRINT )
		cout << posOut[0] << " ";
	else
		cout << tmOut[0] << " ";

	N = nOut;
	if ( FILE_TYPE == MCGREEVY_READ )
		N = nOut-1;

	for ( i=1; i<N; i++ )
	{
		if ( PRINT_START_ONLY && (i%2==0) ) continue;

		if ( PRINT_PEAK_BOT_ONLY )
		{
			if ( i==1 ) continue;
			if ( i != N-2 )
			{
				if ( ((posOut[i]-posOut[i-2])*(posOut[i+2]-
posOut[i])) >= 0 )
					continue;
			}
		}

		if ( !TIME_PRINT )
			cout << posOut[i] << " ";
		else
			cout << tmOut[i] << " ";
	}

	if ( FILE_TYPE == MCGREEVY_READ )
	{
		if ( !TIME_PRINT )
			cout << posOut[nOut-1] << " ";
		else
			cout << tmOut[nOut-1] << " ";
	}
```

```
	cout << endl;
}

main (int argc, char* argv[])
{
	int i, j, tag;
	float ftag;
	int T_start = -1;
	float P_start = -1;
	int StayLength = 0;
	float minP, maxP, oldMinP, oldMaxP;
	FILE* fp;
	char line[1024];
	int t;				// Time - incremented by one each
line
	float P[50000];
	bool StartPrinted = false;
	char tm[32];

	for ( i=1; i<argc; i++ )
	{
		if ( strcasecmp( argv[i], "-s" ) == 0 )
			sscanf( argv[++i], "%d", &MIN_STAY );
		else if ( strcasecmp( argv[i], "-d" ) == 0 )
			sscanf( argv[++i], "%f", &MAX_DIFF );
		else if ( strcasecmp( argv[i], "-t" ) == 0 )
			TIME_PRINT = true;
		else if ( strcasecmp( argv[i], "-1" ) == 0 )
			PRINT_START_ONLY = true;
		else if ( strcasecmp( argv[i], "-2" ) == 0 )
		{
			PRINT_START_ONLY = true;
			PRINT_PEAK_BOT_ONLY = true;
		}
		else if ( strcasecmp( argv[i], "-f" ) == 0 )
		{
			i++;
			if ( strcasecmp( argv[i], "m" ) == 0 )
				FILE_TYPE = MCGREEVY;
			else if ( strcasecmp( argv[i], "mr" ) == 0 )
				FILE_TYPE = MCGREEVY_READ;
			else if ( strcasecmp( argv[i], "mt" ) == 0 )
				FILE_TYPE = MCGREEVY_THINK;
			else if ( strcasecmp( argv[i], "s" ) == 0 )
				FILE_TYPE = STAN;
			else if ( strcasecmp( argv[i], "wn" ) == 0 )
				FILE_TYPE = NEW_WANG;
			else
				FILE_TYPE = WANG;
		}
		else if ( strcasecmp( argv[i], "-h" ) == 0 )
			printUsage();
	}

	// argv[++i] should be a filename to be opened
	fp = fopen( argv[i-1], "r" );
```

```
// cout << "stay length = " << MIN_STAY << endl;
// cout << "diff = " << MAX_DIFF<< endl;
// cout << "filename = " << argv[i] << endl;
// cout << "filetype = " << FILE_TYPE << endl;
cout << argv[i-1] << " ";

// Read data line by line

t = 0;              // Initialize time
while ( fgets( line, 1024, fp ) )
{
      if ( strlen( line ) <= 1 ) break;

      switch ( FILE_TYPE )
      {
      case MCGREEVY :
      case MCGREEVY_READ :
      case MCGREEVY_THINK :
            sscanf( &line[11], "%f%d", &P[t], &tag );
            break;
      case STAN :
            sscanf( line, "%f", &P[t] );
            break;
      case WANG :
            sscanf( line, "%f", &P[t] );
            break;
      case NEW_WANG :
            sscanf( &line[9], "%f%d", &P[t], &ftag );
            tag = (int) ftag;
            break;
      }

      if ( tag == 1 )
      {
            if ( phaseSep < 0 )
                  phaseSep = t;

            if ( isReading )
                  isReading = false;
            t++;
            continue;
      }

      if ( (FILE_TYPE == MCGREEVY_THINK) && isReading )
      {
            t++;
            continue;
      }

      if ( (FILE_TYPE == MCGREEVY_READ) && !isReading )
      {
            t++;
            continue;
      }

      // Output the first position
      if ( !firstPrinted )
```

```
		{
			/*
			if ( !TIME_PRINT )
				cout << P[t] << " ";
			else
				cout << t << " ";
			*/
			store_output( P[t], t );
			firstPrinted = true;
		}

		// cout << P[t] << endl;

		// Should decide INITIAL variables, P_start, StayLength,
minP, maxP
		// Executed only once
		if ( P_start < 0 )
		{
			P_start = P[t];
			T_start = t;
			StayLength = 0;
			minP = maxP = P[t];
			t++;
			continue;
		}

		if ( (minP <= P[t]) && (P[t] <= maxP) )
		{
			StayLength++;
			if (StayLength >= MIN_STAY)
			{
				if ( !StartPrinted )
				{
					// Starting data
					/*
					if ( !TIME_PRINT )
						cout << P_start << " ";
					else
						cout << T_start << " ";
					*/
					store_output( P_start, T_start );

					StartPrinted = true;
				}
			}
			else
				;
		}
		else
		{
			// Update [min, max] with P[i];
			// cout << "UPDATE\n";

			if ( P[t] < minP ) minP = P[t];
			else if ( P[t] > maxP ) maxP = P[t];
			else cerr << "STARNGE   " << endl;
```

```
                        if ( (maxP-minP) <= MAX_DIFF )
                        {
                              StayLength++;

                              if ( StayLength >= MIN_STAY )
                              {
                                    if ( !StartPrinted )
                                    {
                                          // Starting data
                                          /*
                                          if ( !TIME_PRINT )
                                                cout << P_start << " ";
                                          else
                                                cout << T_start << " ";
                                          */
                                          store_output( P_start, T_start );
                                          StartPrinted = true;
                                    }
                              }
                              else
                                    ;
                        }
                        else    // max-min > MAX_DIFF
                        {
// cout << t << " " << T_start << "   1\n";
                              if ( ((t-1) - T_start) >= MIN_STAY )
                              {
// cout << t << " " << T_start << "   2\n";
                                    if ( StartPrinted )
                                    {
                                          // cout << "E-" << P[t-1] << "at("
<< t-1 << ")" << "\n";
                                          // Ending data
                                          /*
                                          if ( !TIME_PRINT )
                                                cout << P[t-1] << " ";
                                          else
                                                cout << t-1 << " ";
                                          */
                                                store_output( P[t-1], t-1 );

                                          StartPrinted = false;   // I
printed END pt, so I need to initialize vars
                                          T_start = t;
                                          P_start = P[t];
                                          minP = maxP = P[t];
                                          StayLength = 0;
                                    }
                              }
                              else
                              {
                                    // P_start is NOT a starting pt
                                    // Check the next points if it is ok as a
starting pt
                                    minP = P[t]; maxP = P[t];
```

```
                                        // Trying to find P_start back from
current time
                                        for ( j = t-1; j>=T_start; j-- ) //
decreasing by -1
                                        {
                                             oldMinP = minP; oldMaxP = maxP;

                                             // Calculate [min, max] for [j ..
i];
                                             if ( P[j] < minP ) minP = P[j];
                                             else if ( P[j] > maxP ) maxP =
P[j];

                                             if ( maxP-minP > MAX_DIFF )
                                             {
                                                  // P_start..j are NOT
starting point
                                                  T_start = j+1;
                                                  P_start = P[j+1];
                                                  StayLength = t-(j+1);
                                                  minP= oldMinP; maxP =
oldMaxP;
                                             }
                                        }
                                   }
                              }
                         }

                         t++;
                    }

                    if ( StartPrinted )
                    {
                         // Ending data
                         /*
                         if ( !TIME_PRINT )
                              cout << P[t-1] << " ";
                         else
                              cout << t-1 << " ";
                         */
                         if ( FILE_TYPE != MCGREEVY_READ )
                              store_output( P[t-1], t-1 );
                         else
                              store_output( P[phaseSep-1], phaseSep-1 );
                    }

                    if ( FILE_TYPE == MCGREEVY_READ )
                         store_output( P[phaseSep-1], phaseSep-1 );
                    print_output();

                    fclose( fp );
```

APPENDIX C

Data Transformation

Table C.1

Skewness Before and After Data Transformations, McGreevy Data

Variable	Transformation	Skewness before transformation (*SE* of skewness)	Skewness after transformation (*SE* of skewness)
The number of movements in the message-receipt phase	$\log(x+5)$	.46 (.27)	-.44 (0.27)
The number of movements in the post-message phase	$\log(x+5)$	1.13** (.27)	.53 (0.27)
The number of positive movements in the message-receipt phase	$\sqrt{x}$	.80** (.27)	-.49 (0.27)
The number of negative movements in the message-receipt phase	$\sqrt{x}$	.73** (.27)	-.50 (0.27)
The number of positive movements in the post-message phase	$\sqrt{x}$	1.27** (.27)	-.02 (0.27)
The number of negative movements in the post-message phase	$\sqrt{x}$	1.35 ** (.27)	.35 (0.27)
Number of micro movement per macro movement in the post-message phase	$\log(x+5)$	1.90** (.28)	.59* (.28)

Note. x in the transformation equation is an untransformed target variable.

**$p < .01$.

Table C.2

Skewness Before and After Data Transformations, Wang Data

Variable	Transformation	Skewness before Transformation (*SE* of skewness)	Skewness after transformation (*SE* of skewness)
The number of positive movements	$\log(x+1)$	1.42** (.29)	.08 (.29)
The number of negative movements	$\log(x+1)$	1.58** (.29)	-.02 (.29)

Note. *x* in the transformation equation is the untransformed target variable.

**p < .01.

Table C.3.

Skewness Before and After Data Transformations, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	Transformation	Skewness before Transformation (*SE* of skewness)	Skewness after transformation (*SE* of skewness)
The number of positive movements	$\log(x+1)$	1.30** (.25)	.09 (.25)
The number of negative movements	$\log(x+1)$	1.99** (.25)	1.14** (.25)
The number of positive thoughts about severe sentencing	$\log(x+1)$	.49 (.25)	-.35 (.24)
The number of negative thoughts about severe sentencing	$\log(x+1)$	.94** (.25)	.14 (.24)

Note. *x* in the transformation equation is the untransformed target variable.

**$p < .01$.

Table C.4.

Skewness Before and After Data Transformations, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	Transformation	Skewness before Transformation (*SE* of skewness)	Skewness after transformation (*SE* of skewness)
The number of positive movements	$\log(x+1)$	.21 (.24)	-.81** (.24)
The number of negative movements	$\log(x+1)$	4.10** (.24)	2.38** (.24)
The number of positive thoughts about tuition increase	$\log(x+1)$	.93** (.24)	.27 (.24)
The number of negative thoughts about tuition increase	$\log(x+1)$	.76** (.24)	-.19 (.24)

Note. x in the transformation equation is the untransformed target variable.

**$p < .01$.

APPENDIX D

Means, Standard Deviations, and Ranges of the Transformed Variables

Table D.1

Mean, Standard Deviation, and Range of Transformed Variables, McGreevy Data

Variable	*M*	*SD*	Range		*N*
			Min	Max	
The number of movements in the message-receipt phase	2.69	.45	1.79	3.58	78
The number of movements in the post-message phase	2.31	.40	1.79	3.30	78
Belief Change after the first movement in the message-receipt phase	-6.99	15.22	-49.50	32.00	62
Belief Change at 1st quartile-point in the message-receipt phase	-15.33	20.34	-49.33	34.67	62
Belief Change at the mid-point in the message-receipt phase	-8.78	22.97	-48.67	50.00	62
Belief Change 3rd quartile-point in the message-receipt phase	12.58	22.23	-49.00	49.00	62
Belief Change at the final point in the message-receipt phase	17.29	25.89	-50.00	50.00	62
The number of positive movements in the message-receipt phase	2.22	1.05	0.00	4.47	78

The number of negative movements in the message-receipt phase	1.92	.92	0.00	3.87	78
The number of positive movements in the post-message phase	1.37	.79	0.00	3.32	78
The number of negative movements in the post-message phase	1.20	1.07	0.00	3.46	78
Positivity of movements in the message-receipt phase	.20	.66	-1.95	2.08	78
Positivity of movements in the post-message phase	.12	.71	-1.61	1.39	78

Table D.2

Mean, Standard Deviation, and Range of Transformed Variables, Wang Data

Variable	*M*	*SD*	Range		*N*
			Min	Max	
Positivity of movements to the number of negative movements	.08	.60	-1.10	1.79	66
The number of positive movements	.93	.56	0.00	2.20	66
The number of negative movements	.85	.61	0.00	2.30	66

Table D.3

Mean, Standard Deviation, and Range of Transformed Variables, Criminal-Sentencing Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*M*	*SD*	Range		*N*
			Min	Max	
Individual message discrepancy	23.24	14.3	.00	48.0	93
The number of positive movements	.82	.50	.00	1.95	93
The number of negative movements	.37	.52	.00	1.79	93
The number of positive thoughts about severe sentencing	.84	.50	.00	1.61	93
The number of negative thoughts about severe sentencing	.55	.48	.00	1.61	93
Initial belief change	-3.30	40.80	7.15	8.1	81
Final belief change	-12.70	38.6	7.74	7.8	81

Table D.4

Mean, Standard Deviation, and Range of Transformed Variables, Tuition-Increase Data (Fink, Kaplowitz, & Hubbard, 2002)

Variable	*M*	*SD*	Range		*N*
			Min	Max	
The number of positive movements	.96	.38	.00	1.61	97
The number of negative movements	.16	.35	.00	1.79	97
The number of positive thoughts about tuition increase	.42	.42	.00	1.39	97
The number of negative thoughts about tuition increase	.80	.53	.00	1.79	97
Initial belief change	2.87	15.79	4.73	2.60	90
Final belief change	1.21	15.17	7.13	3.04	90

APPENDIX E

Instructions for Participants and Decision Scenarios in McGreevy (1996)

Directions:

The admissions office at the University of Maryland is considering adding a student member to its admissions committee and would like to get some input from students currently attending this campus. It is believed that current students will have the knowledge an insight necessary to make a decision about what makes a successful student here at UMCP. Since current students are functioning in the environment in which new students will soon enter, it is thought that current students can provide the committee with invaluable information.

Below is information about two out of state candidates for admission into UMCP. We will refer to these candidates ad **Candidate 1** and **Candidate 2**. An admissions decision must be made on the basis of each candidate's relative grade point averages and SAT scores as well as on the information provided in each candidate's application. Below is summary data about each candidate put together by the admissions office.

Please take some time and decide which candidate you would be willing to accept into college. You **must** choose **one** of the candidates. Your decision process will be recorded on the computer. After you have decided which candidate is more suitable to college, you will be asked to fill out a questionnaire. Please record your choice in the space provided and answer the remaining questions in the questionnaire. Information from the questionnaires will be summarized and forwarded to the Admissions office at the University of Maryland.

All responses will be anonymous and kept confidential.

We appreciate your time and participation.

Similar Candidates Condition

Candidate 1 is a high school senior from New England. He has an impressive academic record and SAT scores. In addition to his academic achievements, he enjoys many activities. He is captain of the schools' debate team, and has won several debate and public speaking competitions. **Candidate 1** is also active in school politics. He is currently President of the student government association (SGA). His junior year he served as Vice President of SBA and his freshman and sophomore he sat on his class council. **Candidate 1** is co-captain of his high school's varsity soccer team. **Candidate 1** claims that debate and student government have helped him develop his leadership and analytical reasoning skills. He credits sports with teaching him the value of hard work and determination. Outside of school, **Candidate 1** is active in the community. Each year he volunteers for his state's Special Olympics program. Through the special Olympics, he serves as an assistant soccer coach for a team of mentally retarded children. **Candidate 1** is also active in his church's youth group. This group serves the community by getting involved in projects such as feeding the homeless, visiting nursing homes, and cleaning up the environment. **Candidate 1** considers himself a well rounded individual who manages his time will. He is extremely excited about starting college and meeting the challenges that await him.

Candidate 2 is also a high school senior from New England. He, too, has an impressive academic record and SAT scores. In addition to excelling in his studies, **Candidate 2** is involved in many activities both within and outside of school. In school, he is captain of his high school lacrosse team and member of the debate team. He has served on student government boards all four years of high school. This year his classmates voted him Vice President of SGA (student government association) for the second year in a row. His freshman year he served on the class council, and his sophomore year he was his class treasurer. **Candidate 2** enjoys combining sports, debate and student government. He claims that these three activities have helped him with his critical thinking, arguing, and leadership skills. Outside of school, **Candidate 2** volunteers for his community's Big Brother/Big Sister program. In addition to serving as a mentor to a child in the community, **Candidate 2** also volunteers as a peer tutor at the local middle school. **Candidate 2** enjoys students of all ages and is looking forward to returning to his summer job as a camp counselor. This will be his third year working for the camp (his freshman year he was a counselor in training). **Candidate 2** describes himself as confident, motivated, and responsible. He is eager to start college and meet the challenges that lay ahead.

Different Candidates Condition

Candidate 1 is a high school senior from New England. He has an average grade point average and average SAT scores. In addition to his academic achievements, he enjoys many activities. While he hasn't participated in sports clubs at school, he is an avid skier and has recently become proficient at snow boarding. He also enjoys skateboarding. He has been a skateboarder since the age of 10 and has won some local skateboarding competitions. In the summer he likes to play tennis and mountain bike. **Candidate 1** describes himself as a shy individual who likes to express himself through art and poetry. In keeping with his artistic nature, he is a proficient musician and plays the drums and both the electric and acoustic guitars. Recently he took his love for poetry and music and started a rock band with a few close friends. They entered their high school talent show and won third place. When not at school or enjoying his extracurricular activities, **Candidate 1** can be found at his part time job. He works as a busboy in a local restaurant. This is his third, and favorite, job he has had since entering high school. **Candidate 1** considers himself well rounded and a good candidate for college.

Candidate 2 is also a high school senior from New England. He, too, has an impressive academic record and SAT scores. In addition to excelling in his studies, **Candidate 2** is involved in many activities both within and outside of school. In school, he is captain of his high school lacrosse team and member of the debate team. He has served on student government boards all four years of high school. This year his classmates voted him Vice President of SGA (student government association) for the second year in a row. His freshman year he served on the class council, and his sophomore year he was his class treasurer. **Candidate 2** enjoys combining sports, debate and student government. He claims that these three activities have helped him with his critical thinking, arguing, and leadership skills. Outside of school, **Candidate 2** volunteers for his community's Big Brother/Big Sister program. In addition to serving as a mentor to a child in the community, **Candidate 2** also volunteers as a peer tutor at the local middle school. **Candidate 2** enjoys students of all ages and is looking forward to returning to his summer job as a camp counselor. This will be his third year working for the camp (his freshman year he was a counselor in training). **Candidate 2** describes himself as confident, motivated, and responsible. He is eager to start college and meet the challenges that lay ahead.

APPENDIX F

Instructions for Participants and Decision Scenarios in Wang (1993)

Hi, we are doing a study concerning opinions about the college admission process. Your responses will be anonymous and confidential. Before we start the study, we would also like you to be familiar with the use of a computer mouse to indicate your thinking process and be familiar with the scales we will use to answer the questions in the last part of the study. After that, you will be hearing a message from the headphone. Please listen to the message carefully (In distraction condition, subjects were told "Please listen to the message carefully and try to decipher the subliminal message in the static.") After the message is finished, please answer the questions on the following page.

[Message for Individuated Condition]

John Roberts is a Caucasian. He is currently a high school senior living in Washington, D. C. His GPA is 2.96 on a scale of 4. His SAT score is 1020. Just like most high school students, he hangs out with his own group of friends. He is easy-going and has fun. His classmates voted him as one of the most interesting people in the class. Most of his teachers regard him as caring and generous. He also likes to participate in extracurricular activities, such as playing baseball and performing in a school paly. He has many different hobbies and interests. One of them is going to the beach. When he has time, he likes to be involved with community services.

Eric Washington is a senior high school student living in Washington D. C. He is an African American. He is also the photographer for the school yearbook. He has many hobbies. He likes music and photography. He can also play some musical instruments. He does not see himself as very athletic and does not play much sports except lacrosse. He and his friends enjoy going to museums and going to concerts during the weekends. He is also involved with volunteer work when he has time. He has served in some of the soup kitchens in the area and feels it was a very positive and rewarding experience. He also has worked part time as a sales person in a local department store during the summer break. He believes this experience has helped his interpersonal skills greatly. He is friendly and has a good sense of humor. He likes to make friends of different cultural backgrounds. He also enjoys different kinds of ethnic food. He is well liked by his friends and teacher.

[Message for No Individuated Condition]

John Roberts is a Caucasian. He is currently a high school senior living in Washington, D. C. His GPA is 2.96 on a scale of 4. His SAT score is 1020. Just like most high school students, he hangs out with his own group of friends. He is easy-going and has fun. His classmates voted him as one of the most interesting people in the class. Most of his teachers regard him as caring and generous. He also likes to participate in extracurricular activities, such as playing baseball and performing in a school paly. He has many different hobbies and interests. One of them is going to the beach. When he has time, he likes to be involved with community services.

Eric Washington is a senior high school student living in Washington D. C. He is an African American. He has many hobbies. He likes rap dance. He likes to play basketball. One of his hobbies is shopping for shoes. During the weekends, he likes to invite his friends to hang out in the shopping mall.

APPENDIX G

Instructions for Participants and Decision Scenarios of the Criminal-Sentencing Issue

(Fink, Kaplowitz, & Hubbard, 2002)

Now we are going to measure your view on the first public issue: Sentencing for Criminals. But first we will give you some information about this topic.

<u>Sentencing Guidelines</u>

The State of Michigan, along with many other states, has issued a Sentencing Guidelines Manual. These Guidelines, which are based on a consensus of legal experts, are to assist judges and provide some degree of consistency in sentencing. Below is a copy of the cover of the Sentencing Guidelines Manual of the State of Michigan.

The sentence you will be examining was for the crime of armed robbery. The Michigan Sentencing Guideline for the crime of armed robbery is **10 years** imprisonment. The sentence for this crime is not only a consensus of legal experts, but has also been found to be supported by a large majority of the public.

These Guidelines, however, are recommendations, not laws. Because many people feel that a judge must be able to take into account the special features of each case, the law permits a judge to pass a sentence which is considerable greater or considerably less than the Guideline.

[Questions for participants' understanding of the Guideline]

While the State of Michigan has Sentencing Guidelines, the State still allows Judges to make up their own minds in passing sentences. Therefore, a sentence may deviate considerably from the Guidelines, for a variety of reasons.

We will now give you some information about a particular judge, whom we shall call Judge Walters. The following are excerpts from a report on various Michigan Judges, which was released one year ago.

[*High credibility condition*]

Judge Walters is a judge in one of the larger metropolitan areas in Michigan. He is in his fifties, has gray hair, is married, and has grown children. He has had many years of experience as a judge in criminal cases.

In imposing sentences, he sometimes imposes the sentence recommended by the Sentencing Guidelines. However, he places the greatest weight on his own judgment. **He is however, one of the MOST respected judges in Michigan.**

[*Low credibility condition*]

Judge Walters is a judge in one of the larger metropolitan areas in Michigan. He is in his fifties, has gray hair, is married, and has grown children. He has had many years of experience as a judge in criminal cases.

In imposing sentences, he sometimes imposes the sentence recommended by the Sentencing Guidelines. However, he places the greatest weight on his own judgment. **He is however, NOT one of the more respected judges in Michigan.**

Answer the following questions on this form, circling the number corresponding to your answer.

	Not at all fair						Extremely fair
1. How fair is Judge Walters? (col 15)	1	2	3	4	5	6	7

	Not at all expert						Extremely expert
2. How expert is Judge Walters? (col 16)	1	2	3	4	5	6	7

After the release of the report which we quoted, Judge Waters had to again sentence someone for armed robbery. We will refer to this person as Convict X. We will shortly present the statement Judge Walters made as he sentenced Convict X and after doing so, we will ask you the appropriate sentence for Convict X.

<u>The statement</u>

By threat of force and violence, you gained access to money which was not rightfully yours. You brandished a lethal weapon and made quite clear that you would not hesitate to use it if your crime were in any way resisted. Since there was no resistance, you did not fire your weapon, but the terror you instilled in all of those present will be with them for a very long time. Clearly, you played a major role in the planning and execution of this crime. Finally, your record shows that this is not the first time that you have violated the laws which create a civilized society. . . Therefore, I sentence you to [**17 years** for the small message discrepancy**; 30 years** for the moderate message discrepancy; **50 years** for the extreme message discrepancy] in the penitentiary.

As you decide the proper sentence of Convict X, please keep in mind

1) the sentencing guideline
2) what you know about Judge Walters and
3) the reasons he gave for his decision.

When the mouse program is turned on, please think about the <u>proper sentence for Convict X (in years)</u> and **move the mouse to reflect any changes in your opinion.** When you have made your **final decision, and will not move the mouse any further, please press the mouse button.** Take your time.

APPENDIX H

Instructions for Participants and Decision Scenarios of the Tuition-Increase Issue (Fink, Kaplowitz, & Hubbard, 2002)

We would now like to ask you to think about another issue: tuition rates at this university. The MSU Board of Trustees has recently voted to increase the undergraduate tuition by 7%, effective Fall 1993. There is however, further discussion within the university and the legislature about the appropriate tuition for next year.

You will be given a message to consider on tuition. After you read the message, we will want you to think about the appropriate **percentage increase in the tuition rate at MSU.** On the screen will be a scale. The numbers represent percentage increases in the tuition rate.

[High source credibility condition]

The message you will read is from a member of the State Legislature. This legislator, whom we shall call **T. L.**, who has been highly involved in the issue of higher education. **However, student groups have often praised TL's knowledge of these issues and his willingness to be fair to students.**

[Low source credibility condition]

The message you will read is from a member of the State Legislature. This legislator, whom we shall call **T. L.**, who has been highly involved in the issue of higher education. **However, student groups have often questioned TL's knowledge of these issues and his willingness to be fair to students.**

[Questions for participants' understanding of the Guideline]

Here is TL's recent statement:

> Our colleges and universities are badly in need of more money. Because of this, they have had to reduce their number of faculty, causing students to have bigger classes and less choice of classes. The best faculty are leaving because their salaries are no longer competitive. The libraries are able to buy very little. All of these things threaten the education of the young people of this state. The 7% increase approved by the Board of Trustees is not sufficient to solve these problems.
>
> I wish we could get a much bigger state appropriation, so that students could pay less of the cost of college, but this is not possible unless the public is willing to pay higher taxes.
>
> So all that can save our student's education an meet MSU's great needs is another tuition increase. I hate to do this to our students once again. But I think being well trained and having good job prospects tomorrow is worth a sacrifice today. I therefore recommend a further tuition increase **to take place in January 1994. In order for this university to give the kind of quality education our students deserve,** the total increase **(including the 7% already approved) must be** [**9%** for the small message discrepancy; **15%** for the moderate message discrepancy; **22%** for the extreme message discrepancy].

As you decide the proper tuition increase, please keep in mind

1) your own view
2) what you know about T. L. and
3) the reasons he gave for his decision.

When the mouse program is turned on, please think about the appropriate **total percentage increase in tuition** and **move the mouse to reflect any changes in your opinion.** When you have made your **final decision, and will not move the mouse any further, please press the mouse button.** Take you time.

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