The emergence of a negative feedback bias as a product of supervisor and subordinate dynamics: Consequences of opportunity-based supervision and performance variation

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Industrial / Organizational Psychology

(ABSTRACT)

Because the act of supervisory feedback can critically affect a subordinate's performance, it is imperative to explicate the various conditions in which the character of feedback is determined. The purpose of the following research was to model the conditions under which supervisors adopt a negative feedback bias (NFB). This bias was first described by Kahneman and Tversky (1973), when they noted that Israeli flight instructors found that praise of exceptionally good piloting was often followed by poorer performance, while criticism of exceptional poor flying was usually followed by improved performance. Thus, the flight instructors came to believe that negative feedback motivated people effectively, while positive feedback appeared ineffective. Of course, supervisors had erred by failing to recognise the natural variation of their students' performance. In general, this error applies primarily to the conditions under which supervisors acquire and interpret information. Two factors were hypothesized as responsible for the emergence of a NFB: (a) limitations caused by opportunity-based supervision, where only a certain amount of subordinate behavior can be sampled at any given moment, and (b) supervisors find it difficult to recognize the natural variation, random fluctuations, and regression to mean processes characteristic of performance governed by common causes (cf. Deming, 1982; Hogarth, 1980 and Kahneman &

Tversky, 1973). Results indicated that NFB was an emergent process occurring over time and under conditions where (a) supervisors managed highly inconsistent subordinate performance and (b) supervisors had limited information regarding a subordinate's performance per evaluation episode. Since this experimental approach and set-up is relatively novel, the results are discussed from several conceptual perspectives. Finally, a discussion regarding the ecological approach to feedback research, and the importance of model building and testing is offerred.

Acknowledgment of Process

The purpose of acknowledgments is to recognize the people responsible, supportive or important to the completion of some endeavor. However, my emphasis is different. I wish to identify the process or historic flow (or muddling) through which this dissertation emerged, rather than strictly focusing on important people. By identifying the clues, training and accidental discoveries I will reveal my own personal ecology of people who embody extra-ordinary talents, geniuses and passions. The resulting "order" you see as a dissertation (or for that matter me) is representative of a multiple of influences, most of which were unplanned and without forethought. I did not have one mentor here at Virginia Tech. No, I had (have) many mentors or models that I have emulated, appreciated, listened to, questioned, and sought direction and guidance. Fortunately, for reasons beyond my understanding this arrangement worked and I'm grateful for where it (they) lead me. Below, I attempt to present the highlights of these influences as related to my dissertation. Although, the following discussion appears linear, the actual flow was much more convoluted and scattered, especially in its initial conditions. I have attempted to keep the following brief as possible, obviously much more could be said regarding each of the participants and their contribution to my development.

Preparing the Mind

(1) Received a B.S. degree in Psychology at University of Florida; specific training in behavior analysis with a strong experimental lab emphasis. I am grateful to Drs. Ron Allen and Ray Pitts (Department of Psychology) who encouraged me to attend graduate school. They showed me the beauty in behavioral order as rendered over time, and as displayed through diverse patterns. They also modeled unchecked appreciation of science, the dedication to mentoring and the nurturing spirit of friendship.

(2) Dr. Jack W. Finney (Department of Psychology) has always approached me with friendship, offering guidance across a multitude of issues. He has helped me greatly with M.S. degree by showing me new ways of portraying temporally-based data. Dr. Finney has further assisted in my understanding of the delicate nuances of community behavioral analysis, and has given important editing input to several of my manuscripts. I will always be grateful to Dr. Finney and look forward to when we can collaborate on future research.

(3) Dr. Scott Sink (Department of Industrial Systems Engineers) provided a practical systems approach to (a) organizational problems, (b) the manifestation of metaphors and paradigms in organizational structures, (c) TQM and SPC, and (d) the importance of recognizing variation in all forms of people and product management.

(4) Dr. Joseph Germana (Department of Psychology) has had a most dramatic effect on my thinking and seeing. He was the first to emphasis the importance of a systems approach to psychology regardless of the area. His undergraduate course in Learning, which I was a T.A., read like a graduate level course. Dr. Germana believes in representing psychology as a interconnection of levels and parts in an ever dynamic interplay as set within a active context. Dr. Germana's contribution to this dissertation may be seen in its overall approach and *esprit de corps*. I am truly grateful for the time he has spent as a mentor, helping me connect up a larger perspective towards life.

(5) Dr. Robert Lickliter (Department of Psychology) has given me over the past seven years a mentoring created out of a passion for science, understanding and perspective. Through many a class and conversation, through many a borrowed book and article, Dr. Lickliter has given me an appreciation of psychology as a multidisciplined and dynamic field. Over many a hour, his rendering of development and the importance of the nervous system slowly effected a change in my apprehension of the whole organism and its place in time and context. I will always be specifically grateful to Dr.

Lickliter for showing me how to live within questions rather than answers. For you're only as good as your next question, mystery or enigma.

(6) Dr. Roseanne Foti (Department of Psychology) was my first and last mentor of my graduate career. Her research methods course was the first (for me) to connect the science of psychology with the philosophy of science. She introduced to me organizational science, with its complexities and its wide range of dynamic issues. During four classes I attended, Dr. Foti taught me the rigors and basis' of industrial-organizational psychology as an important theoretical and conceptual field. Her help in this dissertation is seen in countless ways, both in minor and major respects. She has been behind the motivation and articulation of my research. She has provided invaluable feedback and nudging of my understanding of information processing models. My understanding of my own research has been expanded by her contributions and training. I will always feel fortunate for Dr. Foti's care and dedication to me as a person, colleague, and friend.

Chance Encounter

(7) Dr. Lee Cooper (Lewis Gale Psychiatric Center) several years ago employed several Virginia Tech graduate students to participate in animal learning studies. These graduate students, friends: Mike Gilmore and Philip Cunningham, attended research meetings one evening a week. Fortunately, I was invited to share in these meetings. Besides reviewing lab data and procedures, Dr. Cooper engaged us with the purpose and questions of the field of learning. They were intriguing and fascinating meetings. Dr. Cooper attempted to push our envelopes, make us think, make us find the question, and organize the procedures through which answers might be obtained. His style was extremely didactic and compelling.

During one of our sessions he asked us how we might organize the stimulus configurations as they might be associated with food delivery. I remember that the different light stimuli were randomly configured but were manipulated by how much of each would be presented during daily sessions (i.e., frequency-percents). I remember puzzling and musing over the many different and possible stimulus configurations and its temporal feature. Although, the experimental lab set-up was rather straightforward, the stimulus arrangements represented a highly complex environment, quite different from typical schedules of reinforcement.

I had no idea how important this experience would be to me. I owe Dr. Cooper great thanks for allowing me the opportunity to attend his lab meetings. He is a great teacher. My all to brief experience in his lab meetings were extremely valuable.

Serendipity of Convergence

Serendipity of convergence represents those moments when a rush of inextricable and divergent elements and concepts come together into a crush of wholeness. For me, this moment occurred on an October afternoon in 1991. Dr. E. Scott Geller, after attending a consultant's convention with Dr. Edwards Deming, noted in a conversation to me the connection between Dr. Deming's "common cause" concept and Kahneman and Tversky's observation of Israeli flight instructors and "regression to the mean" concept. Both concepts have extension to conditions that may influence a manager's tendency to use punishment over rewards when dealing with subordinates. On hearing this comparison a serendipitous convergence of ideas struck me. In a fever pitch of imagination, I saw instantly how to model variation, variation of the sort Dr. Deming and Kahneman and Tversky had spoke about. But more than that, from Dr. Cooper's lab meeting I saw how I could then manipulate variation by varying different levels of consistency and inconsistency through frequency-percents. It was all very graphic and took the form of a time series; these visuals were very familiar to me and consistent with my training in behavioral methodology. I had found a space-time universe that was mathematically viable, and symbolic of a complexity I had come to appreciate in several domains of psychology. Appendix B of this dissertation represents the fulmination of this convergence of ideas and training.

In the Process

In constructing the document, as seen in Appendix B, I had determined that this was a dissertation project. It would tackle the organizational feedback literature and extend its existing research. It seemed a perfect project for me, it was consistent with my training in behavior analysis methodology (Drs. Finney, Allen and Pitts), it aligned well with SPC as a metaphor and tool (Dr. Sink), it was amenable to the approaches of developmental, ecological, and systems psychology (Drs. Germana and Lickliter), it had a link to chaos theory which I had studied for my preliminary examination, and finally, it had a firm generalization to organizational psychology (Dr. Foti). The once divergent pieces of my eclectic studies seemed now to have an overarching integration. I wanted to model and study the significance of variation, variation in the dynamical and temporal sense, as rendering an ecological "composition". This composition would be the interaction between supervisors and subordinates in an organizational setting. (However, I did realize that this process was generalizeable to other person to person relationships, e.g., parent to child). I would attempt to find the conditions important to the emergence of a negative feedback bias (NFB).

Although, the above had showed me how to render variation and appreciate its control, the picture (experimental set-up and design) was still not complete. I had focused rather exclusively on illustrating how a subordinate's performance might randomly vary in a controlled manner (as an independent variable). I had not yet considered the other half of the dyad, the supervisor.

(8) Dr. Neil Hauenstein (Department of Psychology) was essential in this regard. During the early steps of my dissertation formulation, Dr. Hauenstein posed to me the concept of feedback loops. He suggested that there were large and small loops. "How did it relate?" Dr. Hauenstein has a beautiful manner of posing questions and allowing students to think them over. Later, after some mulling over this idea of feedback loops, I saw the fit. Supervisors must observe and sample the performance of a subordinate prior to delivery of feedback. I saw "when" and "how much" performance a supervisor observed as features of the feedback loop. Now, there was action on the other side of the dyad (i.e., the supervisor), it was essentially a dynamic dyad. My discussion with Dr. Hauenstein was critical to my conceptualization, he helped complete the picture and the model of interaction between supervisors and subordinates.

The Dissertation

I have in a very rough way tried to represent the events and people important to the creation of my work and what fills my head. Obviously, so much more could be written about them. I hope they see that their influence was important to me. If I have let them down or misrepresented their cause, the fault lies with me. For mentors can only have so much control or influence over rogue students. I have tried to capture, with sincerity, what I could from their teachings and use these teachings in such a way as to extend ideas and approaches to the science and art of psychology. In the final analysis, I am but a metaphor of a school of people. Each of the persons mentioned above have altered me in significant and subtle ways. I came to graduate school to be altered. The exchange between them and me has been achieved. The expense and time of these last eight years of my life have been well spent. I look forward to our continued colleagueship and friendship. As time gives us future opportunities to share ideas, let this dissertation act as a testament to an opportunity we shared, a dedication to teaching and learning, and a process of graduating a person and an idea (the dissertation) to a different degree of understanding.

In Closing

All processes have a context. I would like to thank the context of people surrounding my dissertation. I am grateful to Dr. Joseph Sgro for providing a Department of Psychology. His leadership and stewardship of this Department has been exceptional. I am also grateful to several other faculty who through their courses or personal talks have supported me, they are Drs. Robin Cooper and Danny Axsom. Each of them are great teachers and committed mentors in their own right. Of my fellow graduate students, I would like thank Karyn Carr, Trina Bogle, Sharon Flinder, Tim Ludwig, Dean Stamoulis, Tom McBride, Donna Yaffe, George Demakis and Lance Becker, for their support and stimulating discussions. I would especially like to thank Melanie Bonner for helping proof and debug my feedback program. Melanie's support over these many years has been greatly appreciated, I value highly her friendship and keen insight in all matters. I must also recognize Mike Gilmore. Mike has been a close friend and confident. Without his support over the years my graduate student life and success would have been dimmer and less satisfying. I am grateful to both Diana Corrigan and Lisa Curtain for refining my conceptualization regarding cognitive process theories.

Additionally, I wish to thank several undergraduate students who shared with me, over these last years, the fun of research and discourse. They are: Robert Stephenson, Christy Futch, Keith Kline, Rayne November Scott, and Karen Glago. These young aspiring and bright students kept me inspired and thus forestalled, if not eliminated, the onset of burnout. I owe them all great thanks and wish them well in their chosen careers.

I must acknowledge some very important people in my life, my family. Without them this goal or quest might never have been attempted. I wish to thank my lovely wife Virginia Chapman for her devotion and love, my father-in-law (R. Edward Chapman) for his support and encouragement, my mother (Stephanie M. Berry) and mother-in-law (Natasha Chapman) for their support and nurturing manners. I especially like to thank my grandmother (Olive Branch Mitchell) who has modeled, since I was little, the importance and delight in learning, drawing, and collecting a personal library.

And finally, an artist must always acknowledge his or her muses. I wish to thank Mill Mountain Coffee and Tea, a shop that draws people to discourse while altering their caffeine levels. I am fortunate for this coffee shop, owned by Scott Elrich. The coffee shop attracts a number people from different backgrounds. Many of whom have enriched immensely my world of ideas . I have shared coffee and ideas with Victor Moose (the Writer), Steve Thompson (the Architect-Philosopher), Rob (the Philosopher), Chris (the Mathematician), Wayne Lubin (the Mathematician), Ed Gendron (the Artist), Steve Ashmore (the Architect-Philosopher) Ashraf Khan (the Engineer-Philosopher), Bassam Alsayed-Tulti (the Historian), and many a nameless person. Those who attend and engage the iconographic implications of the coffee shop are indeed fortunate. My interactions with these friends of mine have been greatly appreciated. Along with the caffeine, they have stimulated much thought, musings and questions. Therefore, I pray that the Great Goddess of the Mountain of Caffeine may enlighten me and protect me from future dullness and inactivity. "One Mocha Java coming up."

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Introduction

Feedback about performance has long been hypothesized as a critical organizational variable for enhancing the effectiveness of individual and group behavior. Early research found that performance feedback was an important tool for directing and motivating human behavior (Ammons, 1956; Payne and Hauty, 1955; Vroom, 1964). However, over the years, investigators have examined the multiple dimensions, functions, and applications of feedback as an organizational resource (Ilgen, Fisher, & Taylor, 1979), individual resource (Ashford & Cummings, 1983), regulatory process (Taylor, Fisher, & Ilgen, 1984) and intervention procedure (Balcazar, Hopkins, & Suarez, 1986; Prue & Fairbank, 1981). Additionally, organizational theorists have viewed the role of feedback as either supportive or central to many areas of work life, such as: goal-setting (Erez, 1977; Locke, Shaw, Saari & Latham, 1984), job enrichment (Hackman & Oldham, 1976), employee training (Goldstein, 1986), behavior modification (Luthans & Kreitner, 1975), and performance appraisal (Bernardin & Beatty, 1984).

Indeed, a substantial amount of empirical research has shown feedback as an integral component of any organizational control system. Not surprisingly, much of this research has been concerned with the practical influence of supervisors over subordinates, where feedback is used as a "contrived" intervention or behavioral change procedure. As an intervention, performance feedback has been used across a wide range of organizational needs, including to increase employee punctuality (Lamal & Benfield, 1978), sales production (Ralis & O'Brien, 1986; Feeney, Staelin, O'Brien, & Dickinson, 1982), work production and quality (Chandler, 1977; Emmert, 1978; Goltz, Citeria, Jensen, Favero, & Komaki, 1989; Newby & Robinson, 1983), occupational safety (Komaki, Barwick, & Scott, 1978; Saari & Nasanen, 1989), to promote employee friendliness and communication (Chandler, 1977; Komaki, Blood,

& Holder, 1980), and to establish better training and appraisal programs (Ford, 1984; Maher, 1982).

In addition to demonstrating the benefits of implementing a feedback program, applied investigators have examined factors potentially affecting the efficiency of feedback. Some of these factors include whether feedback was: (a) presented alone or associated with a goal-setting or incentive-consequence procedure (e.g., Brown, Willis & Reid, 1981; Rallis & O'Brien, 1987), (b) given by a supervisor, co-worker, or self-generated (e.g., Greller, 1980), (c) communicated verbally or graphically (e.g., Brown et al., 1981; Dick, 1978; Lamal & Benfield, 1978), (d) represented by specific or general information (e.g., Frederiksen, Richter, Johnson, & Solomon, 1982), (e) based on group or individual performance measures (e.g., Emmert, 1978; Goltz et al., 1990; Newby & Robinson, 1983), and/or (f) scheduled daily, weekly, monthly, and so on (e.g., Chhokar & Wallin, 1984; Ford, 1980; Runnion, Johnson, & McWorter, 1978). For comprehensive reviews of the above characteristics and their influences, see Balcazar, et al., 1986 and Prue and Fairbank, 1981. In general, the purpose of the above research has been to demonstrate that feedback, as an intervention, within organizational settings can positively regulate employee behavior, and to advance the technology of feedback delivery and implementation.

In contrast, another line of research has focused on the inter and intra-personal processes affecting performance feedback between supervisors and subordinates, where feedback is represented as a nexus, or as Larson (1984, p. 44) has suggested, " ... the hub of a complex network of causal relationships." This approach to feedback attempts to unpack the multiple influences thought to take place "naturally" between informal supervisor-subordinate interactions as found within an organizational context. Taken as a natural, day to day process, feedback typically has been examined by identifying and describing what and how certain antecedent variables affect the presentation of feedback, as well as studying the consequences following feedback delivery. To date, some of the major dimensions of feedback studied include (a) the sources of feedback, with an emphasis on the hierarchical and informative richness of the work environment, in which both supervisors and subordinates are embedded (e.g., Becker & Klimoski, 1989; Greller, 1980; Greller & Herold, 1975; Hanser & Muchinsky, 1978), (b) the formation of interpersonal attitudes and attributions by supervisors and subordinates as a function of giving and receiving feedback (e.g., Ilgen & Knowlton, 1980), and (c) the effects of a subordinate's performance on a supervisor's choice and delivery of feedback (e.g., Ilgen, Mitchell, & Fredrickson, 1981; Herold, 1977; Lowin & Craig, 1968).

As noted by Larson (1984, 1989), because the act of feedback can critically affect a subordinate's performance as well as the interpersonal relationship between supervisors and subordinates, it is imperative to explicate the various processes in which the character of feedback is determined. Here the character of feedback refers to the sign, intensity, accuracy and frequency of delivered feedback. Most laboratory research examining factors responsible for feedback delivery have concentrated on variables that influence a supervisor's choice of feedback (i.e., the sign of feedback: positive or negative). To this end, a majority of this research supports the conclusion that the best predictor of the sign of feedback is a subordinate's level of performance (e.g., Ilgen, Mitchell, & Fredrickson, 1981; Herold, 1977; Lowin & Craig, 1968). In general, these studies have found that above average performance was associated with positive feedback or praise, while below average work was usually followed by negative feedback or reprimands. Although these findings by themselves appear obvious, they established a perfunctory basis for research extending our understanding of factors thought to mediate or moderate the relationship between a subordinate's level of performance and type of feedback delivered. Some of these factors studied include a supervisor's: knowledge of work outcomes and their valences (Mitchell & Kalb, 1981), dependence upon a subordinate's performance for work rewards or pay (e.g., Herold, 1977; Ilgen, et al., 1981; Larson, 1986), reluctance to deliver negative evaluations or corrective criticisms (Fisher, 1979; Ilgen & Knowlton, 1980), and causal attributions about a subordinate's performance (Green & Mitchell, 1979; Ilgen & Knowlton, 1980).

The field of feedback research has generated a substantial amount of empirical findings. However, much of this research appears driven by a reductionistic approach that has concentrated its efforts on identifying an ever increasing list of unique factors associated with the feedback process. Such a winnowing and descriptive research paradigm is essential for decomplexifying and defining the contents and boundary conditions of a field of study. Furthermore, this descriptive approach provides the foundation material for the important practice of cataloguing, systematizing and cross-referencing relevant variables and their relationships (e.g., the integration of goals and feedback, e.g., Erez, 1977). Several important literature reviews on feedback attest to this practice by organizing the diverse and extensive corpus of feedback research into heuristic frameworks or theses (e.g., Ashford & Cummings, 1983; Ilgen, Fisher, & Taylor, 1979; Larson, 1984).

However, a reductionistic approach which decomplexifies the field of potential causal variables into isolated factors, runs the risk of potentially over-simplifying the very process being explored and modeled. For instance, much of the past experimental research in feedback delivery has represented supervisor-subordinate interactions (in terms of procedures and analyses) as static or stable independent and dependent variables. Specifically, research that has studied performance as a predictor of supervisory feedback has typically modeled subordinate performance (the independent variable) as either a single instance or uniform level or trend, while a supervisor's feedback (the dependent variable) has been often portrayed as a stable feedback bias or frequency (e.g., Herold, 1977; Ilgen, Mitchell, & Fredrickson, 1981; Larson, 1986). In some cases procedures were arranged where supervisors (subjects) were given only a single opportunity to give feedback during an entire experimental session (e.g., Fisher, 1979). Such a static representation of both independent and dependent variables seems to belie the natural dynamics and complexities found when a manager supervises a subordinate's performance.

Guiding Assumptions and Initial Analyses

Feedback as a Nested Process. One reason feedback research has resulted in relatively static representations is the general lack of appreciation that feedback itself is a nested process between two larger, temporally parallel and interacting processes. These processes are: (a) a supervisor's role as a manager, and (b) the subordinate's role as a performer. Figure 1 illustrates graphically the nested relationship of feedback as a bi-directional mediating process between the two separate roles of a supervisor (as manager) and subordinate (as performer) over time. Here the role of a manager describes a person responsible to many organizational duties and activities which vary day to day, where subordinate evaluation and delivery of informal feedback are but one activity. Likewise, the level of a subordinate's performance may also vary day to day, a function of numerous causes. But because research has traditionally modeled performance as a single instance or criterion, the effects of performance variation over time on the character of feedback have been overlooked and under characterized. Thus, research that narrowly focuses on the feedback process, in one sense, decontextualizes feedback from its embeddedness between management and performance processes. The following analysis attempts to portray

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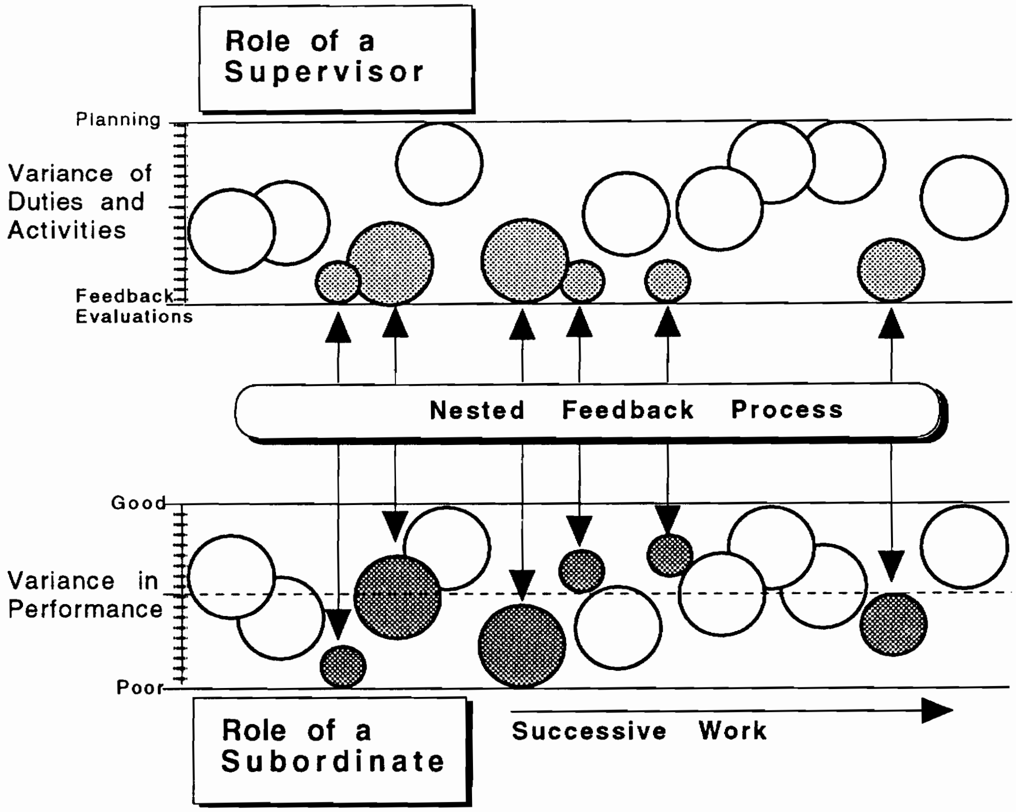

Figure 1. Performance feedback represents a nested process between the two roles of a supervisor and subordinate. Within each role supervisors and subordinates face the dynamics of their work, illustrated here as performance and management variation over time. Circles represent the relative variance in activities and performance over successive days of work. Different size circles indicate relative amounts of information sampled or observed by a supervisor. Grey circles indicate those days when a supervisor's schedule included the evaluation of a subordinate's work behavior. Feedback is nested since it is dependent on: (1) when supervisors have opportunity to sample and observe, and (2) what level of work behavior is observed at the time of the evaluation.

feedback within this larger framework. Specifically, I will render an account of the dynamic, temporally dependent, and contextually bound properties of the two processes mentioned above (i.e., management variation and performance variation) and then discuss the implications of their interaction on the delivery and character of informal feedback.

Management Variation. Managers, in general, must attend to a myriad of organizational functions, from meetings on production strategies to reviewing progress reports, from answering mail and phone calls to directing secretaries and reporting to superiors. Field research has noted that a typical manager's routine from day to day, or hour to hour is characterized by brevity, variety and fragmentation (cf. Borman & Brush, 1993; Mintzberg, 1973). In this light, a supervisor's relationship (or pattern of supervision) with any particular subordinate is likely to be a successive but inconsistent series of spontaneous, disconnected, and discrete episodes, wherein each episode a supervisor observes only a sample of a subordinate's work. Such conditions have been described elsewhere: by Kahn's (1964) "Role Overload" formulation, and Dornbusch and Scott's (1975) "Type III" incompatibility concept of unpredictable evaluations.

As shown in Figure 1, a manager's ability to supervise an employee may be an inconsistent and probabilistic event, controlled by a manager's own personal work schedule and demands. Indeed, it is the informal, unstructured, and time pressed nature of a manager's role, with its numerous responsibilities and activities, that define the limits which a subordinate's performance can be managed. I call this dynamic but constrained management process opportunity-based supervision. There are two main dimensions that constrain the management process, they are: (a) opportunity to observe, and (b) opportunity to sample. In Figure 1, opportunity to observe is illustrated by the arrows that indicate when supervisors made time to observe a subordinate's work. Opportunity to sample is represented by the size of the subordinate circles, their size indicates the amount of performance observed for evaluation and feedback.

Opportunity-based supervision is seen as important since it describes a basic but common antecedent condition to informally delivered feedback. Unfortunately, as we shall see in a later section, opportunity-based supervision represents a situation prone to judgmental bias that may adversely effect the accuracy and efficacy of informal feedback. These potential judgment errors are associated with a manager's limited ability to observe a representative sample of a subordinate's performance at any given moment of evaluation. If accurate and veridical evaluations are based on the representativeness of the sample or amount of information obtained, then the judgments regarding feedback may be aversively effected by sampling bias problems encouraged by opportunity-based supervision. Unfortunately, opportunity-based supervision can set severe limits on how much information may be made available to a supervisor during any given informal evaluation episode. Sampling bias, and therefore inaccurate feedback, are defined by whether a subordinate's behavior observed during a single episode of evaluation is indicative of his or her overall or true performance.

Performance Variation. Even though subordinates, in general, may perform a single job or an invariant routine of tasks, they are no less affected by the dynamics of their role (as performers) than are managers (as supervisors). These dynamics usually manifest themselves in performance and work outcome variations observed over time. Figure 1 represents this performance variation as a visual (i.e., time series of behavior), as related to management variation, evaluation, and the delivery of feedback. As discussed and illustrated above, managers may face diverse responsibilities and hectic schedules, but subordinates also must deal with numerous factors affecting the quality and quantity of their performance. These factors can be divided into three categorizes: organizational contexts, person variables, and system dependencies. First, although not directly affecting performance, organizational contexts may have important non-obvious effects on work behavior and motivation, such as: the level of financial compensation and benefits earned; the existence of union pressures and issues; the enforcement of ancillary organizational policies and ethics (e.g., safety and health issues); and the implicit influence of in-group or out-group pressures on a subordinate's identity or status. Second, person variables represent relatively unstable factors that employees carry each day to their job; these include contemporary experiences, feelings, moods, needs, and desires. Person variables are seen as unstable since their effects on work performance are unpredictable and probabilistic. These factors are unpredictable since (for the most part) they originate from various sources outside the work environment, such as family, health, or personal financial concerns. For example, a single working parent must care for his or her sick child, an employee's individual biorhythm may determine times of fatigue and peak energy, late-night celebrations with friends and family may, the following work day, mitigate an employee's abilities and efforts, and family problems such as a pending divorce or a laid off spouse may alter an employee's concentration or motivation. Third, most subordinates who produce a product or service are typically embedded within a system of dependencies in order to perform their job. These dependencies take on many forms, such as: (a) the depth of employee training and work experience (b) the provision, quality and on time delivery of materials or information to produce goods or services, (c) the quality of tools, machinery, equipment, and work environment for making products or providing services, (d) the assistance, advice and teamwork of co-workers, and (e) the proper leadership, direction and feedback from a supervisor in order to achieve the desired organizational goals.

As conceptualized above, subordinate performance is not conducted within a vacuum, it is a process influenced by a complex set of contexts, variables and dependencies. Furthermore, like a manager's chaotic routine, these factor are assumed to affect a subordinate's performance in a temporally inconsistent, probabilistic and unpredictable manner. In other words, from day to day, the relative influence of these factors may change, covary, or cancel out for a number of reasons, known and unknown to managers and employees. Note that the point here is not to isolate the individual contributions of each factor and its potential affect on performance (i.e., decomplexifying the milieu), but rather to illustrate these factors as a dynamic confluence of causes that wax and wane, and represent some intrinsic properties of a performance process. Indeed, it is these dynamic and probabilistic influences of a performance process that affect behavioral and outcome variation.

It is not intended here to imply subordinates are not responsible for or are not causal to some portion of their own performance. Instead, the intention has been to conceptualize the causes responsible for the natural variation of a performance process, what statisticians have called within variance, error variance, or random variation. Similarly, Deming (1982) has conceptualized this type variance as variation due to "common causes". In terms of statistical process control (SPC) theory, common cause variation represents variance which is inherent and systemic of a performance process. Factors governing common cause variation are by nature difficult to isolate and correct, since the deviations observed are a function of a host of individual, interacting, relatively unpredictable elements of a complex process (cf. Deming, 1982, Chapter 11). In other words, it is the total performance system itself (i.e., an amalgamation of multiple contexts, variables and dependencies), rather than any one element or part of the system that is responsible for the natural variation observed over time.

Misapplication of Feedback. Managers and organizations establish deadlines, performance criteria, production standards, work policies, quality protocols, conduct inspections, and give feedback in order to direct, motivate and control the performance process. Typically, supervisors place the onerous of responsibility on the subordinate to meet organizational specifications and performance criteria. But, as described above, subordinates are rarely in control of all inputs to their job or the natural variation observed in their performance. However, as Deming (1982) has observed, supervisors often fail to recognize the natural variation of a performance process, and instead mistakenly attribute deviations in performance to a subordinate's effort or ability. Unfortunately, failure to accurately discern subordinate controlled and uncontrolled variation, and the sample bias potential associated with opportunity-based supervision can lead to the misapplication of feedback.

Given the probabilistic nature of natural variation and the sample bias potential of opportunity-based supervision, feedback presented to above or below average subordinate behavior is most likely to have little or nothing to do with an employee's objective or overall performance. In other words, although within any single evaluation episode a supervisor's feedback appears appropriate to the supervisor, the behavior observed might not be representative of a subordinate's overall performance or be under his or her control. Therefore, feedback under these dynamic but limiting conditions may appear necessary and correct, but in actuality the feedback is likely to be erroneous, inaccurate, misapplied, and, as we shall see, misleading. Several areas of research may shed light on the mechanisms underlying the misapplication of feedback (i.e., presence of natural variation in performance and opportunity based supervision).

First, Deming's observation that managers often fail to recognize the natural variation of a performance process likens itself to the fundamental attribution error (Ross, 1977; Nisbett & Ross, 1980), where an observer assigns greater responsibility for outcomes to an associated person than to that person's situation. In general, this error applies primarily to the conditions under which supervisors acquire and interpret information (cf. Markus & Zajonc, 1985). As suggested above, opportunity-based supervision is likely to contribute to decisional errors since managers have limited access and time to observe a representative sample of a subordinate's behavior or situation. Typically, evaluations of worker behavior focus on <u>the person</u> within the work situation. Thus, the misapplication of feedback is a consequence, in part, of the under-characterization of the subordinate's situation, which is itself a product of opportunity-based supervision. Under such conditions where situational influences appear pallid as compared to more vivid person variables, causal attributions are usually made in the direction of the latter than of the former (cf. Markus & Zajonc, 1985).

Second, failure to recognize the natural variation of performance appears to be a function of a manager's inability to correctly discern the "cue-criterion relationship" as articulated by multiple-cue-probability-learning (MCPL) theorist (Hammond, 1966;.Hammond, Stewart, Brehmer, & Steinmann, 1986; Hammond, & Summers, 1972; Klayman, 1988). Although MCPL research typically studies how people learn to <u>predict</u> events on the basis of a small set of available cues from a probabilistic environment, this approach is amenable to our understanding of misapplied feedback. Specifically, opportunity-based supervision represents the probabilistic environment by which managers observe and acquire information (cues) regarding the performance (criterion) of a subordinate. Supervisors during an evaluation period must make judgments concerning feedback according to the information cues available (i.e., immediate behavior observed). However, MCPL research has shown that predictive judgments are adversely effected by cue-criterion relationships that are either non-linear or contain random error (cf. Klayman, 1988). Therefore, it appears that the interaction of conditions between opportunity-based supervision and the natural variation of subordinate performance may be responsible for a manager's inability to recognize through cue experience the natural variation of a subordinate's performance. Thus, a manager's inability to discern the cue-criterion relationship between immediate behavior and overall performance may prevent the appropriate administration of feedback.

The two areas discussed above are a consequence of a similar theme, that is, managers are subject to the misapplication of feedback because of the absence or inability to perceive or learn the presence and function of natural variation in subordinate performance. As shown above, this inability to perceive the natural variation of subordinate performance is seen as a function of an opportunity-based supervision style of management. However, for the purpose of this paper, the importance of the misapplication of feedback is that the conditions that promote its occurrence may have devastating consequence on its efficacy. In the next section I will argue that one of these consequences, arising from the conditions of opportunity-based supervision and the presence of natural variation in subordinate performance, will be the emergence of an erroneous negative feedback bias.

Consequences and Implications of Misapplied Feedback

Investigators have sought a better understanding of the causes and consequences of inaccurate or distorted feedback, since it is accepted that employees need accurate feedback for a number of personal and organizational functions, including the purposes of learning, uncertainty reduction, direction, self-esteem, motivation, self-regulation, and self-actualization (cf. Ashford & Cummings, 1983;

Hackman & Oldman, 1976; Ilgen, et al., 1979; Katz & Kahn, 1978; Maslow, 1954; Taylor et al., 1984). Research on inaccurate feedback has usually concentrated on: the positive distortion of negative feedback by supervisors reluctant to deliver critical information (e.g., Fisher, 1979; Ilgen & Knowlton, 1980; Larson, 1984, 1986), and the ingratiating and confessional tactics used by subordinates to proactively mitigate poor impressions or negative feedback (e.g., Larson, 1989; Wayne & Ferris, 1990). In contrast, little research has been dedicated to examining the conditions of opportunity-based supervision or natural variation as factors promoting inaccurate or misapplied feedback. Given the importance of efficacious feedback to organizations, supervisors, and employees, it is surprising that not more research has focused on these conditions, especially given that: (a) they represent some of the natural dynamics surrounding the feedback process, and most importantly, (b) these conditions may seriously affect the integrity of the feedback process itself.

One of the central aims of this paper has been to portray the informal, day to day process of supervisory feedback as one part of an inter and intra-personal system, with feedback nested between and dependent on two other critical parts of this system (i.e., the processes of performance and management variation). With respect to these two processes, special attention was spent on conceptualizing their variability as a function of their own inherent complexities. In each case, variability was illustrated as a product of multiple factors, dependencies, time, and their rich and active contexts, rather than on some unique or isolated agent. In one sense, this analysis attempted to understand and depict the natural ecology that determines and surrounds performance and management variation, and thus the feedback process. From this analysis two features were revealed as potentially important to the veracity of performance feedback. Accordingly, opportunity-based supervision and the natural variation of performance represent the effects of managers and performers under dynamical conditions assumed common to their roles and positions. However, the implications of these features were presumed to contribute to certain judgment errors, ultimately resulting in the misapplication of feedback. Unfortunately, the delivery of misapplied feedback may lead to a number of serious consequences.

Confusion and Disappointment. Subordinates given misapplied feedback may cause subordinates and supervisors some confusion and disappointment, since subordinates may find it impossible to repeat or avoid those responses or performance outcomes associated with feedback. This again, because the deviations observed were not under the control of subordinates, but instead a product of system factors. Although prior to feedback a subordinate's performance may have naturally varied around an acceptable range and average, misapplied feedback may induce subordinates to change prior task habits or motivations to the detriment of meeting existing organizational goals and standards, thus decreasing their organizational effectiveness. In other words, misapplied feedback may prompt subordinates to search through divergent and potentially costly behavioral variations for different ways of approximating performance outcomes asked for and expected by supervisors.

Discrepancies and Conflict. One principle assumption in feedback research, usually not stated, is the notion that supervisors are more accurate perceivers of subordinate performance than are subordinates themselves. On one level, this argument has been justified implicitly on the grounds that supervisors (as evaluators) are apparently in a better position to be "objective", due to their distance, perspective, motivation, and knowledge. Contrary to this assumption, subordinates may also have an advantageous position, although subjective, to observe their own performance over time. These diametrically opposed perspectives are often blamed for supervisor and subordinate discrepancies and interpersonal conflicts during subordinate evaluations. Indications of this conflict are suggested by field and laboratory research reporting that supervisors and subordinates show little agreement concerning the day to day perceptions of feedback timing, specificity, consideration and frequency (cf. Hackman & Lawler, 1971; Harris & Schaubroeck, 1988; Ilgen, Peterson, Martin, & Boeschen, 1981). These interpersonal conflicts are typically explained as a function of an actor-observer bias (cf. Green & Mitchell, 1979; Mitchell, Green, & Wood, 1981), but may also be a result of the different amounts of behavior each person has sampled or experienced (as suggested by Dornbush & Scott, 1975). Therefore, the misapplication of feedback, as a consequence of opportunity-based supervision, may unintentionally foster discrepancies and interpersonal conflicts, since a supervisor's sampling of a subordinate's performance is likely to be suspect.

Emergence of a Negative Feedback Bias. Probably the most serious consequence of misapplied feedback is the potential development of a negative feedback bias. In order to understand how a negative feedback preference emerges, we must first focus on the reciprocal relationship between supervisors and subordinates (e.g., Herold, 1977; Jablin, 1979; Katz & Kahn, 1978). From this perspective, not only do supervisors deliver feedback, but they in turn are given feedback in the form of subsequent changes (or lack of) in subordinate performance. It is assumed that information regarding the success or failure of feedback to change a subordinate's behavior are used by supervisors to judge the effectiveness of any specific mode, type or character of feedback.

Using a learning theory approach, the reciprocal nature of the feedback process suggests that if a certain type of supervisory feedback apparently produces a desired outcome, the use of that type of feedback is strengthened, rewarded or reinforced. Alternatively, if a specific type of supervisory feedback apparently produces an undesired outcome, the use of that type of feedback is weakened, penalized, or punished. Thus, managers may adopt different feedback preferences depending on the differential effectiveness of certain types of feedback to direct and motivate their subordinates. However, given the scenario that performance variations are governed by system factors, feedback in this context may have no contingent effect on behavior, where feedback and a subordinate's behavior represent independent events. They are independent in the sense that changes in behavior following feedback are due to the natural variation of the performance system and not feedback. Consequently, supervisors who do not recognize the presence of natural variation in performance may erroneously conclude that behavior changes following feedback are the result of feedback. Therefore, the apparent effectiveness of misapplied feedback may itself mislead supervisors to falsely believe in the efficacy of certain types of feedback. In other words, when the correlation between feedback and some behavioral effect are accidental, the resulting information regarding feedback's significance is erroneous.

The consequence of this erroneous information was first suggested by Kahneman and Tversky (1973). They believed they observed the scenario described above among Israeli flight instructors. According to Kahneman and Tversky, instructors had noted that praise of exceptionally good piloting was often followed by poorer performance, while criticism of exceptional poor flying was usually followed by improved performance. Here the Israeli flight instructors had fallen victim to failing to discriminate between the natural variation and student-pilot controlled variation of performance. Kahneman and Tversky (1973) argued that such judgments represent a common methodological error, that is, not acknowledging the stochastic process of "regression to the mean". Under such conditions of natural variation, the observations of better or worse than average performance are a product of chance. However, extreme levels of performance are likely to be followed by behavior that appears to regress back toward the mean of a distribution. This process too is determined by chance. Here "regression to the mean" is viewed as one of the fundamental properties of describing the natural variation of performance as discussed earlier. Thus, supervisors presented with such a situation may come to believe that positive feedback given to better than average performance is ineffective, since behavior following feedback is likely to get worse. On the other hand, negative feedback to below average performers appears to be an efficient means to change behavior, since behavior following feedback is likely to improve. Consequently, supervisors given a long-term exposure to such a process may adopt a negative feedback bias unwittingly. Indeed, Kahneman and Tversky (1973, p. 251), using the language of a reinforcement paradigm, lamented over the possible extent of this interpersonal-human dynamic:

> This true story illustrates a saddening aspect of the human condition. We normally reinforce others when their behavior is good and punish them when their behavior is bad. By regression alone, therefore, they are most likely to improve after being punished and most likely to deteriorate after being rewarded. Consequently, we are exposed to a lifetime schedule in which we are most often rewarded for punishing others, and punished for rewarding.

Unfortunately, few studies have attempted to experimentally investigate the observations of Kahneman and Tversky (1973) and Deming (1982). Indeed, I could find only one study that has attempted to understand the process of an emergent negative feedback bias. Using a reinforcement paradigm, Notz, Boschman, and Tax (1987) had subjects, acting as supervisors, reward or punish a subordinate on a data input task. In fact, no subordinate actually existed, and subordinate performance was controlled by a computer-assisted simulation. Subordinate performance was displayed on a computer monitor's screen in the format of a time series chart. This chart displayed 5 data points (in series) per trial for a total of 28 trials or 140 data points. This 140 data point time series was actually a randomly generated series of points, with the intent of exemplifying properties consistent with Kahneman and Tversky's notion of "regression to the mean". Subjects (as supervisor) in this study were instructed to either reward or punish a "subordinate" by giving or taking money, from 1 to 99 cents (i.e., the main dependent variable). Although no statistics, confidence intervals or data analysis methods were given, Notz, Boschman, and Tax (1987) found a modest decrease in reward and a moderate increase in punishment over time. In addition, when subjects were asked to evaluate the perceived effectiveness of reward versus punishment, subjects at the end of the study perceived punishment more effective than at the beginning of the study.

Despite the failure to present statistical information and the method by which their data were analyzed, Notz, Boschman, and Tax (1987) findings represent an attempt to unpack the emergence of a negative feedback bias as described by Kahneman and Tversky (1973). However, several limitations should be noted that may have contributed to their less than robust findings. First, no attention was given to how their independent variable was developed, except to suggest it was a random series of points. No information was given concerning (a) how the random series was constructed, (b) to what degree the time series exhibited regression to the mean properties, and (c) whether a standard, mean, or average level of performance was given to anchor subject's comparisons and judgments. Unfortunately, such a lack of specification limits the depth of possible understanding, explanation, and future ability to replicate or extend this line of research.

Second, the Notz, Boschman, and Tax study neither examined conceptually nor experimentally the notion that a supervisor's ability to observe a subordinate at work is necessarily constrained by some window of opportunity, where only a certain amount of performance can be sampled. In their study, they controlled this window to a 5 data point trial of an unfolding 140 data point time series. Thus, the results of the Notz, Boschman, and Tax study might actually be a function of regression to the mean stochastic and the size of the performance window (i.e., the 5 data point trial), rather than a direct influence regression to the mean alone. Given these limitations and exceptions as well as the relative significance of results found, further experimental research appears warranted.

Synthesizing an Analysis of a Negative Feedback Bias:
A Dissertation Proposal

Suppositions and Working Hypotheses. Using the observations and evidence provided by Deming (1982), Kahneman & Tversky (1973), and Notz, Boschman, and Tax (1987), the purposes of this dissertation are to investigate the emergence of a negative feedback bias by manipulating parameters associated with the misapplication of feedback over time. It was suggested that two factors were responsible for the misapplication of feedback, namely (a) limitations caused by opportunity-based supervision, where only a certain amount of subordinate behavior can be sampled at any given moment, and (b) that supervisors find it difficult to recognize the natural variation, random fluctuations, and regression to mean processes characteristic of performance governed by common causes (cf. Deming, 1982; Hogarth, 1980 and Kahneman & Tversky, 1973). From an ecological perspective, these two factors were conceptualized as necessarily interdependent, representative of the natural circumstances supervisors face when providing informal day to day feedback. In other words, it is important to acknowledge that opportunity-based supervision constrains the amount of behavioral variation a supervisor can sample at any given episode of evaluation. From these two interactive factors four suppositions and six hypotheses can be delineated.

Supposition 1. The smaller the sample of behavior observed by a supervisor, the greater the potential for a negative feedback bias, while larger samples may actually attenuate the negative feedback bias. This supposition, however, is necessarily dependent on how much of the natural variation of performance is observed, at any given opportunity and over successive opportunities. At one extreme, when only a single instance of subordinate behavior is observed deviating from a standard, the behavior may appear vivid since any examples of a subordinate's overall performance are absent or unavailable. Under these conditions where a clear and distinct "difference" from a performance standard is observed, informally delivered feedback appears unquestionably justified. In other words, since the single deviation in behavior is seen in isolation from other examples of past behavior, the behavior is more easily identified, labeled or categorized as being good or poor behavior. Consequently, it is this apparent clarity provided by the limitation of what can be observed of a subordinate's naturally varying behavior, that sets the occasion by which positive and negative feedback are differentially associated with their success or failure in changing behavior. Therefore, negative feedback appears as an effective supervisory tool to direct and motivate subordinates, although in actuality feedback is misapplied.

In contrast, a single instance of behavior seen as part of a pattern of natural variation is likely to decrease the distinctiveness of that single instance of behavior and the eliciting affects prompting feedback. Since natural variation is more likely to be observed within larger samples, determining the cause of this variation is more likely to pose greater difficulty. With larger samples the introduction of behavioral inconsistency may result in a supervisor postponing the delivery of feedback or waiting for further information or instances that might justify giving feedback (e.g., a recognizable trend). Similar to findings in rating accuracy research, a supervisor might be more uncertain about the justification and delivery of feedback, since inconsistencies in behavior may be difficult to categorize or label as good or poor behavior (see Padgett & Ilgen, 1989). Furthermore, when feedback is delivered, its effectiveness to change performance is likely to appear inconsequential, especially since the inconsistency of behavior observed represents a certain unresponsiveness to performance feedback. Given such a situation, neither positive nor negative feedback may be perceived as an effective tool, therefore mitigating any conditional feedback preference.

It must be emphasized, here that supervisors observing single instances or small samples of behavior may implicitly comprehend, over successive but different instances of evaluation, the inconsistency and variability of a subordinate's performance. However, the emergence of negative feedback is assumed relatively immune to such considerations because: (a) the process of informally delivered feedback represents, at one level, an "on-line" judgment task (Hastie & Parks, 1986), and (b) although a supervisor may implicitly recognize the variability in a subordinate's performance, its influence during any specific episode of evaluation may be overshadowed by the vividness and effectiveness of feedback within the immediate situation (i.e., because it gives the impression to a supervisor that he or she is in control, see Langer, 1975).

Supposition 2. The emergence of a negative feedback bias is dependent on the amount of naturally variation in subordinate performance as seen in performance over time. As such, the more variable a pattern of performance is, the greater the likelihood that a negative feedback bias will be exhibited. On the other hand, the more stable the performance, the more likely that supervisors will show no negative feedback bias. Obviously, the degree to which natural variation influences a feedback bias will be dependent on the amount of information or size of the behavioral sample observed, as discussed above. However, in general, with more behavioral variance or regressive bounce around an average performance value, the greater the opportunity for positive and negative feedback to be differentially associated with their respective effectiveness.

The two hypotheses presented below represent the inter-relationship of Suppositions 1 (what amount of performance information is observed) and Suppositions 2 (what type of performance variation is observed: stable vs. variable). The hypotheses attempt to provide predictions concerning the emergence of a negative feedback bias. However, it should be emphasized that these hypotheses are adduced from both ends of a range of parametric values, defining what and how much a supervisor sees when evaluating a subordinate. Furthermore, the hypotheses are believed abstractions when considered singularly; however, considered as a whole, they are expected to function within a three way interaction.

(Hypothesis 1) A negative feedback bias is more likely to emerge under conditions where supervisors evaluate smaller rather than larger samples of subordinate performance.

(Hypothesis 2) A negative feedback bias is more likely to emerge under conditions where supervisors evaluate inconsistent subordinate performance rather than consistent performance.

Supposition 3. The emergence of a negative feedback bias is a temporally dependent process. As suggested by Kahneman and Tversky (1973) and evidenced by the Notz, Boschman and Tax (1987) findings, a negative feedback bias appears to evolve over time. It has been suggested that supervisors adopt a negative feedback preference as a function of experience. Here experience is defined as a supervisor's successive attempts to manage behavior ultimately controlled natural variation.

Accordingly, a negative feedback bias represents a style of management that is acquired.

> (Hypothesis 3) A supervisor's early experiences with conditions that encourage negative feedback bias (see Hypothesis 1 & 2) should be associated with relatively equivalent uses of positive and negative feedback. However, as a history with such conditions and experiences grows, supervisors should decrease their use of positive feedback, and maintain or increase their use of negative feedback. Thus, there should be a ratio shift over time in the use of negative/positive feedback as supervisors experience the apparent differential effectiveness of each sign of feedback.

Supposition 4. This shift in feedback ratios between negative and positive feedback is assumed to accompany changes in latency measures, that is, the amount of time that elapses prior to feedback delivery. Feedback literature has suggested that people are reluctant to give negative feedback because of fears of social retribution (Fisher, 1979, Larson, 1984, 1986). Surprisingly, Fisher (1979) found that the delivery of negative feedback had shorter delays than positive feedback. Two reasons may account for shorter latencies: (a) Larson (1989) proposed a model suggesting that decreases in latencies may evolve when supervisors must manage either severe performance problems, satisfy certain role pressures to act, or both, and (b) the delivery of negative feedback, because of its effectiveness, becomes an automatic and relied upon management tool. In regards to this latter point, as a negative feedback bias evolves with experience, automatism is thought to develop through practice with events, tasks and problems that yield consistent, confirming and/or predictable results (e.g., Smith & Lerner, 1986).

Conceptually, automatism theory suggests that as experience grows with predictable and consistent phenomena, less cognitive effort is needed to process and choose an appropriate action. Therefore, as confidence increases in the nature of an event, task, or problem, people begin to respond automatically, typically indicated by increased decision speed (e.g., Geller & Pitz, 1968). Nonautomatic processing is seen as a function of when events, tasks and problems are novel or display an uncertainty or unpredictability. In such cases, more cognitive effort is typically required, thus decreasing processing speed. Measurement of automatic versus nonautomatic processing is often recorded as a latency, that is, the amount of time taken to respond to a particular event, task, or problem. Latency measures are typically thought of as an "efficiency" indicator of cognitive processing (e.g., Newell & Rosenbloom, 1981). Since a negative feedback bias and the automatism of judgment are both conceptualized as temporally dependent processes several latency hypotheses can be advanced.

(Hypothesis 4) Under conditions when supervisors evaluate smaller samples of subordinate behavior, latencies are expected to be shorter, while larger samples are expected to encourage longer latencies.

(Hypothesis 5) Latency measures for negative feedback are more likely to be shorter than positive feedback when supervisors are under conditions that encourage NFB

(Hypothesis 6) Under conditions when supervisors evaluate either smaller or larger samples of subordinate performance, latencies will be longer when supervisors evaluate inconsistent subordinate behavior, and shorter when they evaluate more consistent behavior.

It is thought initially that positive feedback should have shorter latencies than negative feedback since people in general consider positive feedback socially acceptable, if not desirable, information. But negative feedback latencies will eventually decrease as supervisors learn over successive experiences that such feedback is followed by a relatively consistent and expected change in subordinate performance. However, experience with positive feedback may cause supervisors to pause and review this decision since it has shown to be, more than likely, ineffective. Thus, as a negative feedback bias emerges, an inverse relationship between the latencies of positive and negative feedback should be observed. In addition, latency changes may be indicative of a categorization process, whereby supervisors develop evaluation schemata for responding to certain subordinate behaviors (i.e., good vs. poor performance).

Additionally, negative feedback may appear inconsequential as embedded within a context of inconsistent performance, supervisors may begin over successive encounters to notice that individual instances of poor performance improve after the presentation of negative feedback. Therefore, supervisors may focus on the relationship between negative feedback and singular instances of poor work behavior, and selectively discount the rest of the larger sample of variable behavior. Negative feedback under these conditions may show decreases in latencies since there is a greater probability that single instances of poor performance will appear responsive, and thus predictable.

However, because more information is provided (i.e., greater variability to be observed and evaluated) more cognitive effort and more processing time will be necessary in order to make a judgment. It is doubtful that such judgments will become automatic since supervisors must consider the variation and inconsistency of performance prior to making a feedback decision. Similarly, supervisors will probably have difficulty attempting to categorize or label a subordinate when his or her behavior is "seen as" inconsistent, thus preempting any automatic processing of performance information into a feedback decision (see Padgett & Ilgen, 1989, on a related issue concerning rater accuracy).

Furthermore, a supervisor may attempt to use feedback as a means to prompt positive behavioral change, experience with unresponsive performance is likely confuse and frustrate a supervisor, causing greater cognitive effort and consternation. However, latencies under such conditions may be influenced by numerous factors, such as: (a) when a supervisor feel obliged to give feedback regardless of current or past performance, because it fulfills a supervisor's role and responsibility. In such cases feedback latencies may actually decrease, since effort is given to meeting role requirements rather than evaluating carefully the behavior and subordinate in question. (b) A supervisor may give feedback in order to motivate unresponsive subordinates to work harder or better. Here feedback latencies are likely to decrease since presumably an understanding of the subordinates behavior has already been decided upon. (c) Latencies for feedback may also decrease when supervisors are under great pressure to have employees meet certain job responsibilities, deadlines, or performance changes. Thus, feedback latency measures of supervisors faced with unresponsive but stable subordinate performance are likely to be a function of a manager's situation and needs.

Computer-Assisted Simulation and Experiment. Similar to the Notz, Boschman, and Tax (1987) study, a computer-aided simulation was designed to test the hypotheses stated above. In the following experiment, subjects will assume a managerial role by supervising a secretary's word-processing task on a computer. The simulation will have subjects believe they are presenting positive or negative feedback messages to a secretary in an attempt to improve performance. Procedurally, subjects will view a computer display which presents a graphical representation of a secretary's performance, and will be asked to give performance feedback by pressing one of three keys (i.e., positive, negative, and a no feedback key). Subjects will be told that feedback messages will be electronically sent from their computer to a secretary's computer and displayed on the monitor's screen.

Although subjects will believe they are presenting performance feedback to a secretary, no secretary will actually exist. In all instances, the feedback will have no influence over subordinate performance. Instead, secretarial performance, as shown to subjects graphically, will be probabilistically predetermined and modeled as three distinct time series (i.e., three different random patterns of "secretarial performance"). Each time series will differ according to the amount of natural variation and regressiveness around a mean level. The details on how these random time series will be constructed are discussed below. Additionally, each time series will be broken down into 80 segments and set into successive experimental trials, illustrating and representing an unfolding of a secretary's performance (i.e., varying across trials). During each of these successive trials, subjects will be responsible for giving performance feedback. Furthermore, to model the limitations of opportunity-based supervision, subjects will be shown two types of information-size formats which further defined each trial (i.e., a 2 versus a 4 data point cycle trial). Thus, subjects will be randomly assigned to one of six experimental conditions of a 3 x 2 design, that vary three levels of regressiveness and two levels information-size formats as observed within each trial.

In addition, a post-experimental survey will be given to subjects to ascertain what different attributions and attitudes are formed as a consequence of experiencing the six experimental conditions described above. In general, attribution theory posits an actor-observer bias, where supervisors (as observers) are more likely to attribute a subordinate's poor performance to internal causes of effort and ability than on external causes, such as task difficulties and luck (cf. Green & Mitchell, 1979; Mitchell, Green, & Wood, 1981, Weiner, Frieze, Kukla, Reed, Nest, & Rosenbaum, 1972). However, the seriousness of this attributional process is not just in the formation of attributions, but the potential reification and development of implicit personality theories (Schneider, 1973) or relational schemata (Baldwin, 1992), where cognitive scripts or expectations concerning a subordinate's poor performance persist across evaluations. In other words, a subordinate's future evaluations may be continually judged against or influenced by such prior expectations and memories. Given such circumstances, understanding what potential attributions may evolve from the dynamical conditions associated with the misapplication of feedback are important. The post-experimental survey, therefore, was constructed using the Weiner et al. (1972) conceptualization, so as to examine the influence of the six experimental conditions on attribution formation, as well as other items ascertaining information on other work related perceptions and attitudes.

In summary, given that the Notz, Boschman, and Tax (1987) study is the only published study to date which attempted to test the observations of Kahneman & Tversky (1973) and Deming (1982) it is evident that further research is needed. I have attempted to approximate conceptually as well as methodologically the "mundane realism" (Berkowitz & Donnerstein, 1982) or "ecological texture" (Brunswik, 1956) of informally delivered feedback. This approximation is advanced by representing feedback as a process naturally nested between two dynamic, temporally dependent, and contextually bound processes (i.e., management and performance variation). Finally, this approximation underlines the purpose of this dissertation, establishing the milieu whereby an analysis of a negative feedback bias might emerge and be understood.

Methods

Subjects

Sixty undergraduate males participated as role-acting managers. The males were recruited from an introductory psychology course and given class credit for their participation. Only male subjects were used to control for possible gender effects.

Apparatus

Two Macintosh® computers and their modified keyboards were used to conduct this research. The modified keyboards each include a hard plastic cover with carefully placed holes, exposing two types of keys: (a) three feedback keys, and (b) a reset key. The covered keyboard was used to mitigate any need for typing skills by subjects. Each type of keys were placed in separate areas on the keyboard, to avoid accidental key responses on the part of subjects.

The feedback keys were defined as the Positive, Negative and No Feedback Key. Each of these keys were labeled, and for the positive and negative feedback keys an example of a positive and negative feedback statement was provided. The reset key also was labeled "Reset Key to Continue."

In addition, a black box with a clear plastic cover revealing "sophisticated" computer hardware was located next to the computer. This black box, labeled as the "Gramtech Communicator", was attached to the computer, a telephone and electric wall jack by cables and extension wires. Subjects were told that this box was responsible for the feedback program's execution and computation of a secretary's word-processing performance. The purpose of the "Gramtech Communicator" box was to lend realism to the cover story told to the subjects.

Procedures

Before participating in the study, subjects read and signed a standard informed consent form, which included information concerning their voluntary participation and their right to discontinue the study at any time (see Appendix A for "Informed Consent Form"). Then subjects were seated in a small room at a table with the computer and were familiarized with the computer and keyboard arrangement. A research assistant then started the computer program which began with an introduction to the cover story, instructions, and a tutorial; these were followed by the initiation of the experimental session (i.e., the feedback program). Subjects were left alone during the experimental session, although a research assistant, located in an adjoining room, was available to answer questions.

Introduction to the cover story. Subjects were told that they would supervise a secretary's word-processing performance (i.e., a typing task) by presenting positive, negative, or no feedback. Acting as managers, subjects were asked to improve the production (words typed per unit time) and quality (e.g., words typed correctly) of their secretary's performance by using the feedback keys. Subjects were encouraged to find the best supervisory approach to motivate their secretaries to do a better job. In a broader context, subjects were told that their participation would aid the understanding of computer assisted monitoring and feedback, as these computer systems are increasingly used by automated offices, such as telemarketing, credit-card, and phone companies.

Subjects were told that the computer program selected each secretary at random from a pool of secretaries, each located at one of several participating university business offices. Subjects were informed that feedback was sent from their computer, over a telephone line, to their secretary's computer where he or she is word-processing. It was explained that managerial feedback was displayed on a secretary's computer monitor as a "supervisory message". Subjects were given examples of both positive and negative feedback messages. For example, the positive message read: "Your performance is good. Keep up the good work." The negative feedback message read, "Your performance is poor. You need to do better." Furthermore, subjects were told that each secretary participating in this study had at least 1.5 years of experience and therefore had the ability to type well and is at least an average typist. In actuality, the subject's computer was not connected to a secretarial office, a computer, or a secretary's word-processing task. Instead, secretarial performance was prearranged and probabilistically defined as a time series (see sections below), forming the basis of the computer-aided simulation.

Instructions. The computer program led subjects through a step by step familiarization of the program's operation, including its information screens, its portrayal of word-processing performance, the keyboard and key responses. In particular, the instructions concentrated on acquainting subjects with reading the performance chart. The performance chart illustrated a standard "control chart" (Walton, 1986, p. 114), with the exception that the upper and lower control limit lines were omitted. The performance chart displayed a secretary's typing performance over time. The performance itself was represented by black dots (scores), connected by a line, and ranged between 5 levels of performance, with the control chart's ordinate labeled (from bottom to top) poor, average, and good. Subjects were instructed that each performance score was a combination measure of both a secretary's typing quality (e.g., number of spelling errors) and production (e.g., number words typed per unit time). Average scores represented the industry's minimal standard for word-processing proficiency.

In addition, subjects were informed of a point system. Subjects were told that the point system gave or took 10 points if secretarial performance increased or decreased (respectively) as a consequence of their feedback presentation. However, if the No Feedback Key was chosen, no points were gained or lost, despite how performance changes. Subjects were notified that the purpose of the point system is to give an added means of judging their managerial effectiveness. However, subjects also were informed that points collected would not be used for some comparative or competitive process between themselves and others. This was done to mitigate the perception that their task was analogous to a computer game, where collecting points could become the primary and potentially overshadowing goal rather than the task and its context. Thus, no counter of total points gained or lost was presented during a subject's participation. Instead, subjects were told that their results would be made available after they completed their participation in the study.

The purpose of the point system is to (a) direct the subjects' attention toward the subsequent performance variation after they presented feedback (b) enhance the saliency or meaning of performance variation, and (c) provide subjects some extrinsic task motivation and consequence. It should be noted that since secretarial performance is preconfigured, the number of points gained or lost are also predetermined and dependent only on the use of the No Feedback Key. Therefore, a subject's choice of either positive or negative feedback could be associated with either subsequent performance increases or decreases.

Program Tutorial. After completing the introduction and instruction sections, subjects were given a short test to insure that they understood: (a) the use and purpose of keyboard responses and their locations, and (b) how to interpret secretarial performance charts. In the latter test, subjects were asked to identify among an array of performance charts whether a two event performance series increased, decreased or showed no change. Subjects were allowed to begin the feedback program only when they answered all of the above questions correctly and felt comfortable about the operation of the feedback task.

Procession of the Feedback Program[1]. The feedback program consisted of 2 phases of 40 trials, with each trial made of four successive slides. Examples of the four slides are given in Figure 2. As illustrated, the first slide shows a performance chart, where secretarial performance is portrayed, and requests that the subject (i.e., the role playing manager) give performance feedback by using one of the three feedback keys. After the subject selected and executed a feedback response, the second slide informed the subject that his feedback was being sent over the telephone line to a connected computer and to "please wait" for a performance update. When the second slide timed out, the third slide presented a performance chart showing how performance changed subsequent to the presentation of performance feedback. When the third screen elapsed, a fourth slide displayed point information, either 10 points gained or lost, depending on whether updated performance increased or decreased. However, if the No Feedback Key was selected, subjects were reminded that no points were gained or lost. The point information slide required a subject to press the Reset to Continue Key, producing the next trial of four slides. Together the successive slides and trials provided a quasi-interactive video impression, lasting for approximately 40 min.

Development of Experimental Conditions: The Independent Variables

Time series construction. In order to test the affects of performance variation on the emergence of a negative feedback bias, natural variation stochastics were modeled as three distinct time series. Each time series varied according to the amount of variation exhibited around an average level. The three time series (representing secretarial typing performance) were constructed using Minitab's® "discrete" random data generator (Minitab, 1991, p. 15-3). The actual process that defined the time

[1]The feedback program was constructed using a general object-oriented software language.

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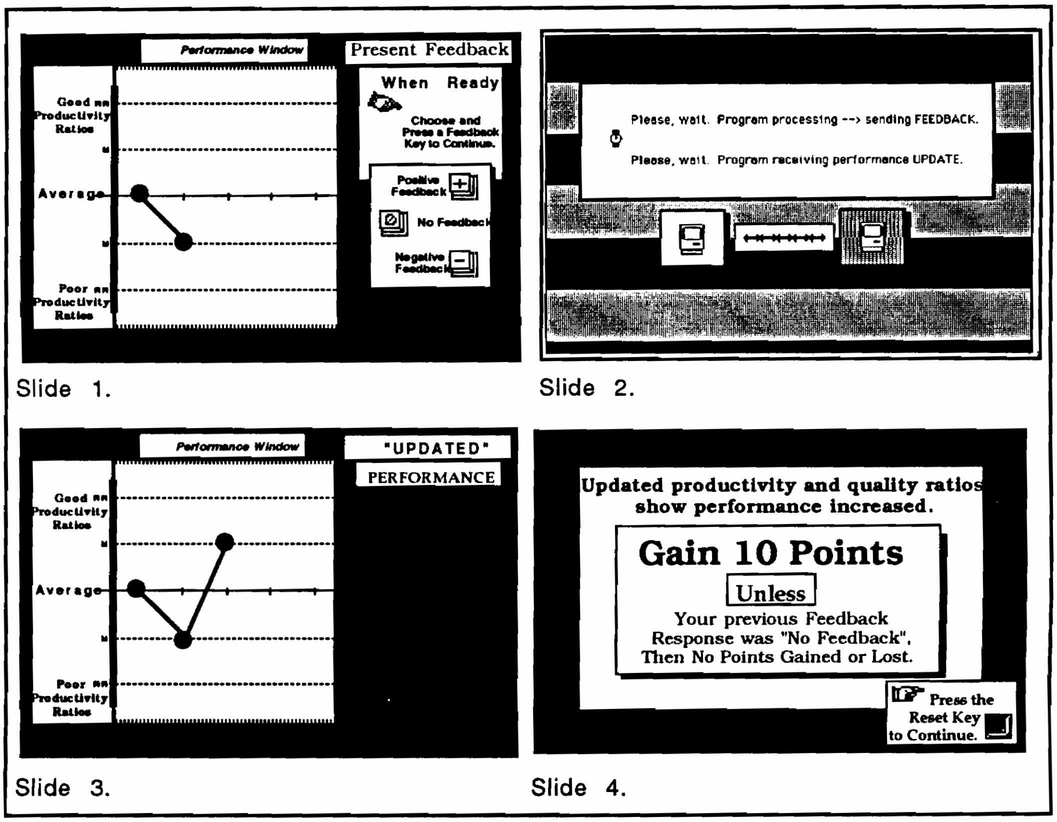

Figure 2. During each trial, the feedback program displays four successive slides: Slide 1 displays secretarial performance and requests a feedback response, Slide 2 ask the subject to be patient while information is transferred, Slide 3 shows how performance has changed subsequent to feedback, and Slide 4 presents point informantion concerning the apparent effectiveness of feedback.

series realizations followed a "formal operation" (the formal operation is discussed in Appendix B). Prior to generating the time series, I decided apriori that the series would range between five horizontal levels (or events), representing varying levels of performance (e.g., "good", "average" and "poor").

In accordance with the introduction, constructing time series with varying degrees of variability were determined by noting the level of performance to be "average" and assigning this level a probability density, to be called a mean regressive density (MRD). In this study, the average performance was designated as the middle level. The remaining four levels represented the bounce or variation around the average level. These four levels (i.e., two above and two below the average level) were then given equal probability densities, adding up to the reciprocal of the MRD. This reciprocal was referred to as the variance density or VAR. Consequently, time series were randomly generated by giving each level (or event) a discrete probability density, and then choosing the number of events to be sampled in series (i.e., the length of the time series).

Three MRDs studied were: .80, .50, and .20. Consequently, the reciprocal VAR densities to be included were .20, .50, and .80 respectively. For the sake of clarity, each time series is designated by their VAR density, with the densities referred to as Hi-VAR (.80), Md-VAR (.50), and Lo-VAR (.20). Note that the three VARs chosen represent a wide range of relative variation around an average level (i.e., the MRDs). At one extreme the .80 VAR and its four levels, each with a 20 percent probability, constructs an "all" random performance time series, since its MRD is equal to .20. Alternatively, the .20 VAR and its four reciprocal levels, each with a 5 percent probability, represents a highly stable performance time series, since its MRD is equal to .80. The three time series generated are illustrated in Figure 3, panel (A).

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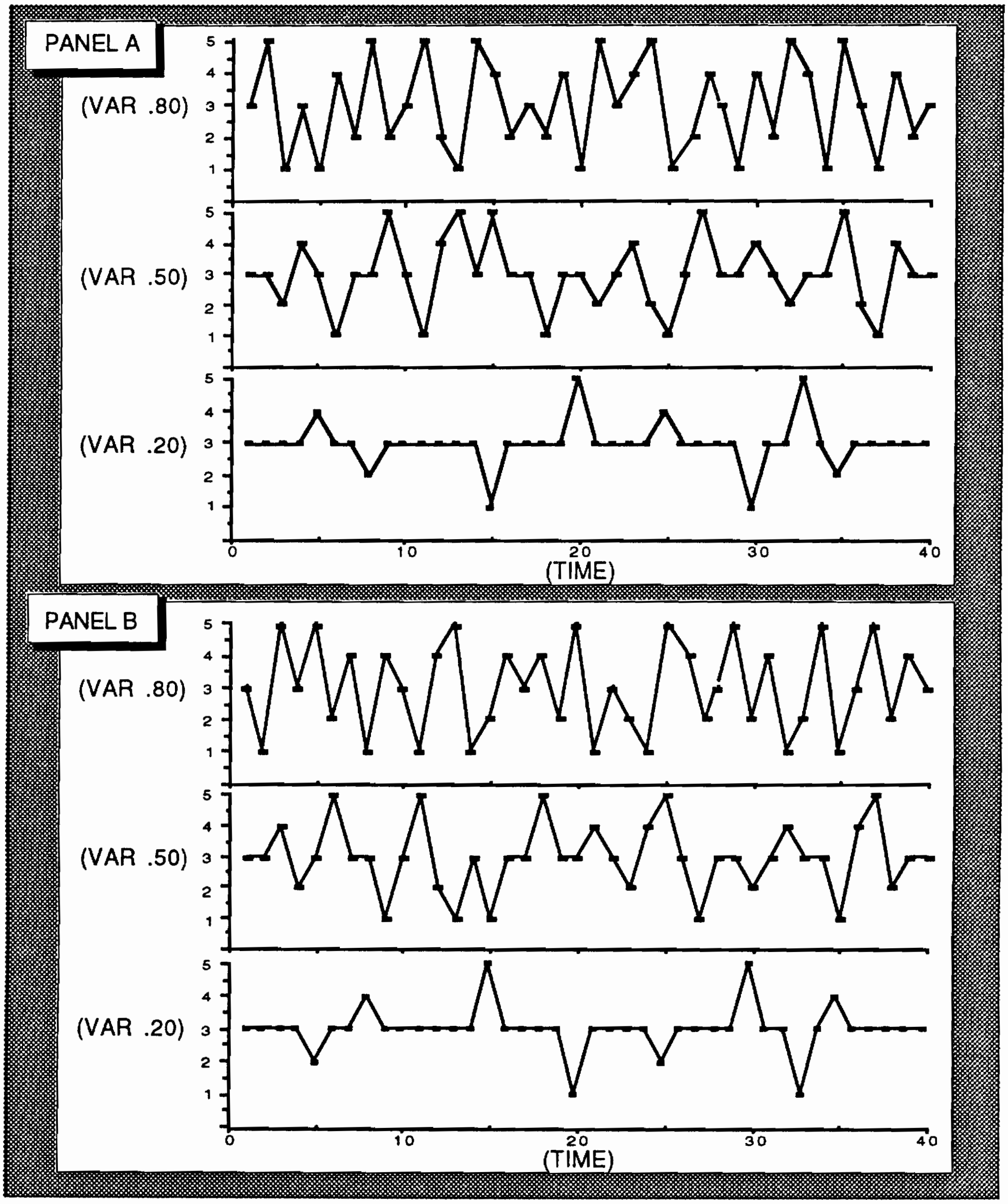

FIGURE 3. Panels A and B each show three serial distributions as constructed by Minitab's "Discrete Command" random generator. Each series is defined by its variance density (VAR). Panel B represents the counterbalance (i.e., the vertical flip) of Panel A.

These three time series were each selected from a sample of 10. This was done in order to select a time series which limited unintended trends or obvious asymmetries around the average. To correct for nonobvious trends or asymmetries, each of the three time series chosen was analyzed and adjusted using both a "Draw and Quarter" and "Balancing Bounces" procedure (see Appendix C). Additionally, the second phase of each time series condition, illustrated in Figure 3, panel (B), represented a "counterbalance" of the original series. This was done to further control for any possible unplanned trends due to time series asymmetries. Furthermore, each time series was tested for goodness-of-fit against several criteria defining an ideal time series realization (see Appendix B for how the analyses were formulated and conducted).

Trial format and information size. To test the effects of opportunity-based supervision on the emergence of a negative feedback bias different information sizes were designed. Restricting the amount of information presented to each subject (per trial) attempted to model managers under the opportunity-based supervision condition, specifically, the opportunity to sample dimension. Thus, each time series was broken down into two different trial sizes, defining two information-size windows called INFO. The first information-size window configured each VAR time series into two phases of 40 two-event trials, with each trial illustrating two successive performance scores (INFO 2). The second information-size window arranged each VAR time series into two phases of 40 four-event trials, with each trial portraying four successive performance scores (INFO 4). In both information-size formats, performance variation changed trial by trial by shifting the information-size windows across a time series (shown in Figure 3) over to the right by one performance event at a time. Therefore, each trial in either INFO format presents performance as concatenated but viewed in separate segments as each trial is displayed. In other words, subjects saw a series of trials (i.e., performance charts), each including either two or four successive performance scores (i.e., INFO 2 or 4), to which subjects were asked to give performance feedback.

Experimental Design

A 3 x 2 between groups design with repeated measures was used. The first factor modeled performance variation (VAR density), including three levels: a high variation density of .80 (Hi-VAR), a medium variation density of .50 (Md-VAR), and a low variation density of .20 (Lo-VAR. The second factor, amount of information observed per trial (INFO), consisted of two levels: a low information format where two successive performance scores were observed per trial (INFO 2), and a high information format where four successive performance scores were observed per trial (INFO 4). The repeated measures factor, the within variable, consisted of two phases of 40 trials (PHASE), each representing the unfolding of performance variation, as defined by each time series.

Dependent Variables

In each trial two dependent variables were electronically recorded by the computer program. First, a subject's feedback response was recorded (i.e., a Positive, Negative, or a No Feedback Key response). Second, the subject's temporal latency to respond with a Positive, Negative, or a No Feedback Key was recorded. Latencies will be measured in "ticks" (16.62 milliseconds) or about one-sixtieth of a second.

Demographic, Attribution and Manipulation-Check (DAM) Survey

A survey was given to all subjects at the conclusion of the experimental session (see Appendix D). This survey was designed to observe the effects of the experimental conditions on subjects work related attributions and attitudes. The DAM survey included three main sections. First, subjects were asked to answer demographic questions concerning age, class level, degree major and minor, computer knowledge, and work experience; particularly if subjects had ever supervised employees before. Second, subjects answered two manipulation check questions, which assessed how seriously each subject took his role as a manager and the credibility of the computerized feedback program (see survey items 45 and 48). Finally, the main part of the survey included questions designed to explore the effects of the different experimental conditions (i.e., MRDs and information sizes) on the formation of work related attributions, attitudes and perceptions. In brief, items asked subjects (supervisors) to: (a) assess the extent secretarial performance was attributed to luck, task difficulty, ability, or effort, whether the causes of performance were due to internal or external factors and whether performance was considered stable or inconsistent (see survey items 1, 6, 10, 20, 23, 25, 27, 30, and 31); (b) characterize the coerciveness, cohesiveness, communication, and satisfaction between themselves, the task and their secretaries (see survey items 2, 3, 4, 13, 15, 19, 22, 26, 37, 39, 42, and 43); (c) estimate the amount of influence they had over secretarial performance (see survey items 11, 12, and 24); (d) judge the likelihood that their secretaries should be recommended for promotion, special recognition, or a special training course (see survey items 16, 21, 32, 34); and (e) rate and describe their secretary's performance, ability, effort, consistency, motivation to do well, need for constant supervision, and acceptance of positive and negative feedback (see survey items 5, 7, 8, 9, 14, 17, 18, 28, 29, 33, 35, 36, 38, 40, 41, and 44).

Results

The results are organized in five sections. The first section presents the results of the manipulation check measure. The second section reports omnibus tests associated with the feedback response hypotheses (i.e., Hypothesis 1, 2, and 3). The third section presents the omnibus tests for the latency hypotheses (i.e., Hypothesis 4 and 5). In addition to the omnibus analyses, the above sections will give the results of pairwise comparison tests. The fourth section investigates the primary data at a more micro-level of analysis, that is, the overall response and latency data are unpacked according to temporal, sequence and individual subject effects. The fifth section, explores subjects' answers to the post-experimental survey and their relationship to their response data.

Section One: Manipulation Check Measure

During the post-experimental survey subjects answered the following item: "How serious did you take your role as a manager using 'Computer-Assisted Feedback'?" On a seven point scale (where 4 indicates average), 41 subjects (68.3 percent) rated their seriousness as above average to very serious. Another 13 subjects (21.7 percent) rated their seriousness as average, while only 6 subjects indicated that their seriousness as below average. These 6 subjects were distributed evenly across the six experimental conditions, as were the other subjects' answers.

Section Two: Feedback Response Data

Feedback bias was calculated by a percent difference score for each individual subject (see Appendix E for why this measure was devised). A percent difference score was calculated by the following formula:

$$PercentDifference = \frac{P - N}{P + N},$$

where P is equal to the number of positive feedback responses and N is equal to the number of negative feedback responses. Therefore, when calculating percent differences: positive numbers represent a positive feedback bias, negative numbers represent a negative feedback bias, and near zero numbers indicate a no feedback bias.

Using these percent-difference scores, Figures 4 and 5 show the box plots and confidence intervals of supervisory feedback bias across the different experimental conditions and phases. Each condition's mean, median, variance and standard deviation is given across the bottom of these figures. These measures were analyzed by a 3 x 2 x 2 repeated measures ANOVA (i.e., 3 types of performance variation [VAR - levels] by 2 information-size windows [INFO - levels] by 2 repeated phases [PHASE - levels]). Hypothesis 1 stated that NFB was more likely to emerge under conditions where supervisors evaluate smaller samples of subordinate performance (i.e., INFO 2). Hypothesis 2 stated that NFB was more likely to emerge when supervisors managed inconsistent performance as opposed to consistent performance (i.e., Hi- VAR vs. Lo-VAR). Finally, Hypothesis 3 predicted that NFB would emerge as a function of time (i.e., that Phase experience with the conditions previously stated would increase the likelihood of a NFB). As discussed, the variables named in the NFB hypotheses were expected to interact. Thus the potential for a three-way interaction was expected (i.e., VAR x INFO x PHASE).

As listed in Table 1 the 3 x 2 x 2 ANOVA shows qualified support for these hypotheses. Specifically, the table indicates a significant main effect for VAR, $F(2, 54) = 3.651$, $p < .032$ and a three way VAR x INFO x PHASE interaction $F(2, 54) = 3.212$, $p < .048$. Thus, the significant differences depended on: (a) the degree of inconsistent subordinate performance; and (b) the amount of inconsistent-consistent performance observed by a supervisor over time. All other main effects and interactions were found statistically not significant. Although, the overall ANOVA provides evidence that

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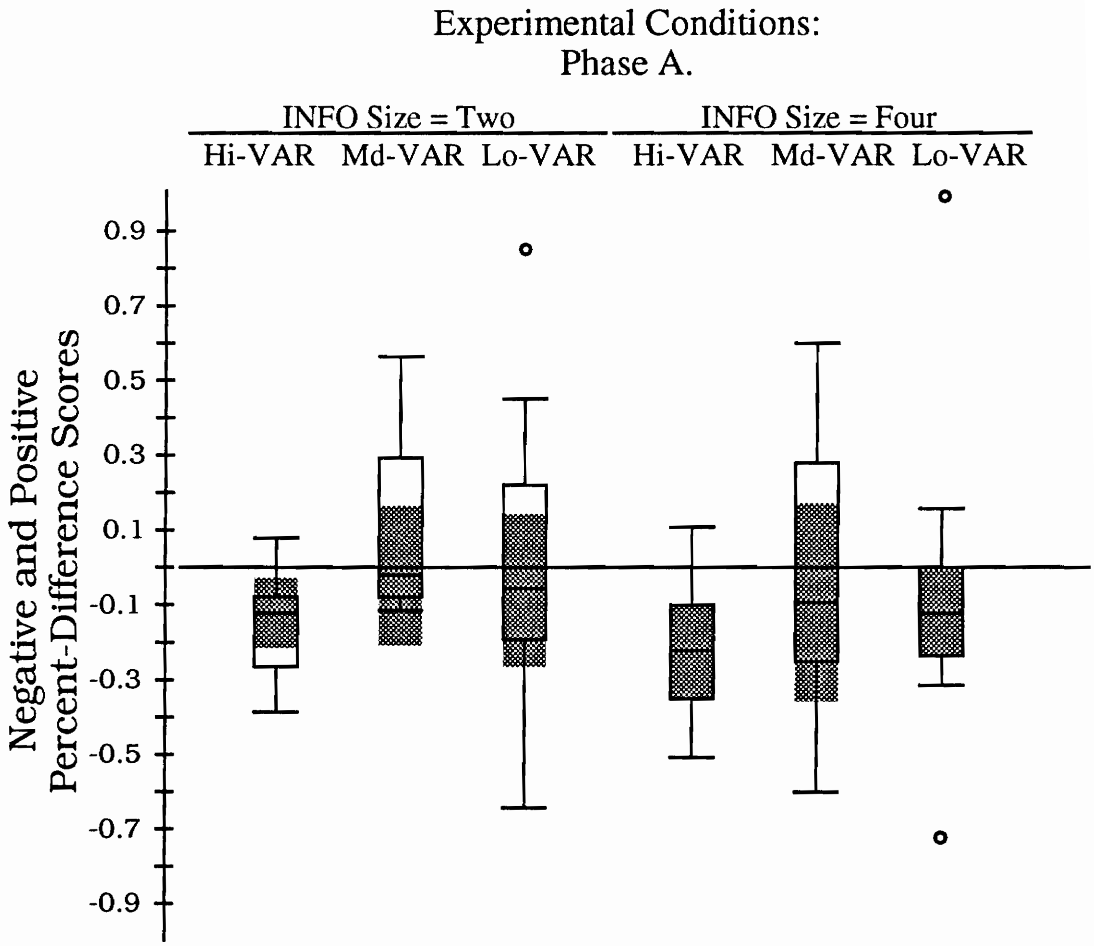

Mean	-0.15	0.10	0.00	-0.20	-0.01	-0.06
Median	-0.12	-0.02	-0.06	-0.22	-0.09	-0.12
Variance	0.02	0.06	0.20	0.04	0.18	0.19
Standard Dev.	0.15	0.24	0.44	0.20	0.43	0.44

Figure 4. Box plots, whisker ranges and median-based confidence intervals (grey shaded areas) across the six experimental conditions for response feedback percent-difference scores in Phase A. Small circles indicate outliers.

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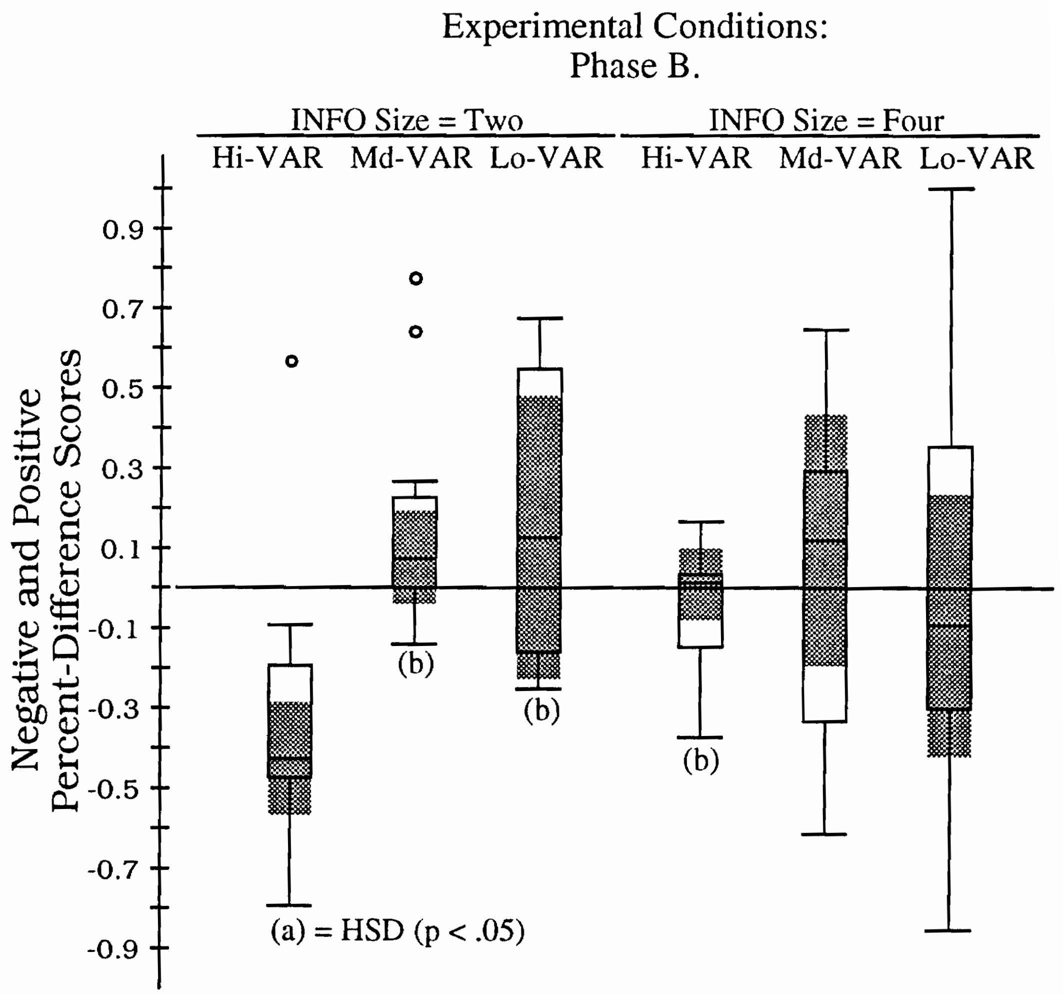

Mean	-0.34	0.17	0.19	-0.06	0.02	0.03
Median	-0.43	0.08	0.13	0.02	0.13	-0.09
Variance	0.15	0.09	0.14	0.03	0.16	0.29
Standard Dev.	0.39	0.30	0.38	0.18	0.40	0.54

Figure 5. Box plots, whisker ranges and median-based confidence intervals (grey shaded areas) across the six experimental conditions for response feedback percent-difference scores in Phase B. Small circles indicate outliers. Different notation (a vs. b) identify which groups are significantly different from each other, using Tukey's HSD ($p < .05$).

Table 1.
Results of 3 x 2 x 2 Repeated Measures ANOVA for
Feedback Response Percent-Difference Scores.

Source	df	SS	MS	F-ratio	Prob.
VAR	2	1.59842	0.799208	3.6514	0.0326*
INFO	1	0.048401	0.048401	0.22113	0.6401
VAR*INFO	2	0.373282	0.186641	0.85272	0.4319
Subject	54	11.8194	0.218878		
PHASE	1	0.084801	0.084801	2.0374	0.1592
VAR*PHASE	2	0.123912	0.061956	1.4886	0.2348
INFO*PHASE	1	0.029768	0.029768	0.71519	0.4015
VAR*INFO*PHASE	2	0.267405	0.133703	3.2123	0.0481*
Error	54	2.24757	0.041622		
Total	119	16.5929			

*= p values less than .05.

significant differences exist, the following analyses attempt to pinpoint where these obvious and non-obvious differences lie.

By testing the two phases (A and B) independently we may better clarify when and what conditions influenced the significance and insignificance of the effects. Furthermore, Hypothesis 3 stated that NFB would be a function of experience, that no differences were expected during early trials while during later trials NFB was predicted. Therefore, the original 3 x 2 x 2 repeated measures ANOVA was split into two 3 x 2 ANOVAs representing PHASEs A and B. Tables 2 and 3 give the results of each of these ANOVAs. As predicted, the PHASE A analysis shown in Table 2 indicates no significant difference between the two factors of VAR and INFO. In contrast, in Table 3, the PHASE B ANOVA shows that VAR was statistically significant, F (2, 54) = 4.136, p < .021. However, the p-value for VAR x INFO interaction remained not significant (F (2, 54) = 2.17, p < .124). This lack of effect appears due to the great variances observed by the VAR and INFO conditions seen in Figure 5. Thus, in combination, these analyses support Hypothesis 3, in that differences appeared to emerge over time (i.e., in Phase B) although apparently driven by the VAR factor. Given the above, we must still characterize the location of the differences and the NFB effect.

One clue as to the location of the NFB effect may be seen in Figures 4 and 5. First, note that in both figures the whisker ranges of each group except one, include the "no preference" zero value. The exception, seen in Phase B, represents the group of supervisors who managed the very inconsistent subordinate performance (Hi-VAR) and who observed a smaller portion of this performance per trial (INFO = 2). In addition, this group's 95 percent confidence interval, for comparing medians (i.e., the gray shaded area), also did not include the zero value, while the confidences intervals of the other groups in Phase B did overlap the zero value. Such evidence indicates that the degree of

Table 2.
Results of 3 x 2 ANOVA for Phase A.

Source	df	SS	MS	F-ratio	Prob.
VAR	2	0.522503	0.261252	2.2626	0.1139
INFO	1	0.077042	0.077042	0.66722	0.4176
VAR*INFO	2	0.011323	0.005662	0.04903	0.9522
Error	54	6.23519	0.115466		
Total	59	6.84606			

*= p values less than .05.

Table 3.
Results of 3 x 2 ANOVA for Phase B.

Source	df	SS	MS	F-ratio	Prob
VAR	2	1.19982	0.599912	4.1364	0.0213*
INFO	1	0.001127	0.001127	0.00777	0.9301
VAR*INFO	2	0.629363	0.314682	2.1697	0.1241
Error	54	7.83176	0.145033		
Total	59	9.66207			

*= p values less than .05.

inconsistent performance and the amount observed may reliably differentiate feedback choice but only at one extreme (i.e., the Hi-VAR and INFO 2 condition).

To substantiate the specific differences observed above pairwise comparisons were conducted on all orthogonal related median scores observed in Phase B. Since no significant main or interaction effects were found in Phase A, nor were any effects expected, no pairwise tests were conducted. Medians were employed in order to limit the influence of outlier scores, especially since relatively small n-sizes were used in each experimental group. Median differences found in Phase B were tested using Cicchetti's approximation for Tukey's HSD ($p < .05$) for unconfounded comparisons (see Cicchetti, 1972, in Appendix F). Of the nine unconfounded comparisons only those found to be statistically different were associated with the Hi-VAR and INFO 2 condition. All other comparison were found to be non-significant. Thus, within the context of this study the prediction of a NFB relies on the unique interaction between degree of performance variation (Hi-VAR) and the amount of performance sampled (INFO 2).

Section Three: Latency Data

For each subject median latency measures, for representing the central tendency of Phase A and B latencies, were used in calculating the following analyses. Table 4 reports the mean of these median latencies for each experimental group across INFO, VAR, PHASE and the type of feedback associated with the latency measures (FDK). Three hypotheses were made regarding processing time. First, Hypothesis 4 stated that when supervisors observed the smaller INFO size (2pt) they would respond with shorter latencies than when presented the larger INFO size (4pt). Second, Hypothesis 5 predicted that supervisors would take more time when responding with positive feedback than with negative feedback. Third, Hypothesis 6 predicted that latencies would be longer when supervisors managed inconsistent subordinate behavior and shorter when managing more consistent performance.

T4

Table 4.
Mean of Median Latencies Across INFO Size, VAR FDK and Phases.

	INFO Size: Two		INFO Size: Four	
	Phase A	Phase B	Phase A	Phase B
Hi-VAR				
Positive Feedback	4.64	3.22	2.14	1.11
(No Feedback)	(2.82)	(2.14)	(2.80)	(1.85)
Negative Feedback	1.93	1.65	1.21	0.83
Md-VAR				
Positive Feedback	2.41	1.96	1.98	0.86
(No Feedback)	(4.01)	(2.21)	(2.20)	(1.18)
Negative Feedback	3.80	1.79	1.89	0.94
Lo-VAR				
Positive Feedback	2.43	1.52	1.59	1.16
(No Feedback)	(3.19)	(1.80)	(1.95)	(0.96)
Negative Feedback	2.09	1.47	1.22	0.88

Pairwise comparisons conducted between positive and negative latency pairs within phase were found not significant using Tukey's HSD test ($p < .05$). Parenthesis around "No Feedback" medians indicate they were not included in the ANOVA analysis (see Table 5).

These hypotheses were tested by a 3 x 2 x 2 x 2 repeated measures ANOVA, (i.e., 3 types of performance variation [VAR - levels] by 2 information-size windows [INFO - levels] by 2 repeated phases [PHASE - levels] by 2 feedback choices, positive vs. negative, [FDK - levels]). Table 5 of this ANOVA reports a main effect for INFO F (1, 108) = 15.66, $p < .0001$, an interaction effect for VAR x FDK F (2, 108) = 3.21, $p < .044$, and a main effect for the repeat factor PHASE F (1, 108) = 32.36, $p < .0001$. All other effects were not statistically significant. Although, the main effect for INFO was significant, the direction of the difference does not support Hypothesis 4. Surprisingly, the mean of median latencies, shown in Table 4, across all conditions were longer for the INFO = 2 level and shorter in the INFO = 4 level. In other words, supervisors spent more median time reacting to subordinate performance when less information was given than when more information was presented.

Given the VAR x FDK interaction there was some qualified support for Hypotheses 5 and 6. In general, across FDK latencies positive feedback processing times were longer than negative feedback latencies. However, the degree of these FDK differences appear subject to the influence of the VAR factor. So as to ascertain the significance between positive and negative feedback latencies pairwise comparisons were conducted. Of the 12 pairs of positive and negative feedback latencies, shown in Table 4, across INFO size, PHASE and VAR, none were found significant using Tukey's HSD test, $p < .05$.

Although the No Feedback response latencies played no part in the hypotheses tested, their measures are none-the-less informative. In each experimental group across Phases A and B the No Feedback latencies are larger than in both Positive and Negative Feedback, except the Hi-VAR and INFO 2 condition. In this later case, the No Feedback latency was shorter than the Positive Feedback latencies but longer than the Negative Feedback latencies.

Table 5.
Results of 3 x 2 x 2 x 2 Repeated Measures ANOVA for Feedback Latency Scores.

Source	df	SS	MS	F-ratio	Prob.
VAR	2	12.9194	6.45971	1.4170	0.2469
INFO	1	71.4158	71.4158	15.666	0.0001 **
VAR*INFO	2	7.63045	3.81523	0.83690	0.4358
FDK	1	11.8784	11.8784	2.6056	0.1094
VAR*FDK	2	29.2476	14.6238	3.2078	0.0443 *
INFO*FDK	1	1.06893	1.06893	0.23448	0.6292
VAR*INFO*FDK	2	12.7003	6.35017	1.3930	0.2528
Subject	108	492.345	4.55875		
PHASE	1	41.2336	41.2336	32.359	0.0001 **
VAR*PHASE	2	3.17850	1.58925	1.2472	0.2914
INFO*PHASE	1	0.868205	0.868205	0.68134	0.4109
VAR*INFO*PHASE	2	0.158993	0.079497	0.06239	0.9396
FDK*PHASE	1	0.240224	0.240224	0.18852	0.6650
VAR*FDK*PHASE	2	6.37045	3.18523	2.4997	0.0869
INFO*FDK*PHASE	1	0.416583	0.416583	0.32692	0.5687
VAR*INFO*FDK*PHASE	2	3.59943	1.79971	1.4124	0.2480
Error	108	137.619	1.27425		
Total	239	832.891			

*= p values less than .05.
**= p values less than .0001.

Section Four: Unpacking Analyses

The previous sections reported overall and pairwise analyses which tested the dissertation's hypotheses. However, these examinations present a relatively unrefined representation of the data trends embedded within the "complex" of experimental conditions and results. The following analyses re-examine the previous data by using three alternative data portrayal approaches, they are: (1) temporal block analysis, (2) ternary percent chart analysis, and (3) event-path analysis. The goal of these analyses is to explore and reveal relationships obscured by traditional omnibus approaches.

Temporal block analysis. Although, the ANOVAs associated with the response data showed statistical differences when percent-difference scores were used, they compromised an overall description of the relationship between the three feedback choices: positive, negative and No Feedback. Figure 6 presents how each experimental group allocated their feedback choices across time. The percent means for positive, negative and No Feedback are plotted against their cumulative percent of trials within Phase A and B. Note that within each cumulative block of trials the percents sum to 100. The dashed line in each plot represents when the feedback choices are allocated equally (i.e., "unity" is established at 33 percent).

The purpose of these plots is to reveal the temporal emergence of the feedback effects: their relative allocations, trends and patterns. Unlike the percent difference scores, the percent means are referenced to the total number of feedback responses emitted by an individual, such that:

$$FeedbackPercent_i = \frac{Count_{FDK_i}}{Pos.+Neg.+NoFDK}$$

Feedback Percents, therefore, are calculated for each individual$_{(i)}$ by taking the frequency of each type of feedback$_{(j)}$ and dividing it by the total number of feedback responses emitted. Thus, for each cumulative percent block the percent means represent the average of the individual "feedback percents" for a given group subjects, for that block of trials.

In Figure 6, the right column of plots, representing the three VAR conditions with an INFO size of 4, show that the allocations of positive, negative and NO Feedback vary within a relatively narrow range around the dashed line, indicating a lack of a feedback preference. In contrast, the left column of plots, representing the three VAR conditions with an INFO size of 2, indicate quite different feedback allocations. At the top, the Hi-VAR condition shows that, during Phase A, the feedback allocations were relatively similar but with definite trends being established. In Phase B, these trends show the emergence of NFB as a consequence of the abatement of positive feedback relative to the maintenance of negative feedback, and the increase of the No Feedback response option. In the two plots below, where Md-VAR and Lo-VAR are displayed, the relative feedback percents show greater variance than seen in those conditions where the INFO size was equal to 4. In neither condition did the feedback allocations across cumulative percent trials indicate any dramatic change in trend or preference as seen in the Hi-VAR x INFO 2 group. In general, for both Md-VAR and Lo-VAR, it appears that the percent means across the different feedback choices remained relatively constant across cumulative percent trials. In other words, despite the greater variance in how feedback was allocated, there was no dramatic cross over trends.

Ternary percent chart analysis. The block analysis showed the relative patterns of different feedback choices as a function of the experimental conditions and cumulative trials. These patterns, however, represented group percent means. The ternary percent

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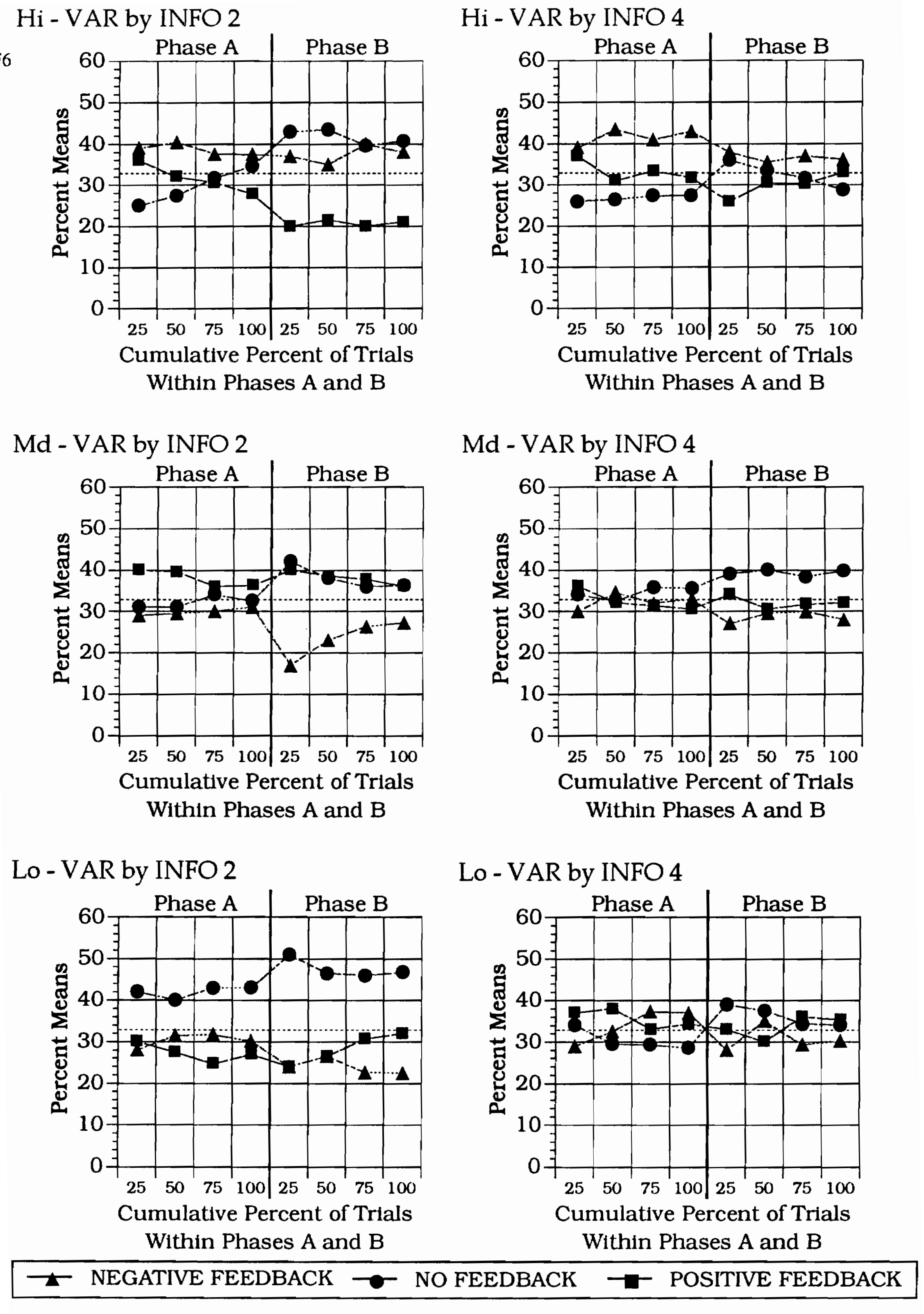


Figure 6.
For each experimental condition the charts plot the percent means across three feedback choices over cumulative percent of trials within Phases A and B.

chart analysis is used to show the internal structure (i.e., the individual-subject variance) behind these group percent means. In other words, the ternary charts will plot the "feedback percents" (as defined above) for each individual as a function of the experimental conditions and phases. Thus, the ternary chart will investigate the individual variance surrounding the percent means shown in the block analysis above. Such analysis will give us a better understanding of the reliability of (or lack of) group effects.

Figure 7 explains how the ternary charts work. In general, ternary charts show the percentage of a whole based on three discrete parts of information. In terms of our three feedback choices, each individual's count regarding positive, negative and No Feedback responses are totaled and used as a denominator. By dividing this total into each individual feedback count three percents are derived and used to coordinate (triangulate) where a point lies on the ternary chart. Each of the charts are organized similarly: (a) the left side of the triangle indicates the positive feedback percent, (b) the right side indicates the negative feedback percent, and (c) the bottom of the triangle represents the No Feedback percent. Thus, each point on the ternary chart represents an individual and how he allocated the different types of feedback. The dashed line is an indicator line that cuts the ternary chart in half on a angle and is labeled the "Positive/Negative Feedback (PNF) Line." Data points above this line represent individuals whose feedback preference were positive, while data points below this line indicate individuals whose feedback were negatively biased. Therefore, by plotting individual data we can discover the internal structure and variance behind the mean percent scores, percent-difference scores, and the significance of the ANOVA tests.

Figures 8 through 11 give the ternary charts for each VAR and INFO condition across Phases A and B. Figures 8 and 9 show the Hi, Md, and Lo VAR by INFO size 4 conditions. Data from these figures show that individual feedback preferences were

Ternary Charts

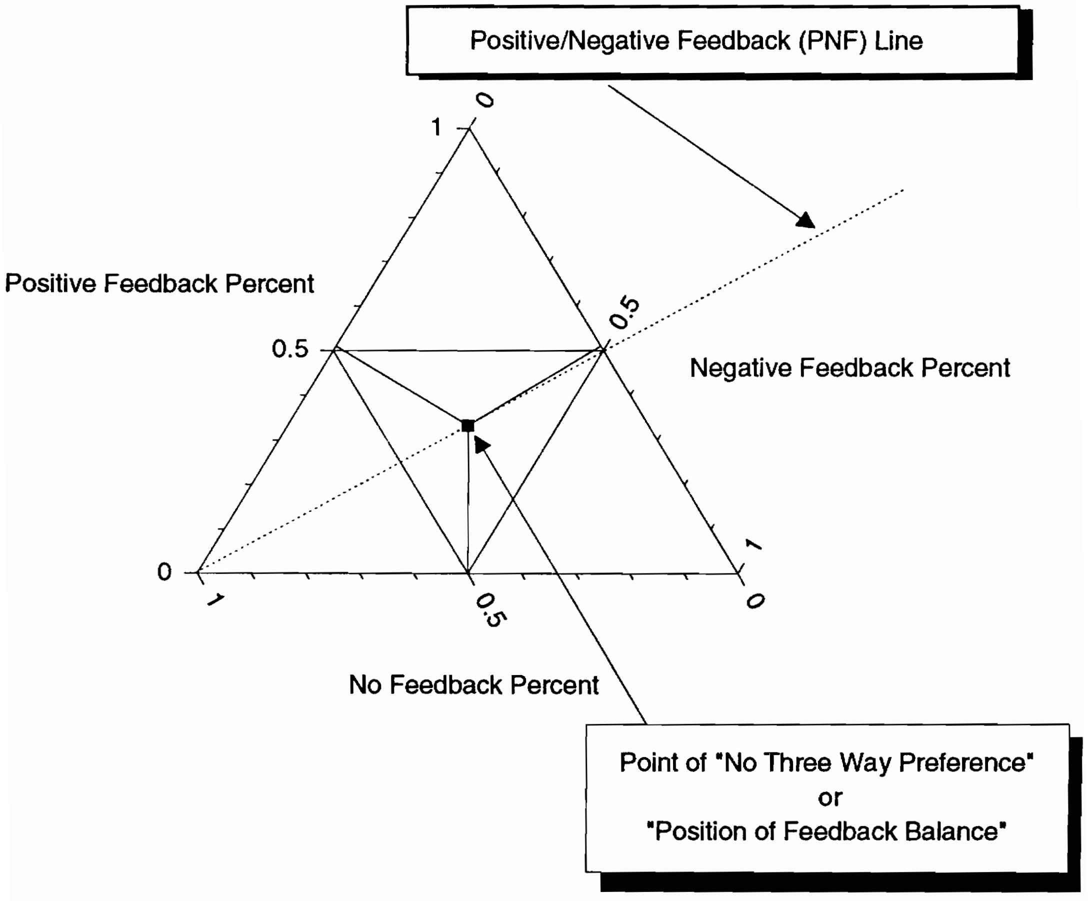


Figure 7.
Ternary Charts show the percentage of a whole based on three parts of information. In terms of Feedback Preference: each individuals responses to Positive, Negative and No Feedback are totaled and used as a denominator. By dividing this total into each individual feedback count three quotients are derived and used to coordinate where a point lies on the ternary chart .

$$FeedbackPercent_i = \frac{Count_{i \cdot FDK}}{Pos.+Neg.+NoFDK}$$

Points that lie below the "Positive/Negative Feedback (PNF) Line" represent a Negative Feedback Preference, while points above this line indicate a Positive Feedback Preference.

Phase A

F8

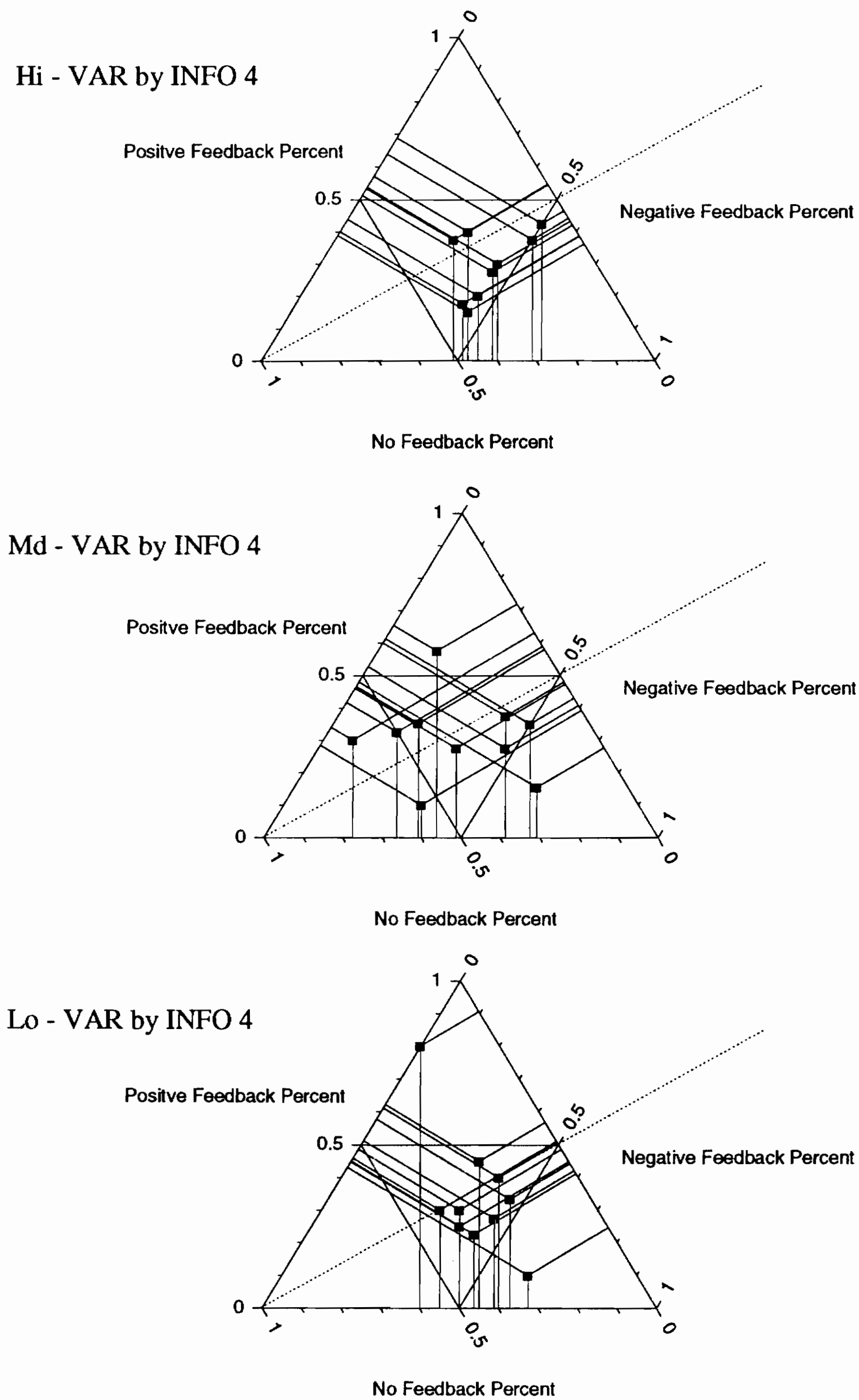
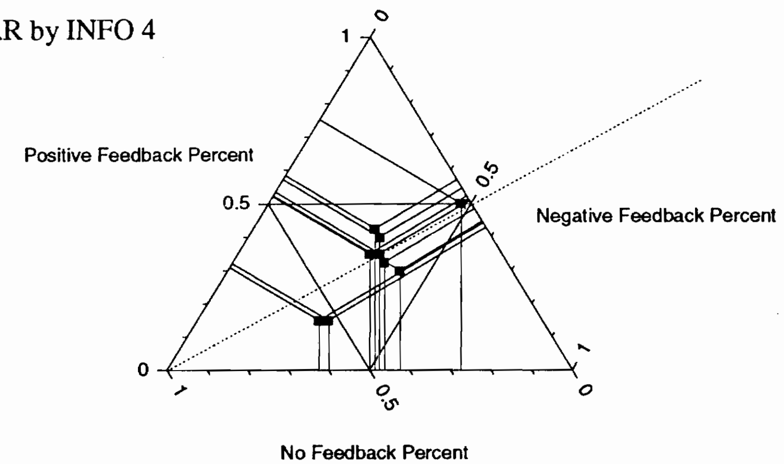


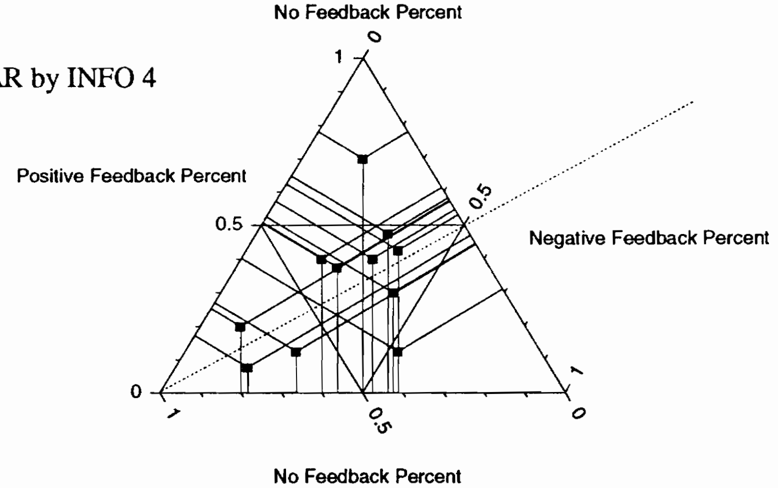
Figure 8.
Three Ternary Charts showing the internal structure or variance betweeen each supervisors responding across three feedback choices.

F9

Hi - VAR by INFO 4



Md - VAR by INFO 4



Lo - VAR by INFO 4

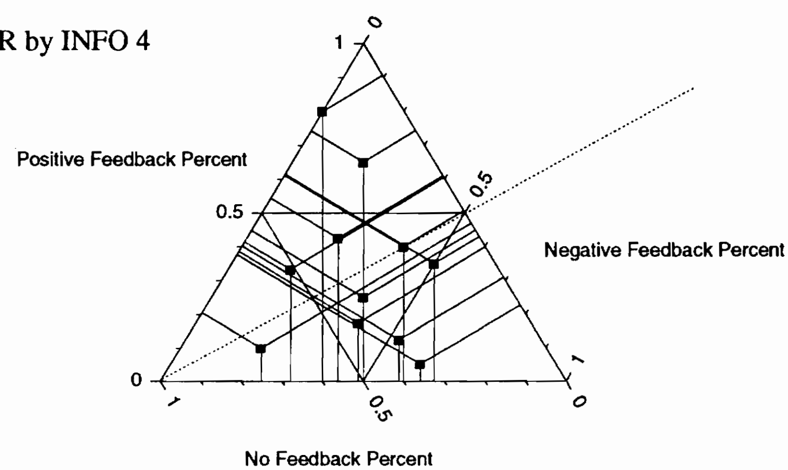


Figure 9.
Three Ternary Charts showing the internal structure or variance betweeen each supervisors responding across three feedback choices.

Phase A

F10

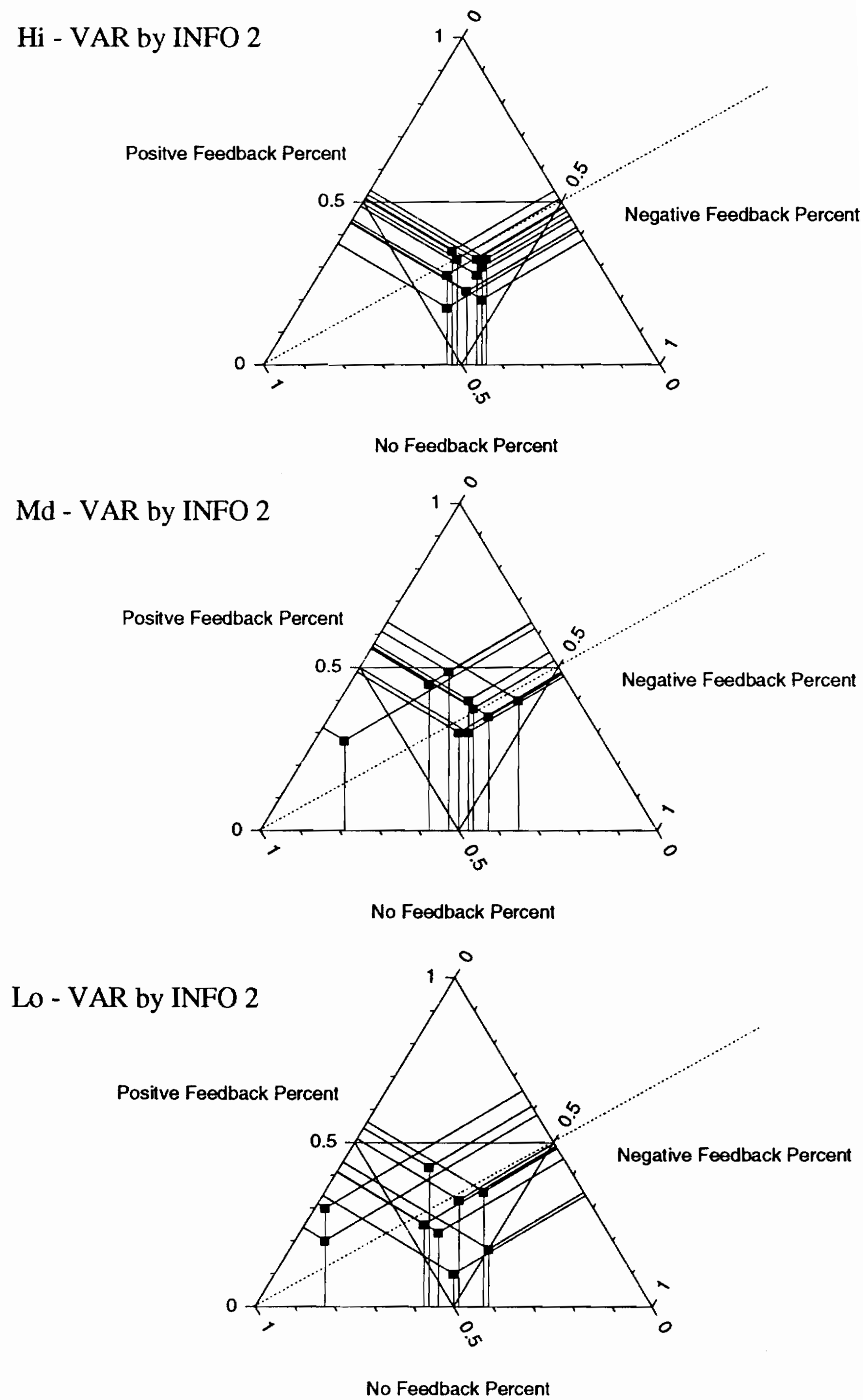
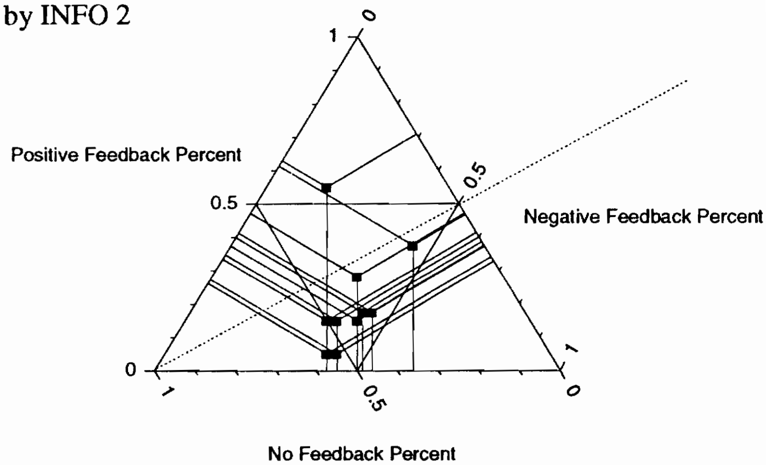


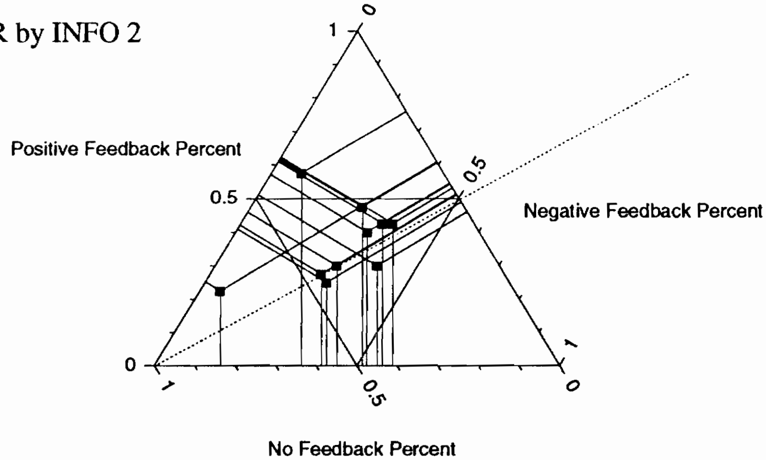
Figure 10.
Three Ternary Charts showing the internal structure or variance betweeen each supervisors responding across three feedback choices.

Phase B

Hi - VAR by INFO 2



Md - VAR by INFO 2



Lo - VAR by INFO 2

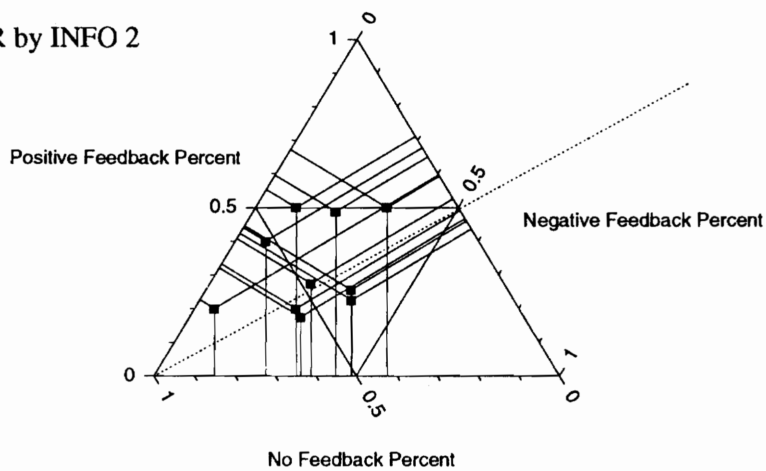


Figure 11.
Three Ternary Charts showing the internal structure or variance betweeen each supervisors responding across three feedback choices.

relatively variable both within and between conditions. In general, the higher the VAR the less variability, that is, the data points tend to cluster as VAR is increased. Furthermore, the variance of the internal structure appears to increase from Phase A to B. Note that this variability is spread across the PNF Line, indicating no reliable group effect or feedback bias.

Figures 10 and 11 show the Hi, Md, and Lo VAR by INFO size 2 conditions. Similar to the above analysis, the data show that the higher the VAR the less variance expressed within the internal structure. Unlike the data seen in the INFO size 4 groups, the Hi-VAR condition shows that in Phase A individuals were clustered below the PNF Line. In Phase B this cluster of individuals, in general, showed an increase in negative feedback bias by moving down and further away from the PNF Line (although an exception exists). In contrast, the internal structure of the Md and Lo-VAR groups showed greater variance and scatter across the PNF Line, though not as great as the experimental groups observed in the INFO size 4 conditions. As indicated by the boxplots in Figure 5, the Ternary chart for the Hi-VAR x INFO 2 group expresses a reliable group effect for NFB.

Event-path analysis. As the ternary analysis explored individual-subject variance, the event-path analysis attempts to unpack feedback variance as a function of individual events observed within the time series (i.e., the independent variable representing subordinate performance). Thus, the event-path analysis explores what aspects of the subordinate's time series behavior (event-paths observed during each trial) were associated with what types of supervisory feedback (e.g., improved performance and positive feedback).

The first step of this analysis is to calculate an event-path matrix. An event-path matrix is constructed by determining all possible 2 event-paths. This is done by relating each potential time series event (as Lag 0) to every other potential time series event (as

Lag 1), representing all possible two event paths. In the present research, since the time series varied within a five event range (as defined in the methods section) there were at most 25 potential two event-paths. Once the event path matrix is constructed, the second step is to relate each path to each of the three feedback choices emitted as a response to that path (shown as percents).

Tables 6 through 11 present event path matrixes for each of the experimental conditions across Phases A and B. Event paths that are blackened represent paths prohibited by the Formal Operation (i.e., see Method section and Appendix B). Events paths showing an asterisk represent paths not expressed within the specific time series, a consequence of the discrete probability functions outlined in the Formal Operation. In each matrix events labeled 1 - 5 indicate a performance event, representing "poor" to "good" subordinate behavior (respectively), with 3 indicating "average" performance. In each event path the cell percents are arranged from left to right: from negative feedback, No Feedback to positive feedback.

Event paths can be further differentiated by whether they are above or below the blackened diagonal. Event paths above the diagonal indicate increasing paths, illustrating improved subordinate performance. Event paths below the diagonal indicate decreasing paths, illustrating that subordinate performance has deteriorated. Event paths beginning and ending with event 3 (average performance, displaying a horizontal path), illustrate subordinate performance that did not change. Note that supervisory feedback allocations (i.e., the dependent variable) are based on what performance is observed trial by trial (i.e., specific event-paths over time). Thus, for the INFO 2 groups each trial includes 2 events, representing a complete event-path. However, for INFO 4 groups each trial includes 4 events or 3 event paths. Therefore, for the INFO 4 conditions only the last 2 events were used when associating performance with feedback.

Tables 6, 7, and 8 display the matrixes for the experimental groups of INFO size 2. Table 6 (a & b), as shown in previous analyses, represents the Hi-VAR x INFO 2 condition where NFB was found to emerge. A review of the feedback allocations show marked percent shifts from Phase A to Phase B. Specifically, Table 6 (b) shows that for increasing event-paths there are declines in positive feedback across a majority of individual event paths. These declines in positive feedback percents correspond with increases in the No Feedback option. For decreasing event paths the feedback allocations are relatively stable from Phase A to Phase B, with negative feedback percents dominating. These results support the findings found in the block analysis (see Figure 6): that NFB was a function of the abatement of positive feedback relative to the maintenance of negative feedback.

Tables 7 and 8 show consistent results found in the Block Analysis for experimental conditions of Md and Lo-VAR by INFO 2. Note that in each Table asterisks represent event-paths not experienced by supervisors, which are indicative of the configuring effects of the Formal Operation and its VAR. These Tables show that positive feedback percents, for increasing event paths, do not show abatement, unlike the positive feedback percents found in Table 6. Likewise, for decreasing event paths the feedback allocations were relatively stable with negative feedback notably the larger percent.

Tables 9, 10, and 11 display the matrixes for the experimental groups of INFO size 4. Table 9 (a & b) represents the Hi-VAR x INFO 4 condition. Although, this condition is similar to the Hi-VAR x INFO 2, except for the INFO size, the allocation percents reveal, in general, no substantive abatement of positive feedback from Phase A to B. Also, Table 9 (b) indicates that for decreasing event paths negative feedback percents were quite high but still less than those percentages found in identical event paths of the Hi-VAR x INFO 2 condition. Tables 10 and 11 show the experimental conditions of Md and Lo-VAR at INFO 4. Similar to their counterparts in the INFO 2 conditions, the percent allocations were relatively stable across phases.

Given these global observations concerning the percent allocations, the main purpose of the event path analysis was to examine the relative influence of trial by trial features expressed by a subordinate's performance on a supervisor's feedback choice. By matching how these features relate to the feedback allocations, vis-a-vis specific event patterns, we can determine their relative importance to NFB. These performance features can be broken down into three principle dimensions: (1) direction of performance change: increasing, decreasing or maintaining (2) amplitude of performance change: 4, 3, 2, 1, and 0, and (3) where performance begins and ends (see an event path matrix, its rows and columns). The following discussion focuses initially on Phase B of the Hi-VAR x INFO 2 condition since it alone demonstrated the emergence of NFB. This analysis proceeds by looking for allocation invariance among the columns, rows and similar amplitude event paths (cells associated with left to right diagonals). Ascertaining feedback invariance will indicate a certain degree of predictability as linked to the features outlined above.

In Table 6 (b) a review of the columns in Phase B of the Hi-VAR x INFO 2 condition, on either side of the diagonal, indicates that the feedback allocations across rows are relatively similar. For example, in Column 5 the negative feedback measures range across rows between 0-5 percent, the No Feedback measures range between 80-90 percent, and the positive feedback measures range between 10-20 percent. However, if similar amplitude changes are compared across rows and columns the percent allocations do not show any consistency. For example, for event paths with amplitudes of 1, such as (1,3), (2,4) and (3,5), shown above the diagonal, the percents are not invariant: (10, 45, 45), (00, 70, 30), and (00, 90, 10) respectively. Likewise, a review of the row allocations show that feedback percents vary as event paths change across columns and amplitude.

T6

Tables 6 through 11.

Event-Path Analysis describes the allocation of supervisory feedback as a function of the time series' portraying subordinate performance (i.e., the independent variables). This time series is partitioned into all possible two event paths, where column and row numbers represent "Poor", "Average", and "Good" performance events. Column numbers indicate the last event and row numbers indicate the first event of an event path. Thus, each cell illustrates a performance event path (e.g., subordinate performance increasing or decreasing). In each cell the three percents express how feedback was allocated across (from left to right) negative Feedback, No Feedback, and positive Feedback. Cells that are shaded or filled by an asterisk indicate paths not expressed by that time series illustrating subordinate performance (i.e., the dependent variable).

Table 6 (a)
Event-Path Analysis for Hi - VAR by INFO Size 2 in Phase A.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		20-20-60	10-20-70	08-46-46	00-80-20
2	90-10-00		13-20-67	10-60-30	05-70-25
Average 3	90-07-03	80-10-10	*	10-50-40	00-40-60
4	90-05-05	63-27-10	40-40-20		00-80-20
Good 5	100-00-00	85-10-05	25-45-30	05-60-35	

Event Paths Decreasing ↓ Event Paths Increasing ↑

Table 6 (b)
Event-Path Analysis for Hi - VAR by INFO Size 2 in Phase B.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		30-10-60	10-45-45	05-70-25	00-80-20
2	100-00-00		20-40-40	00-70-30	05-85-10
Average 3	90-00-10	80-10-10	*	00-60-40	00-90-10
4	85-00-15	90-00-10	37-33-30		00-90-10
Good 5	86-00-14	86-04-10	40-50-10	10-60-30	

Event Paths Decreasing ↓ Event Paths Increasing ↑

Table 7 (a)

Event-Path Analysis for Md - VAR by INFO Size 2 in Phase A.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		*	06-24-70	00-25-75	*
2	85-15-00		10-35-55	00-20-80	*
Average 3	80-10-10	73-27-00	20-44-36	05-45-50	00-23-77
4	*	60-20-20	40-50-10		00-40-60
Good 5	*	70-20-10	42-42-16	*	

Event Paths Decreasing ↓   Event Paths Increasing ↑

Table 7 (b)

Event-Path Analysis for Md - VAR by INFO Size 2 in Phase B.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		*	02-23-75	10-10-80	*
2	70-00-30		03-57-40	10-20-70	*
Average 3	75-17-08	60-30-10	07-57-36	10-43-47	03-37-60
4	*	70-30-00	40-50-10		10-30-60
Good 5	*	65-30-05	43-43-14	*	

Event Paths Decreasing ↓   Event Paths Increasing ↑

T8

Table 8 (a)

Event-Path Analysis for Lo - VAR by INFO Size 2 in Phase A.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		*	20-15-65	*	*
2	*		20-35-45	*	*
Average 3	75-20-05	45-50-05	29-49-21	05-35-60	10-20-70
4	*	*	55-40-05		*
Good 5	*	*	35-55-10	*	

Event Paths Decreasing ↓

Event Paths Increasing ↑

Table 8 (b)

Event-Path Analysis for Lo - VAR by INFO Size 2 in Phase B.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		*	20--35-45	*	*
2	*		15-50-35	*	*
Average 3	75-10-15	55-30-15	18-50-32	20-20-60	05-40-55
4	*	*	05-55-20		*
Good 5	*	*	25-50-25	*	

Event Paths Decreasing ↓

Event Paths Increasing ↑

Table 9 (a)

Event-Path Analysis for Hi - VAR by INFO Size 4 in Phase A.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		20-10-70	20-20-60	10-30-60	03-67-30
2	90-00-10		10-37-53	10-30-60	05-65-30
Average 3	97-00-03	80-10-10	*	10-40-50	00-45-55
4	95-00-05	85-05-10	40-30-30		00-60-40
Good 5	80-10-10	85-00-15	60-20-20	20-40-40	

Event Paths Decreasing ↓

Event Paths Increasing ↑

Table 9 (b)

Event-Path Analysis for Hi - VAR by INFO Size 4 in Phase B.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		20-10-70	15-25-60	00-40-60	00-80-20
2	90-00-10		10-40-50	08-27-65	00-75-25
Average 3	90-00-10	80-10-10	*	00-40-60	07-60-33
4	85-00-15	80-00-20	33-37-30		00-60-40
Good 5	83-07-10	73-10-17	40-40-20	20-40-40	

Event Paths Decreasing ↓

Event Paths Increasing ↑

T10

Table 10 (a)

Event-Path Analysis for Md - VAR by INFO Size 4 in Phase A.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		*	17-27-56	05-05-90	*
2	75-10-15		15-25-60	00-30-70	*
Average 3	80-07-13	55-28-17	27-49-24	10-45-45	03-46-51
4	*	70-30-00	33-53-14		10-60-30
Good 5	*	80-00-20	46-46-08	*	

Event Paths Decreasing ↓ / Event Paths Increasing ↑

Table 10 (b)

Event-Path Analysis for Md - VAR by INFO Size 4 in Phase B.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		*	05-30-65	00-30-70	*
2	90-10-00		10-33-57	10-20-70	*
Average 3	80-05-15	60-35-05	14-57-29	10-30-60	03-74-23
4	*	70-20-10	25-55-20		05-70-25
Good 5	*	65-25-10	37-53-10	*	

Event Paths Decreasing ↓ / Event Paths Increasing ↑

T11

Table 11 (a)

Event-Path Analysis for Lo - VAR by INFO Size 4 in Phase A.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		*	30-20-50	*	*
2	*		10-55-35	*	*
Average 3	80-10-10	70-20-10	39-27-34	05-25-70	05-30-65
4	*	*	42-47-11		*
Good 5	*	*	50-30-20	*	

Event Paths Decreasing ↓ (rows); Event Paths Increasing ↑

Table 11 (b)

Event-Path Analysis for Lo - VAR by INFO Size 4 in Phase B.

Lag=0 x Lag=1	Poor 1	2	Average 3	4	Good 5
Poor 1		*	05-35-70	*	*
2	*		15-35-50	*	*
Average 3	80-15-05	60-20-20	30-34-36	10-35-55	10-40-50
4	*	*	35-50-15		*
Good 5	*	*	45-45-10	*	

Event Paths Decreasing ↓ (rows); Event Paths Increasing ↑

For example, in row 1 positive feedback ranges from 60 to 20 percent from column 2 to column 5 respectively.

This suggests that where performance begins (a row event) and amplitude data by themselves contributes little to the prediction of NFB. In contrast, allocation invariances are shown to exist if the direction of performance and where a performance event terminates is taken into account. In other words, the relative percent differences between event paths are predicted best by first determining the direction of the performance (e.g., increasing or decreasing), and secondly, by determining how good or poor the last performance event was, given any event path. This rule appears to generalize to the other conditions. Although not showing NFB, the feedback allocations of these conditions seem amenable to the invariance observations made above. For example, across all experimental conditions where subordinate performance is shown to decrease, we find that supervisor's negative feedback for each column is consistently similar in magnitude. In general, predictions based on this invariance observation appear to hold across the experimental conditions, but particularly for Phase B conditions.

Section Five: Post-Experimental Survey

A post-experimental survey was given to each subject in order to explore additional information behind the conditions and effects studied. The following two tables present survey items related to (a) what attributions and attitudes were formed by supervisors (the subjects) about their subordinate's behavior and (b) what attitudes and perceptions were formed by supervisors about their own performance. Each table includes a list of items, the item correlation with percent-difference scores (as defined in the Results section), and item means across VAR conditions. Item means were confounded across INFO size since item means referenced against separate interaction conditions (e.g., VAR x INFO) were found to have low power relative to estimated effect sizes, variances and n-sizes.

Additionally, an attempt was made to construct scales using like items. Unfortunately, the item correlations were below minimum requirements and thus scales were not formed (Crocker & Algina, 1989). The significance tests used to compare VAR item means and the item correlations with percent-difference scores were executed in an unprotected manner. This was done since the survey data was: (a) considered a way of providing supplemental information, (b) thought vulnerable to low power and items with large variances, and (c) representative of an original piece of experimental research. This latter point attempts to stress that undue conservative tests may have committed important Type II error. At least with Type I errors, replication should shed light on the reliability of a finding, while Type II errors may prompt a researcher to ignore the finding prior to replication. Thus, the findings to be discussed below must be regarded as suggestive and still under study (i.e., for both significant and nonsignificant results). The selection of items were not based on their significance, but rather on which ones fit certain categories of interest (e.g., attribution and control items), and which ones assisted in our understanding of the response and latency data.

In Table 12, as defined by Weiner et al., 1972, Items 1 - 4 address managerial attributions regarding the assumed causes responsible for subordinate performance. Item 1 showed that supervisors perceived consistent subordinate performance (Lo-VAR) as requiring significantly less effort. In Items 2 and 4 supervisors believed that greater ability and task difficulty were associated with moderately consistent-inconsistent performance (Md-VAR). The results observed for Item 3, on the amount of task "luck" involved, did not differentiate across VAR conditions.

Items 5 and 6 asked supervisors to estimate how much control their subordinates had over their good and poor performance. In both items supervisors believed that

Table 12.
Survey Items Describing Manager's Attributions and Attitudes Regarding his Subordinate.

		Item Correlation with Percent-Difference Scores	Item Means Across VAR Conditions Hi	Md	Lo
1.	How much of your secretary's performance was due to effort?	-.031	4.5[b]	4.6[b]	3.9[a]
2.	How much of your secretary's performance was due to ability?	.158	4.2[a]	4.6[b]	4.2
3.	How much of your secretary's performance was due to luck?	.171	3.2	3.6	3.9
4.	How much of your secretary's performance was due to task difficulty?	.192	3.7[a]	4.5[b]	3.9

Scale: (1) None --- (7) Lots

5.	How much control did your secretary have over his/her "good" typing performance?	-.056	5.0[a]	4.7	4.0[b]
6.	How much control did your secretary have over his/her "poor" typing performance?	-.097	5.1[a]	4.8	4.5[b]

Scale: (1) No Control --- (7) Complete Control

7.	How would you rate your secretary's performance?	.073	3.9	3.3	3.8
8.	How would you rate your secretary's effort toward his/her typing?	.203	4.0	4.3	4.1
9.	How would you rate your secretary's ability toward his/her typing?	.256*	4.4	4.6	4.2

Scale: (1) Poor --- (7) Outstanding

How likely would it be that your secretary would be:

10.	selected for a pay increase?	.067	3.5	3.6	3.6
11.	selected for special recognition?	.004	3.0	3.2	3.0
12.	selected for promotion?	.057	3.4	3.5	3.6

Scale: (1) Not Likely --- (7) Very Likely

13	What extent did your secretary enjoy working with you?	.231	3.2	3.6	3.5

Scale: (1) Did Not Enjoy --- (7) Did Enjoy

★ = $p \leq .05$

Different superscripts (a and b) indicate = $p \leq .05$

subordinates had more control over inconsistent performance (Hi-VAR) than consistent performance (Lo-VAR). Items 7, 8 and 9 asked supervisors to rate their secretary's performance. In Item 7 each group of supervisors rated their secretary as below average, although, in items 8 and 9 they rated their subordinates' effort and ability as average or slightly above average. Interestingly, the item by percent-difference correlation for Item 9 was found significant. Its interpretation suggests that as supervisory feedback was positively biased, they tended to rate subordinate's higher in ability (and vice versa). In items 10 - 12, supervisors across conditions believed it was less likely that subordinates would be selected for a pay increase, special recognition, or for promotion. Finally, in Item 13 supervisors were asked to estimate the extent to which subordinate's enjoyed working with them. The item means across conditions were found to be below average, suggesting supervisors did not think subordinates enjoyed working under them.

Table 13 presents survey items describing the supervisors' attitudes regarding their own performance. Items 1 - 3 asked supervisors to rate their own performance. Item 3 showed the most differentiation. In terms of ability, supervisors saw themselves as having better ability as the consistency of their subordinates' performance increased. In Item 2, supervisors rated their effort, across conditions, as above average, while in Item 1 supervisors tended to rate their overall performance as higher as the consistency of their subordinates' performance increased.

Item 4, although similar to Item 1, asked supervisors to characterize their managerial style, rather than to rating their performance as a manager. The results indicate that across conditions the more consistent the subordinate performance the more likely a supervisor was to characterize their managerial style as outstanding. Additionally, the item by percent-difference correlation suggests that the greater the NFB the more likely supervisors perceived themselves as having a poorer managerial style.

Item 5 attempted to ascertain if supervisors perceived a difference between the effectiveness of positive and negative feedback. Both the item by percent-difference correlation and the differences between means showed strong effects. Supervisors perceived that negative feedback was much more effective when managing inconsistent performance (Hi-VAR) than consistent performance (Lo-VAR) of subordinates. Furthermore, the significant correlation of -.599 supports the mean difference findings, by indicating that the greater the NFB the more likely supervisors were to perceive negative feedback as being more effective. The correlation of Item 6 compliments Item 5's findings. Item 6 asks supervisors to rate the quality of feedback given to subordinates (i.e., mostly positive or negative feedback). The significant r = .516 suggests that supervisors demonstrating a NFB did perceive a greater tendency to respond with negative feedback than with positive feedback. However, this perception must be reconciled with the findings presented in the Block and Event-Path analyses. That is, NFB was not so much an increase in the frequency of negative feedback as an abatement of positive feedback.

Items 7 and 8 address the issue of how comfortable supervisors felt about giving positive and negative feedback. In both items, the item by percent difference correlations were significant. Item 7's correlation (r = .48) suggests that supervisors demonstrating a NFB were less comfortable about giving positive feedback than supervisor with a more positive feedback preference. Item 8's correlation (r = -.292) indicates that supervisors showing a NFB were more comfortable about giving negative feedback than supervisor with a more positive feedback preference. In general, comparing the item means across items 7 and 8 reveals that supervisors were more comfortable about giving positive feedback than negative feedback, which supports much of the literature regarding managerial reluctance to give negative feedback (Fisher, 1979; Ilgen and Knowlton, 1980, Larson, 1986).

Items 9 and 10 refer to a supervisor's early and later experience with the experimental task (i.e., of giving feedback and interpreting performance charts). In general, comparing the item means across Items 9 and 10, supervisors found the experimental task much easier at the end of the study than they did at the beginning. Additionally, Item 9 indicates that supervisors who managed consistent performance (Lo-VAR) were significantly more likely to see the feedback task as easier, than supervisor who managed inconsistent performance (Hi-VAR). However, in Item 10 this difference was not maintained, indicating experience overcame any initial feelings of task difficulty. Similarly, Item 11 asked supervisors to rate the extent to which they enjoyed working as a manager. Overall, supervisors who managed the relatively inconsistent performance of subordinates (Hi and Md-VAR) enjoyed more role-playing a manager than did supervisors of more consistently performing subordinates (Lo-VAR).

Although not listed in the tables above, one other important survey item needs mentioning. Supervisors were asked to rate whether the amount of information seen during each trial was adequate enough for them to give accurate feedback. Supervisors scores were blocked according to the INFO size factor. Both groups (INFO size 2 vs. 4) rated the adequacy of the amount of information as being very poor. However, the supervisors in the INFO 2 group (mean = 2.13) believed their INFO size to be significantly worse than the supervisors in the INFO 4 group (mean = 3.2), $t = -2.78$, $\underline{p} \leq .007$ (where measures were rated on a seven point scale, 4 indicating average).

Table 13.
Survey Items Describing Manager's Attitudes, Beliefs, and Perceptions Regarding Performance.

	Item	Item Correlation with Percent-Difference Scores	Item Means Across VAR Conditions: Hi	Md	Lo
1.	How would you rate your performance as a manager?	.050	3.8[a]	4.6[b]	4.3
2.	How would you rate your effort in managing your secretary's performance?	.086	4.6	5.1	4.7
3.	How would you rate your ability to manage your secretary's performance?	.032	3.7[a]	4.5[b]	4.4[b]
		Scale: (1) Poor --- (7) Outstanding			
4.	How would you characterize your managerial style?	.412*	3.9[a]	4.4	4.5[b]
		Scale: (1) Poor --- (7) Outstanding			
5.	Of the two feedback options (positive vs. negative) which improved performance best?	-.599*	5.8[a]	4.5[b]	4.7[b]
		Scale: (1) Positive Feedback --- (7) Negative Feedback			
6.	How would you rate the quality of feedback given to your secretary?	.516*	3.7	4.3	4.2
		Scale: (1) Mostly Negative --- (7) Mostly Positive			
7.	How comfortable did you feel about giving positive feedback?	.482*	5.0	5.7	5.7
8.	How comfortable did you feel about giving negative feedback?	-.292*	4.7	4.9	4.8
		Scale: (1) Not Comfortable --- (7) Very Comfortable			
9.	During the beginning of this study, did you find the feedback task to be difficult or easy?	.181	4.1[a]	4.7	5.3[b]
10.	At the end of this study, did you find the feedback task to be difficult or easy?	-.099	5.2	5.3	5.0
		Scale: (1) Very Difficult --- (7) Very Easy			
11.	To what extent did you enjoy working as a manager?	-.027	4.4[b]	4.7[b]	3.6[a]
		Scale: (1) Did Not Enjoy --- (7) Did Enjoy			

★ = $p \leq .05$

Different superscripts (a and b) indicate = $p \leq .05$

Discussion

Since, informally delivered supervisory feedback is instrumental to the guidance and motivation of subordinate performance, it is important that research attempts to understand the numerous conditions that may influence the character and delivery of feedback. The purpose of this dissertation was to investigate conditions under which supervisors may adopt a negative feedback bias (NFB). This bias was first outlined by Kahneman and Tversky (1973), and later by Deming (1982). From their general observations two sources of variation critical to NFB were inferred: (a) the variation of subordinate performance, and (b) the variation of a supervisor's activities. It was the interaction of these two roles, as modeled by Figure 1, that provided the heuristic framework for representing NFB as an emergent and embedded process. Conceptually, NFB was considered a consequent of an information by acquisition mechanism: whereby information was represented by the natural but inconsistent performance of a subordinate over time, while acquisition was represented as an information constraint: in that supervisor's had limited opportunity to observe and sample a subordinate's performance at any given moment (i.e., what and how much was observed). This mechanism was referred to as opportunity-based supervision.

Given the above account and the model in Figure 1, several hypotheses regarding NFB were made and tested. The following is divided into four sections: first, each of the response hypotheses will be discussed, second, each of the latency hypotheses will be explored, third, the results regarding the post-experimental data will be examined, and fourth, a discussion regarding the limitations of the present research and advancement of future research directions, models and theories.

Section One: Feedback Responses and Hypotheses

Three hypotheses made predictions regarding feedback responses. Specifically, NFB was depicted as dependent on: (a) the amount of information a supervisor could see per feedback episode, (b) the degree of variation expressed by the subordinate's performance, and (c) that NFB was a temporally emergent process. In general, the response measures of this experiment support the response hypotheses stated. It was found that supervisors were more likely to demonstrate a NFB when managing, over time, a highly inconsistent performance, whose pattern information was restricted per observation opportunity. This effect was generally reliable within the Hi-VAR by INFO 2 group where 9 out 10 subjects showed a NFB by the end of the experiment. However, as shown in the box plot of Figure 6, and the ternary charts of Figures 8 - 11, the range of individual subject data across the other experimental groups showed that some individuals expressed a NFB, although no reliable group effect was indicated. Thus, the experimental conditions affecting NFB represent sufficient but not necessary reasons for the emergence of NFB. Obviously, numerous other extra-experimental factors could have played a part in influencing a subjects feedback choice, such as social, cultural, sociological, and pathological factors, to mention a few.

In general, this research represents a departure from past feedback research and findings. First, the determination of the sign of feedback has been strongly associated with level of subordinate performance; poor performance is usually followed by negative feedback, while good performance is often followed by positive feedback. The present research indicates that not just the level of subordinate performance may effect feedback decisions, but also a supervisor's history and experience with the inherent dynamics of subordinate performance. Specifically, I found that good subordinate performance was associated with the inhibition of positive feedback. Second, traditional studies on the sign of feedback were based on research using only static stimulus examples of subordinate performance (i.e., good vs. poor). In contrast, a stochastically determined and controlled time series of subordinate performances was modeled and examined. Third, past feedback research has been entranced with the reluctancy/distortion hypothesis first proposed by Fisher (1979). I found that under specific conditions supervisors were not reluctant to deliver negative feedback. As will be discussed in later sections, the reluctancy hypothesis may be dependent on conditions that better approximate formal evaluations (e.g., annual ratings or performance appraisal sessions). In contrast, the present research modeled the feedback situation on the informal dynamics of supervisory evaluations. Despite the support found for the reluctancy hypothesis (Fisher, 1979; Ilgen & Knowlton, 1980; Larson, 1986) the results presented here underscore the complicated terrain circumscribing the processes responsible for informally delivered feedback.

The following sections attempt to interpret the results found within two different conceptual approaches. The first perspective reconciles the patterns of data associated with NFB within a reinforcement paradigm, with its behavioristic nomenclature. The second approach employs an ecological-cognitive approach that treats subjects as strategy finders in obtaining specified goals.

These alternative approaches offer insight into the possible underlying mechanisms operating on informally delivered feedback and NFB in particular. Given that this research is relatively novel, several alternative theories and models may apply or be heuristic to the overall pattern of results found. I prefer to render several alternatives so as to display different view points and perspectives. The purpose for discussing each alternative is <u>not</u> to test which approach best fits the data, rather to show how each approach emphasizes certain formulations that punctuate certain variables, features, and processes. From such discussion new ways of combining or framing questions or concepts may emerge. At this time, it is the author's firm belief that theory testing or posturing some conceptual commitment is premature. In contrast, the emphasis here is to be broad rather than narrow, and to be inclusive rather than exclusive. This orientation is further elaborated in later sections regarding the importance of modeling the ecology of informally delivered feedback.

Interpretation - 1: Reinforcement Framework

Several explanations can be offered to why NFB should emerge under the Hi-VAR by INFO 2 condition. Originally Kahneman and Tversky's (1973) used a reinforcement paradigm, suggesting that: if managers failed to recognize regression to mean fluctuations in their subordinates' performance when determining reward and punishment feedback, then they may unwittingly suffer the conditioning effects of having their own rewarding behavior punished and their punishing behavior rewarded. Given this logic NFB is established by the extinction of positive feedback relative to the expression of negative feedback. Notz, et al. (1987) has labeled this process as "superstitious supervision" since NFB represents supervisory feedback accidentally correlated with subordinate performance. As in the present experimental set-up, subjects' "supervisory feedback" had no actual effect on subordinate performance nor its future occurrences. In other words, in this experiment, supervisory feedback had no contingent link to performance, only a coincidental relation. It is important to remember that these conditions attempted to model certain complex characteristics associated with the context of informally delivered feedback.

Although, the superstitious supervision explanation adequately describes the data observed, in the Hi-VAR by INFO 2 group, it offers little insight into the data expressed by the other experimental groups. For instance, why in the Hi-VAR by INFO 4 group would a reliable NFB not emerge? Why would not the reinforcement mechanisms inferred by Kahneman and Tversky (1973) be dampened with the addition of more information (i.e., INFO = 4)? Particularly if the instructions given to the subjects concerning the point system are recalled. Briefly, subjects were told that in order to "better judge their managerial effectiveness" a notice would be displayed indicating that they earned 10 points when subordinate performance improved, lost 10 points when performance worsened, and received no points when performance remained unchanged. Given that this system was designed to be salient throughout a subject's participation reliance on it might be expected.

However, in the case of the Hi-VAR by INFO 4 group reliance on the point system appears to have been limited. For the other experimental groups, including both INFO sizes, a lack of a reliable NFB group effect is likely due to the VAR densities studied (i.e., Md = .5 and Lo = .2). Figure 6 shows that for Md and Lo VARs across INFO 2 and 4 negative feedback percent levels were typically lower than positive feedback percents. Although, the grouped data in Figure 6 render the measures as consistent in trend and direction individual subject measures reveal a different picture. As illustrated by the ternary charts (Figures 8 - 11), within and between each group individual subjects displayed a fairly wide and diffuse range of feedback percent allocations (i.e., across positive, negative and no feedback choices).

Such wide variances may be attributed to the conditions associated with lower VAR densities . In one sense, NFB was assumed to be facilitated by exposure to highly variable subordinate performance. Therefore, it follows that greater variability would more likely encourage NFB, while less variability or more consistent performance would reduce this likelihood. Here VAR densities translate into greater and less variability that subjects are exposed to and experience. Thus, Md and Lo VAR conditions represent situations where subjects received less experience with highly variable performance, thus dampening the potential for NFB conditioning to take place.

Obviously, one implication of this reasoning is that the lack of a NFB effect may hinge on temporal exposure or amount experience. In other words, additional time may be required for NFB conditioning to take place for VAR densities less than .80. This also may apply to the Hi-VAR by INFO 4 group as well. If a temporal dimension plays a strong part in the conditioning of NFB across VAR and INFO conditions, then the results here would then illustrate the first part of each conditions different NFB acquisition curve.

Interpretation - 2: Cue-Configuring Framework

In contrast to the reinforcement paradigm, social judgment theory (SJT) proposes a more ecological approach to conditioning. Founded on the lens model this approach concentrates on the parallel analysis of both perceptual and behavioral achievement regarding a person's social environments (cf. Brehmer, 1988). Using Brunswik's probabilistic functionalism (1955) and Tolman's molar behaviorism (1932), SJT rests on the fundamental principle that people set goals for themselves, and use, construct, and discover strategies and tactics to achieve their goals (cf. Brehmer, 1988).

According to SJT, a person obtains goals by adjusting to an array of proximal cues which to an important degree are unpredictable. Furthermore, a person achieves his or her goals through a process of adjustment that includes the influence of feedback regarding the success or failure in obtaining one's goals (cf. Brehmer, 1988). In this experiment all subjects were asked to role play as managers, that included the goal of: "... to find the best supervisory approach to motivating your secretary to do a better job". Manipulation check data indicated that subjects seriously approached their role as a manager, and thus presumably their goal (i.e., the role subsumed the goal). In addition, each subject prior to beginning the experiment was asked whether they understood this goal, if they did not, further instruction was given.

In terms of goal related cues, each subject was given probablisitically expressed cues (i.e., subordinate performance as defined by its VAR density) and a perceptual frame (i.e., the INFO size) that quantitatively and qualitatively altered the performance cue structure, array, or pattern that was observed by subjects per trial. Also, the point system must be included as an additional cue. Although the point system was blocked (as an instruction) across each experimental group, a differential amount of points were associated with each VAR density, since points were ultimately determined by how performance varied across trials. Thus, between VAR conditions subjects were presented a different amount of possible points, whereas within VAR conditions subjects were shown the same amount of points potentially earned or lost. Altogether, the interaction of these three cues provided different cue configurations that subjects confronted trial by trial.

Thus, conditioning (or not) of NFB is viewed as a response to the cue-configuring properties of the different experimental conditions. Given that subjects were attempting to find an effective means of improving performance, SJT suggests that subjects will search for those cue(s) that best predict goal achievement. In other words, cues become more or less diagnostic as a person becomes familiar with their relative signaling or prompting properties in goal attainment. Differences among the experimental groups, therefore, may be seen as how the different cues were integrated and processed as information. Using this cue-configuring framework the discussion below first examines the Hi-VAR data, and then the Md and Lo-VAR results.

Hi-VAR by INFO 2 and 4. NFB as affected by the Hi-VAR by INFO 2 condition may have been encouraged by how the individual cues were configured. First, subjects were more likely to find the 2 event trials less ambiguous in pattern (i.e., either increasing or decreasing relative to an average value). Second, given the clarity of these trial patterns subjects should easily interpret performance trends (as viewed within individual trials), thereby allowing subjects to better associate feedback with subsequent performance changes and the transaction and meaningfulness of the point system. Thus, this unique configuration of experimental conditions perhaps facilitated the superstitious supervision of subordinate performance and NFB.

However, the Hi-VAR by INFO 4 group had a different cue configuration which might account for the results observed for this group. Although this group received the same VAR density, their INFO size adjusted and increased the pattern of subordinate performance observed in each trial. Consequently, for each subject the pattern to be interpreted was more complex than was observed by the INFO 2 group. In other words, subjects in the INFO 4 condition observed greater variability in each trial (i.e., a random 4 event performance pattern). Thus, given a continuously complex pattern of performance, trial after trial, subjects may have found it difficult to discern reliable cues that predicted goal achievement. And, since the trial patterns observed typically showed no overall or sustained change, the cues presented may have appeared less than veridical.

Additionally, if the overall pattern was assumed to be the unit of information to which the Hi-VAR by INFO 4 group were to direct feedback, then subsequent changes in subordinate behavior and points transacted may have had a more ambiguous and difficult association with feedback. This association may have been inhibited by the greater performance variability observed (INFO 4) which obscured the point system and its cue-signaling potential. Recall that points were offered and determined by how performance changed from the last event in a trial, and not according to the overall pattern observed in a trial. Thus, if subjects were managing a 4 event performance pattern, then it may have been more difficult to see the relevance and link of feedback and the point system to a single performance event embedded within a larger pattern of performance. In other words, subjects may have discounted the signaling properties of the point system as a consequence of emphasizing and attending more directly to the overall performance pattern presented. This discounting of the point system may have been supported by the instructions given to subjects: they were advised that the point system was "just an added means of judging their managerial effectiveness." Therefore, subjects in a complex and "more enriched" information environment (i.e., INFO 4 condition) may have found the point system an ancillary cue, while the pattern of performance the primary cue. In contrast, the Hi-VAR by INFO 2 group may have considered their information environment as less ambiguous but "scant", and therefore, facilitating the integration of performance and point cues.

Obviously, the importance of the point system as a relevant cue to NFB is an empirical question. If the NFB occurs within conditions absent of a point system, then conceptual and research attention can emphasize the cue-configuring properties of the VAR and INFO variables more directly. If the point system is important to the NFB emergence, then the point system should be examined and explored as representative of factors and conditions present in natural supervisor-subordinate contexts. These representative factors should then translate into research better approximating and simulating a supervisor's context of demands and presses. Recall that the principle purpose of the point system was to substantiate the meaningfulness of the performance changes, by representing by analogy an accountability typical of a manager's position (i.e.,, a manager's reputation, self-esteem or advancement are usually dependent on the success and failure of his or hers subordinate's performance). Therefore, future research might explore the many possible ways of inducing supervisor-subordinate dependence (e.g., instructions to subjects that stipulate: "review of your effective and ineffective feedback will be examined in detail").

Md and Lo VARs by INFO 2 and 4. For the other experimental groups with lower VAR densities NFB did not emerge as a reliable group effect. As mentioned earlier, Md and Lo VARs were thought responsible for the non-emergence of NFB since subjects experienced less of the conditioning effects associated with increased variability (i.e., the Hi-VAR condition). However, the cue-configuring properties of Md and Lo VARs and INFO 2 and 4 may provide some insight to the results observed. In this experiment the reduced variability in subordinate performance was executed by increasing the probability of "average" performance (see Appendix B, for how this was realized). In Md and Lo VAR conditions there was an increased likelihood that subjects would observe consistent average performance (i.e., a horizontal pattern of event segments representing average subordinate performance). Additionally, recall that such patterns were associated with no performance points earned or lost. Such horizontal performance segments viewed as cues were diagnostically neutral and uninformative to how well subjects performed as supervisors and which feedback was more effective. The increased proportion of consistent average performance in Md and Lo VAR conditions altered the degree of variability subjects experienced. It is noteworthy that even when feedback associated with these average performance patterns are excluded from the NFB analysis, the relative proportions of negative and positive feedback do not change substantively (i.e., no NFB emerges).

The configuring properties of the INFO condition did change the relative amount of performance variability that was observed across individual trials. Recall that trials were defined as an information window that either showed 2 or 4 performance events (INFO 2 or 4); that from one trial to the next the information window added only one new performance event and displaced the oldest performance event. Subordinate performance was displayed as if on a conveyor belt, with the INFO sizes constraining what could be observed during any given trial. Therefore, in the INFO 2 condition there was, during any given trial, one previously observed performance event and one new event. While in the INFO 4 condition there was, during any given trial, three previously observed performance events and one new event. As the information window moved from one trial to another, depending on the INFO size, different amounts of variability were observed trial per trial. For INFO 2 conditions there were more trials that showed no variability at all, just "average" and consistent performance. In contrast, for the INFO 4 conditions any performance deviations from average were observed for at least four consecutive trials until it was the oldest event to be discarded.

Consequently, the differences between the Md and Lo-VAR by INFO 2 and 4 groups may have been determined by the cue-configuring properties of these conditions. In Figure 6 the percent means suggest feedback allocations between positive, negative and no feedback options were more disparate for the Lo-VAR by INFO 2 group than the other groups. For this group, the results indicate that the No feedback option was preferred continuously over the positive and negative feedback options. Review of the trial data show that subjects in the Lo-VAR by INFO 2 group were more likely to choose the No feedback option when the trial showed only average subordinate performance.

For the Lo-VAR by INFO 4 group consistently average performance was seldom observed by subjects since deviations, trial by trial, were more long lived. Since this variability was more often observed by this group, subjects may have surmised that subordinates were more capable of changing their level of performance. Therefore, as compared to the Lo-VAR by INFO 2 group, the Lo-VAR by INFO 4 condition may have facilitated an increased use of positive and negative feedback since more variability was associated with its trials. Interestingly, survey data suggests that subjects perceived subordinates as having more control over their performance when that performance was more variable (see Table 12, Items 5 and 6). Thus, feedback may have been given not to adjust past performance, but to encourage new performance, that is, performance they were 'capable" of executing (Ilgen et al., 1979). Unfortunately, no measures of this feedback differentiation was recorded or asked by the post-experimental survey. But such measures may give insight into the motivation behind feedback delivery.

In general, the diffuse range and spread of data as observed in the Md and Lo-VAR conditions (see box plots of Figures 4 and 5 and the ternary charts of Figures 8 - 11) suggest that a complicated set of mechanisms may play a role. Below, a few alternative hypotheses are briefly discussed and evaluated as possible generalizations of the data. For instance, one alternative proposes that subjects may have acquired a learned helplessness approach to the task demands and outcomes. The learned helplessness hypothesis (Seligman, 1975) states that subjects given a history where behavior is ineffective in obtaining rewards or avoiding adversity will become passive. The hypothesis suggests that a subject's expectancies will reflect a loss of control and a depression of motivation. In this experiment the data does not appear to support this hypothesis. One would expect loss of motivation to manifest as a "response-set" style of behavior, where the subjects responded by using one type of feedback regardless of the performance information given (Crocker & Algina, 1989). In other words, subjects would select a default response as a means of terminating their participation. However, most subjects showed a diversity in feedback allocation (see ternary charts, Figures 8 -11). Also, if subjects were intent on leaving the experimental situation, the latency data would have been expected to be shorter, not on the order of 1 to 4 s. Additionally, post-experimental survey showed that subjects in Md and Lo-VAR groups perceived their ability and effort in managing performance as above average (see Table 13, Items 2 and 3). One would expect such measures to be suppressed if learned helplessness was an active mechanism, particularly in the ability measures.

A second alternative proposes that subjects may have manifested a frustration-aggression approach to the task of feedback delivery. According to the frustration-aggression hypothesis (Dollard, et al, 1939) persons having a history with rewards which are then denied or made more difficult may acquire an increased tendency to exhibit hostility or aggressive responses. In this experiment, the frustration-aggression hypothesis also predicts a "response-set" style of feedback delivery: where subjects, due to their frustration with task outcomes, give negative feedback regardless of the level of subordinate performance observed. Again, the data do not support this hypothesis. No response-set style of an extreme negative feedback preference was found among these experimental groups. As illustrated in the ternary charts subjects showed a general differentiation in feedback responding.

Furthermore, the post-experimental survey suggests that subjects were not frustrated by the feedback task. If the subjects were frustrated by the feedback task one would expect subjects to have perceived the task as difficult. Additionally, if subjects in the Md and Lo-VAR groups found the feedback task as continually difficult and performance outcomes unacceptable, then one might expect feelings of frustration to increase over time. However, subjects felt in the beginning of the study that the feedback task was of average difficulty and ease, while at the end of the study they perceived the task as even easier (see Table 13, Items 9 and 10).

A third alternative proposes that subjects become frustrated not only by the denial of reward but also by the nonreward of a response. The frustration-nonreward hypothesis (Amsel, 1958 & 1962) describes a situation where a person expecting a reward and then receiving no reward reacts with frustration. The motivational effect of the frustrative nonreward situation is seen as "intensifying or speeding up of responses" (Hilgard & Bower, 1966, p. 488). The historical significance of the frustration-nonreward hypothesis was its alternative explanation to the resistance to extinction effect (cf. Bolles, 1979). Later it was described as representative of partial-reinforcement schedules. In contrast to the frustration aggression hypothesis, the frustration nonreward hypothesis does not predict the emergence of a hostile or aggressive response-set style of responding. Instead, the responses under nonreward appear to be quickened (Hilgard & Bower, 1966).

In the present experiment, the frustration nonreward hypothesis may best apply to the Md and Lo-VAR conditions since subjects are more likely to observe trial by trial consistent, average and "non-reacting" subordinate performance. Thus, the subjects' are likely to be frustrated by such unchanging average performance, and where feedback appears ineffective. The hypothesis, therefore, predicts that this felt frustration will encourage quicker responding, and thus shorter latencies.

The support for this hypothesis appears mixed. On one hand, Md and Lo-VAR groups associated with more nonreward trials (i.e., more trials displaying consistent average performance) showed shorter latency measures than the Hi-VAR groups, therefore potentially supporting the frustration nonreward hypothesis. However, it is difficult to reconcile the frustration nonreward hypothesis with the strong ANOVA main effect for INFO size latencies (see Table 5). This difficulty rests on the fact that subjects in INFO 2 and 4 conditions, relative to their VAR conditions, received the same number of nonrewarded trials (i.e., trials where performance did not deviate from average after the presentation of feedback). Perhaps, because of the greater within trial variability observed in the INFO 4 conditions, subjects concluded that subordinates were "capable" of improving their performance, but were not acting on it. Thus, frustration was heightened in the INFO 4 conditions since more variable trials demonstrated the potential of a subordinate's capabilities. Whereas, individual trials in the INFO 2 conditions may have given the impression that subordinates were less "capable." This is because less variability was displayed and more "average" performance observed across trials. However, as mentioned above, the post-experimental survey indicates that subjects did not perceive the feedback task as difficult, and therefore, presumably, the task was not frustrating (see Table 13, Items 9 and 10).

In Summary. The above discussion has provided several mechanism potentially important as clues to the processes governing the form and structure of the results. First, the results suggested that NFB was a product of highly variable subordinate performance and limited trial information. Using a reinforcement paradigm NFB, was thought to have emerged as a consequence of a superstitious supervision mechanism: where positive feedback was punished and negative feedback was rewarded as a consequence of the coincidental covariations of feedback and subsequent performance. Second, a cue-configuring framework was introduced so as to better understand the results in total. Here the NFB effect was thought to be determined by the clarity of the performance patterns expressed by the Hi-VAR by INFO 2 condition, and the ability of subjects to use effectively the point system as a relevant signaling cue. The results of the other groups not expressing a NFB were found to have cue properties that appeared to interfere with the emergence of NFB, such as: a more complex information environment or greater consistency in subordinate performance. Third, several alternative hypotheses were proposed as generalizations attempting to explain the mechanisms underlying the delivery of feedback in Md and Lo-VAR groups, they included the: (a) learned helplessness hypothesis, (b) frustration-aggression hypothesis, and (c) frustration-nonreward hypothesis. Suggestive support was found only for the frustration nonreward hypothesis that predicted shorter latencies as a consequence of encountering an increased likelihood of average performance. Although, latency data may be indicative of the frustration caused by nonrewarded behavior, it may also suggest some underlying cognitive processes used by subjects when making feedback decisions. We now turn to the next section where the latency data, hypotheses and cognitive functioning will be discussed.

Section Two: Latency Measures and Hypotheses

Three hypotheses made predictions regarding latency measures. In general, the latencies were expected to be: (a) shorter for supervisors encountering less information per trial than more information, (b) shorter for negative feedback responses than for positive feedback, and (c) shorter for supervisors managing consistent subordinate performance than inconsistent performance. Each set of hypotheses will be discussed in turn.

Latency Hypothesis 1: The Significance of Information Size

The principle latency hypothesis predicted that the INFO 4 condition would show longer latencies as compared to the INFO 2 condition. It was assumed that the four event trials of the INFO 4 condition would be perceived as more complicated and needing more time so as to form a decision (Geller & Pitz, 1968). In contrast, as Table 4 and 5 indicate the exact opposite was found. Latency measures for INFO 2 conditions were significantly longer than those found in the INFO 4 conditions ($p < .0001$). Below, two compelling cognitive processing models provide heuristic frameworks to assist in the interpretation of these data, they are: (a) the category-based vs. feature-based model, and (b) the memory vs. on-line task model.

The category-based vs. feature-based model. Latency data have often been used in social cognitive research as a means of inferring how information is processed. In brief, social cognitive theory views individuals as information processors, who acquire, encode, and retrieve information from memory (Fiske & Talyor, 1984; Taylor & Fiske, 1981). When encoding newly acquired information individuals attempt to efficiently process this information into categories. These categories are seen as fundamental to perception, storage, and organization of information. A person is categorized when certain informational attributes describing this person match or generalize with the prototypical attributes defining a category (Fiske & Talyor, 1984). This mode of processing is generally referred to as "category-based" processing (Fiske & Pavelchak, 1986).

Persons employing category-based processing typically rely on heuristics (Maheswaran & Chaiken, 1991), social categories (Fiske & Pavelchak, 1986) or prototypes (Favero & Ilgen, 1989) when making judgments or evaluations regarding a target person. Category-based processing is usually associated with person information that is perceived as familiar, readily labeled, easily encoded, consistent with a preexisting schema or a given impression. Such information is presumed to require less effort, energy and cognitive analysis. Thus, category-based processing is analogous to a process short-cut or short-hand that simplifies the perception, encoding, recall and evaluation of person information.

However, when person information is difficult, needs special encoding, is not easily labeled, is novel, or is incongruent with existing schemas, categories or impressions, more deliberate and careful analysis of the information is facilitated. This mode of processing has been referred to as "feature-based" processing (Fiske & Pavelchak, 1986). Since feature-based processing describes a more effortful processing mode than category-based processing, latency measures are expected to be longer than category-based latencies (e.g., Kulik & Ambrose, 1993).

The experimental results indicate that latency measures were much longer for the INFO 2 group than for the INFO 4 group, contrary to the original hypothesis (see Table 4). These findings suggest that subjects in the INFO 2 conditions used feature-based processing, while subjects in the INFO 4 conditions relied on category-based processing. Two reasons may explain why the data were organized as such: first, subjects perceived subordinate performance in the INFO 4 conditions as presenting a more complex pattern of information per trial. One would expect such a complex pattern to induce feature based processing, since its interpretation would be apparently a difficult task. However, the latency results indicate subjects found it a simpler task than one might expect. In an apparent contradiction, subjects given a complex set of performance patterns may have been prompted to construct a heuristic so as to simplify the feedback judgment process. Depending on the VAR condition, subjects categorized subordinate performance as either prototypic of "consistent" or "inconsistent" workers. Additionally, for the Hi-VAR by INFO 4 group, it may have been this category initiated process that displaced the importance of the point system from being integrated into feedback judgments. In other words, decisions regarding subjects' feedback relied exclusively (once formed) on the category heuristic to which subordinate performance was assigned.

Second, in contrast to the complex pattern hypothesis, subjects may have used the experimental instructions concerning their subject's abilities and past performance as a given prior impression (i.e., a category). The experimental instructions told subjects that their secretary had the "ability to type well and was at least an average typist." Thus, subjects determining a feedback judgment, trial by trial, matched this performance to the prior impression. Research has shown that when new information is congruent with a prior category, subjects latencies tend to be shorter than if the new information is incongruent with this prior category (e.g., Schul, 1986). Thus, latencies across conditions may have been a product of category consistent vs. inconsistent responding.

Given the above, we would expect a category consistent latency for those conditions that best matched the prior impression category mentioned during the experimental instructions. For instance, subjects in the INFO 4 conditions observed per trial a pattern of performance that could be described as (a) "average", (b) including "average" , or (c) as "inconsistent" but was overall "average" performance. Whereas, subjects in the INFO 2 groups observed within each trial a pattern of performance that was more likely (and more definitively) to be either an increasing or decreasing trend, and not suggestive of "average" performance. The longer latencies associated with the INFO 2 groups are then suggestive of a category inconsistent response. Furthermore, relative to the INFO conditions, latencies appear to decline as one moves from Hi to Lo

VARs. However, the ANOVA on Table 5 indicates that the neither a VAR main effect nor an INFO by VAR interaction were significant, therefore, suggesting two different processing modes were in effect across INFO conditions.

Memory vs. on-line task model. Hastie and Park (1986) developed a framework to better understand the mixed results found in the literature on memory-judgment relationships. In their framework judgment tasks are emphasized as critical factors to how and what mode of information processing will be employed. Their framework distinguished between two types of judgment tasks, each illustrating the model task conditions important to memory-judgment relationships, they are: on-line tasks vs. memory-based tasks. On-line tasks were characterized as: persons making spontaneous judgments; as decision makers not waiting or referring to prior memories but as revising their judgments as new information is encountered. In contrast, memory-based tasks were characterized as: persons relying on stored information to make judgments; as meditated as opposed to spontaneous processing; and as dependent on retrieval mechanisms associated with long-term memory (Hastie & Park, 1986). In terms of latency measures, Hastie and Parks framework appears to imply that (relative to the task conditions) latencies should be shorter for on-line processing as opposed to the more effortful memory-based processing.

Although, two sets of tasks are dichotomized, Hastie and Park qualify that these tasks are representative of conditions that may not always divide into two neat unequivocal categories. Such task conditions, however, can be distinguished experimentally on how memory-judgment protocols are operationalized. The "forced adoption" procedure, for instance, presents subjects with personnel information regarding a person's suitability for a job. Prior to the presentation of the information, half the subjects are told that are going to make a job selection judgment, while the other half are told of the judgment task only after hearing the personnel information (Hastie & Park, 1986). Thus, the former manipulation attempts to force on-line processing, while the latter attempts to force memory-based processing.

In the present experiment a complex set of task conditions were presented to subjects. Instructionally each subject was told that they were to make feedback decisions as referenced to the trial performance observed. According to Hastie and Park (1986) such an announcement should prompt an on-line mode of information processing. However, the latency data on Table 4 and 5 indicate that task conditions associated with INFO 2 are different than INFO 4.

One possible important component to this difference may have to do with how subordinate performance was displayed across trials. Recall that in the INFO 4 trials the three most recent performance events had already been observed in prior trials, and the fourth event was added as a new event. Metaphorically, the INFO 4 condition provided "material memory" in the form of these three past performance events. Thus, given any trial, subjects had a certain degree familiarity, with the performance observed, whereby attention could be dedicated to updating the decision process with the fourth performance event (i.e., defining an INFO 4 trial). Because of this built in access during each trial to past performance events (i.e., material memory), subjects required less memory regarding the recall of past performance and feedback effectiveness. Therefore, the feedback task as associated with the INFO 4 conditions may be best characterized as inducing on-line processing.

On the other hand, the feedback task as associated with the INFO 2 conditions may have induced memory-based processing. The INFO 2 conditions presented only one past performance event, as observed during the previous trial, and one new performance event. If feedback effectiveness was judged by how performance changed across trials, the INFO 2 condition made such information less available as opposed to the INFO 4 condition. Again metaphorically, the INFO 2 condition had less "material memory" for subjects to reference their next feedback decision against. Such conditions, therefore, called for more effort and the retrieval from memory information important to the feedback decision process. Thus, the INFO 2 conditions as configured may represent a task condition that graduated a processing mode from an on-line to a memory-based.

In Summary. Whether subjects employed category or featured based processing, or whether the feedback task was suggestive of an on-line or a memory-based task, necessitates testing and the formation of hypotheses. For instance, discussion regarding the INFO 4 conditions as representative of an on-line task, suggested that a critical component was the presence of previously observed performance events, that the redundancy acted to lessen reliance on memory. In contrast, category-based processing makes no such requirement, the categorization process is made against information that "approximates" the category prototype. Thus, the two information processing models can be tested against each other. For example, within the INFO 4 condition, two types of trials can be manipulated: one group of subjects are given trials where past performance from previous trials are included (i.e., material memory), and a second group where each trial has completely different and independent performance events (but are representative of the type of performance observed in a specific VAR density). Thus, the only difference between the two manipulations is the presence or absence of previously observed performance events among the trials. Given the same VAR conditions, if subjects were using category-based processing, then trials including completely different and unrelated performance events should have no change in their latency measures because in this experimental set-up each group's trials are representative of the category or prototype. In comparison, if subjects were employing on-line processing, then trials including completely different and unrelated performance events should show increased latencies since no "material memory" exists. Thus, when each trial represents a independent sample of subordinate performance, without any reference to past performance or outcomes, on-line processing should be compromised, but not if category-based processing is being used.

This test should produce results that further discriminate category-based and on-line processing. However, in the context of this study, the discrimination between memory-based and featured-based processing may prove to be more difficult. Conceptually, both constructs suggests a more effortful and deeper analysis of current and past information, particularly when incongruent information must be processed. Thus, more conceptual definition and specification (and consensus by researchers and theorists) of the two models is warranted.

Finally, an additional manipulation needs some discussion. Obviously, whether subjects were induced to use simplifying heuristics or use prior impressions requires testing. Future research can easily manipulate the presence and absence of prior impressions. These kinds of manipulations can examine whether subjects maintain prior expectations or form their own category or strategy when faced by a complex feedback task. Furthermore, follow-up post-experimental questions can also be asked within interviews or on surveys as to what kinds of impressions, strategies or processing modes might have been used when feedback judgments were made.

Latency Hypotheses 2 & 3:

The Significance of Feedback and Performance Conditions

The experiment included two other latency hypotheses, they were: (a) subjects would display shorter latencies when giving negative feedback as opposed to positive feedback, and (b) subjects would display shorter latencies when managing more consistent performance than inconsistent performance. In Table 5, the ANOVA indicates no significant main effect for either feedback (FDK) or subordinate performance variation (VAR). However, the ANOVA does show a significant VAR by FDK interaction ($p < .043$). Table 4 reveals the source of this interaction; note the larger differences seen between positive and negative feedback latencies at Hi-VAR conditions relative to the smaller differences associated with lower VAR conditions.

A major purpose of these hypotheses was to shed further light on the often touted negative feedback reluctancy and/or distortion hypothesis (Fisher, 1979). The reluctancy hypothesis proposes that managers are more likely to hesitate and/or positively distort feedback given to a poorly performing subordinate. Managers hesitate and distort because they are mindful of the potential for social retaliation, disagreement, and admonishment. Research on the reluctancy hypothesis has shown mixed results (e.g., Fisher, 1979; Ilgen & Knowlton, 1980; Larson, 1986), prompting theorists to recognize the complexity of conditions surrounding the delivery of negative feedback (Larson, 1989). Table 4 shows a clear trend across conditions that for positive feedback latencies were longer than for negative feedback, particularly for the Hi-VAR conditions. These results, therefore, present continued evidence that informally delivered negative feedback is more complicated than the reluctancy hypothesis proposes. However, research needs to further explore and test the relevant conditions surrounding informally delivered feedback. Typically, the reluctancy hypothesis is tested under conditions where subjects believed they were going to face the subordinate in person when giving feedback (e.g., Ilgen & Knowlton, 1980). Such an "in person" manipulation in the context of the present experiment might reveal changes in both latency and response data.

Section Three: Post-Experimental Survey

The purpose of the post-experimental survey was two-fold. First, the survey was intended to support or explore indirectly the variables associated with feedback responses and latencies. These questions were used and discussed in the above sections. Second, the survey was principally designed to apprehend the causal attributions made by subjects regarding subordinate performance as well as their own performance. Unfortunately, the results appear to be effected by the lack of statistical power (Cohen, 1977), most likely due to the low n-sizes observed in each experimental cell (i.e., 10 subjects per cell). Thus, the survey data were blocked according to the VAR conditions so as to increase power. None-the-less, interpretation of these results must remain suggestive, and be received with caution until further research can be conducted, employing larger samples. Given this manipulation and proviso, Table 12 illustrates the survey items describing a subject's attributions and attitudes regarding his subordinate's performance. And, Table 13 displays the survey items describing a subject's attitudes, beliefs and perceptions regarding his own performance as a feedback giver.

Table 12: Attributions and Attitudes Regarding the Subordinate

The attributional approach used to form these questions were first conceptualized by Weiner, Frieze, Kukla, Reed, Rest, and Rosenbaum (1971). This approach uses four elements for explaining achievement related tasks (Weiner, et al, 1971), they are: ability, effort, task difficulty and luck. Research has shown that how supervisors rate the relative importance of these elements, as explaining a subordinate's performance, can predict future supervisor-subordinate exchanges (Ilgen & Knowlton, 1980). Thus, the answers to these survey items reveal potential tendencies and attributions formed by subjects regarding their subordinates.

In Table 12, of the four elements examined attributions regarding effort (Item 1) showed the greatest VAR condition discrimination. The data report that subjects in both the Hi and Md-VAR conditions were significantly more likely to attribute effort as effecting subordinate performance than the Lo-VAR condition. In other words, the more inconsistent the subordinate performance the more supervisors felt such performance was due to effort. Table 12 also indicates that subjects were significantly more likely to believe that subordinates had more control over both good and poor performance when that performance was inconsistent rather than consistent (Items 5 and 6). Unfortunately, if these conditions do encourage such attributions they may only further assist the emergence of a NFB. First, although performance variability was stochastically determined it somehow implies greater subordinate control (for a interesting discussion regarding the illusion of control when dealing with chance related events, see Langer, 1975). Second, research has shown that attributions suggesting poor subordinate performance is due to lack of effort are typically met with greater negative feedback, than if the attributions were made to ability (Ilgen & Knowlton, 1980). Together, the perception of control and the formation of an effort attribution may serve to further facilitate the emergence of a NFB, especially since both imply internal factors governed by the subordinate.

Such attributions regarding subordinate effort and control are likely to influence how supervisors rate subordinate performance (Items 7 - 9) and whether subordinates are selected for promotions or pay increases (Items 10 - 11). On the first dimension subjects rated subordinates, across VAR conditions, as being average or just below average performers, and just average in effort and in ability. Supervisors appear ambivalent regarding the likelihood that subordinates deserve pay increases or promotions. Unfortunately, these results do not differentiate across VAR groups, possibly indicating that subjects used some overall impression of the subordinate. In actuality, the overall performance of the subordinates was average (i.e., if a mean was tallied across each time series), subjects may have referenced their answers to this fact and the pre-experimental impression given to them at the beginning of the study (i.e., a secretary was "at least an average typist").

Table 13: Self Perceptions and Attitudes From Subjects

Items 1 - 4 asked subjects to rate and characterize their managerial effectiveness and style. Items 3 and 4 best differentiate the effects of the VAR conditions. Item 3 indicates that subjects in the Hi-VAR condition were significantly more likely to rate their managerial ability less than subjects in the Md and Lo-VAR conditions. Item 4, in accordance with Item 3, shows that subjects in the Hi-VAR condition characterized their managerial style as significantly poorer than subjects in the Md and Lo VAR conditions. Both items seem to suggest that subjects faced with highly inconsistent subordinate performance may consider their own abilities at fault. Such circumstances may engender a vicious circle that encourages NFB. For instance, supervisors faced with subordinates who appear to be in more control of their performance (Item 5 and 6 of Table 13) and using greater effort (Item 3 of Table 13), may work even harder to find the most effective feedback technique (i.e., improve one's managerial abilities).

As modeled in this experiment, subordinate performance is controlled by a stochastic process that is functionally independent of a supervisor's feedback, and since supervisors fail to recognize the natural variation of inconsistent performance, no amount of improved ability will change the performance. However, a supervisor who changes the type of feedback delivered to inconsistent performance (i.e., NFB) may change his or her self-perception regarding his or her ability to supply effective feedback, although the perception of effectiveness would be erroneous (e.g., Bem, 1972). The perception is, of course, dependent on delivering negative feedback to poor performing subordinates, whose performance has been shown to improve (coincidentally) after such feedback presentations. Thus, the conditions responsible for a NFB may partly be supported by the cognitive desire by supervisors to feel self-efficacy (Bandura, 1986).

The efficacy of using negative feedback did not go unnoticed by the subjects. Items 5 asked subjects to judge whether positive or negative feedback improved performance best. The Hi-VAR condition saw negative feedback as much more effective than subjects in both the Md and Lo-VAR conditions. Furthermore, the Item 5 correlation with percent-difference scores showed that subjects, across all conditions, with a NFB thought negative feedback improved performance best, likewise those who showed a positive feedback bias felt that positive feedback was better. Interestingly, in Item 6, subjects are asked to rate the quality of feedback given to subordinate performance (i.e., mostly negative to mostly positive). However, the results show no VAR condition differences were indicated. Yet, a significant item correlation did show that subjects who showed a NFB were more likely to rate the quality of feedback as negative, while others who showed a positive feedback bias thought the quality of their feedback was more positive.

Items 7 and 8 asked subjects how they felt about giving positive and negative feedback. The item means across VAR conditions did not show any significant differences. However, comparison across Items 7 and 8 reveal that subjects felt significantly more comfortable about giving positive feedback than negative feedback. However, item correlations with percent-difference scores showed a contrasting understanding. For Item 7 the more a subject displayed a NFB the less comfortable he felt about giving positive feedback, while the more a subject showed a positive feedback bias the more comfortable he felt about positive feedback. For Item 8, a significant correlation was also found. In this case, the more a subject displayed a NFB the more comfortable he felt about giving negative feedback, while the reverse was true for individuals with a positive feedback bias. Such data, again, conflict with the traditional understanding of negative feedback. The feedback literature has attempted to verify the conditions that promote the reluctancy/distortion hypothesis. The data presented here are seen as additional evidence that negative feedback and its use is more complicated than traditionally understood.

In Summary

The survey results do not assist directly to the understanding of the emergent process of NFB. Since conditions were blocked according to INFO condition, all results were referenced to the VAR conditions. Therefore, the significance of each items to the understanding of NFB must be speculative. It appears that the inconsistent performance of the Hi-VAR conditions fosters attributions regarding subordinate effort and control over their own behavior. Additionally, supervisors who showed a NFB felt relatively comfortable about giving negative feedback, and believed that negative feedback improved performance better than positive feedback. However, despite these beliefs, NFB supervisors rated their own managerial abilities and styles more poorly than non-NFB supervisors. Together, these survey highlights suggests that NFB may be encouraged by the situational features arranged by the Hi-VAR condition.

Section Four:

Limitations[1] that Inspire a Line of Programmatic Research

I must strongly emphasize that the present research represents the initial conditions (i.e., a beginning) of a line of programmatic research. I have always considered this research as a single study laying the groundwork for future examinations, directions and questions. I have over the years foreseen the replication and extension of this research in countless ways. The following discussion will attempt to render the limitations and set-up the context by which future research might draw direction.

Limitations found in the present experiment are common to most studies, but particularly for those whose methodological or conceptual basis is novel. Of course, one common criticism of a lab-experiment is its external validity. How representative were

[1] Personally, I believe limitations do not mean necessarily a weakness in an experiment's validity. Rather, they represent the seeds of curiousity and a motivations source for exploration. Of course, if one pursues the "true experiment" and stresses solutions and answers over new questions, then, yes, limitations do become the walls that confine the espirit de corps that empassioned scientists find addicting. The only thing wrong with limitations is the acceptance of them without compulsion to act on them. Limitations whether technological or conceptual are nothing less than invitations sent by the vast and mysterious unknown. We either reply and attend or stay home. I prefer to party with strangers and enigmas then channel surf with reruns that serve only to provide certainty of plot. No, uncertainty, though risky, is more fun.

the conditions studied to those found in actual supervisor-subordinate feedback relationships? Obviously, many asymmetries exist between the actual and the model.

First, one can comment on the type of subjects studied: college age undergraduates attending a psychology course. This difficulty can be easily addressed by new selection and sampling procedures and criterion. Differential analysis of different groups of subjects may hold new knowledge and questions (e.g., gender or age differences).

Second, the present experiment attempted to model the informality of performance feedback between supervisors and subordinates. However, the degree to which this informality was obtained was not specifically measured. Subjects did not have personal contact nor was it implied that any contact would occur. Instead, subjects as supervisors attended to information that represented the behavior of a subordinate in a "outside office". Such conditions that manipulate face to face contact between subjects and their "subordinates" deserves analysis, especially since past research has shown that such manipulations alter the delivery of feedback (e.g., Ilgen & Knowlton, 1980).

Third, as stated above, the principle independent variable was the presentation of subordinate performance as time series data, illustrated on a run chart. Such a portrayal may exert its own influence quite apart from actually observing subordinate performance. In the context of a lab experiment, the study of how important specific stimulus features are to feedback can be reconciled in numerous ways. On one hand, manipulating video-tape and the use of dataesque information may tackle issues concerning the influence of vividness and portrayal formats on feedback delivery. Research has shown that such manipulations do bear on how information is processed and integrated (Kulik & Ambrose, 1993). On the other hand, the experiment presented here may actually approximate some supervisor-subordinate situations. With the advent of computer technology many supervisors are managing subordinate performance via computer networks, particularly within automated offices and factories (e.g., Henriques, 1986; Koepp, 1986; Sheridan, 1986; Tobin, 1985).

Fourth, one unique aspect of the experiment presented was its attempt to model the temporal dimension of supervisor-subordinate relationship. However, the 80 consecutive trials that subjects observed over a 40 minute session, may be considered as a unique set of circumstances. How often do supervisors continually observe subordinates over repeated moments? Most supervisors have many duties and activities that demand and divert their attention. Disregarding an automated office example, certain manipulations that provide distracter tasks (e.g., anagram puzzles) may serve to explore the influence of this added level of authenticity. Previous feedback research has used distracter tasks as a means of increasing the external validity of their studies (e.g., Larson, 1986).

Furthermore, this limitation represents one component of the opportunity-based supervision construct discussed earlier. The present experiment manipulated the opportunity to sample, which translates into the amount of information observed per trial by subjects. However, opportunity-based supervision also refers to the opportunity to observe, which translates into the when and the frequency of observation. Thus, distracter tasks may prove an ecologically relevant way to manipulate and examine the effects of the opportunity to observe condition. This manipulation could also include a condition where subjects choose when and at what frequency observation is needed. Such may reveal, as a dependent variable, some interesting results regarding the timing of feedback, and the cognitive processes employed.

Fifth, another facet that may better approximate supervisor-subordinate dynamics is the introduction of multiple subordinates. Supervisors usually are responsible for many subordinates and their level of work. Differences in performance levels among subordinates may effect how supervisors differentially manage individuals or how general strategies for feedback delivery are formed. Group performance may establish standards by which individual subordinates are judged. Thus, having subjects manage multiple subordinates and the complexities that emerge from such an arrangement, may address questions regarding the formation of feedback strategies and standards.

Sixth, in this experiment a point system was intended to mimic several supervisory experiences and pressures common to their work situation. Recall that subjects were told that the point system was just another way of evaluating their managerial effectiveness. Although, the point system appears quite artificial, the system attempted to induce a supervisory motivation often associated with such positions of responsibility. Supervisors are themselves judged by how well subordinates perform, such conditions are usually referred to as an interdependence (e.g., Ilgen et al., 1981a; Larson, 1984), accountability (e.g., Stamoulis, 1993), or hedonic relevance (e.g., Green & Mitchell, 1979). Therefore, the intention of the point system was to more fully capture and map the contextual pressures surrounding a supervisor. As an experimental feature, the interdependence condition can be more fully explored by manipulating its presence and degree of intensity. The manipulation of an interdependence condition may than determine to what degree NFB is dependent on such supervisory pressures. Of course, how this interdependence is modeled may take on many forms, previous research has used financial contingencies to induce such dependencies (e.g., Hinton & Barrow, 1975; Larson, 1986).

Ecology Inspired Modeling

It has been debated whether a lab experiment must generalizes to actual circumstances (Mook, 1983). From the start, the experimental set-up has attempted to model a specific natural phenomenon. Thus, recognizing the above limitations, the present research approach offered a heuristic understanding of the emergence of NFB, specifically in its findings, methods and conceptual basis. Additionally, external validity issues may be misplaced in the present context, since the proper experimental question is whether NFB can happen, rather than does it typically happen. This distinction is critical when one seeks to model natural phenomena, especially since most psychological research use paramorphic type models, rather than homeomorphic ones (for a discussion regarding the many categories of models, see Harré, 1970).

Typically, lab experiments model natural phenomena by taking them apart, and using only those features amenable or relevant to a particular research question. In short, the process is one of simplifying the subject and object matter. This bias has been supported by the erroneous but classical assumptions that knowledge statements should be parsimonious and variance is but error. Recent alternative perspectives and approaches to the study of natural phenomena have sought methods that better capture the complexities, details, contexts, and underlying dynamics of nature, such as: chaos theory (Barton, 1994; Pickover, 1990), nonlinear dynamics (Prigogine & Stengers, 1984) and fuzzy logic (Kosko, 1993).

The present research was inspired by these new ways to approach natural phenomena. In the psychological sciences the ecological movements of Lewin (1951), Brunswik (1955), and Barker, (1963) to name a few, were earlier approaches that grappled with the rendering of complex social phenomena. Thus, the present research attempted to construct a system by which the complexity of informal supervisor-subordinate relationships could be modeled. The model emerged out of a process of noting the natural ecological elements and movements of the participants. Of course, the factors and systems derived and eventually modeled (e.g., time, performance variation, information size) were simplifications, but simplifications inherently dynamic and complex. The simplification was in the rendering of actual complexity, rather than the isolating static parts or properties of this complexity. The limitations discussed above, are therefore seen as additional aspects of the informal supervisor-subordinate ecology.

When future research adds these variables to the present experimental set-up the ecological validity[2] of the model will presumably increase.

Inspiring Feedback Theory Through Modeling

What is feedback theory? Or, more to the point, where is feedback theory? The study of feedback has a long history. Its importance has been established in both general and specific ways, from directing and motivating human behavior (Ammons, 1956; Payne and Hauty, 1955; Vroom, 1964) to its application to goal setting, job enrichment, and employee training (Erez, 1977; Locke, Shaw, Saari & Latham, 1984; Hackman & Oldham, 1976; Goldstein, 1986). Several excellent feedback frameworks or conceptual taxonomies have attempted to document the overwhelming range and diversity of variables and processes, that either directly or indirectly influence feedback or how feedback influences them (Ashford & Cummings, 1983; Ilgen, Fisher, & Taylor, 1979; Larson, 1984; Taylor, Fisher, & Ilgen, 1984). These frameworks pursued, in one sense, an ecological analysis, where the complex world surrounding feedback was examined in detail.

Given this conceptual and experimental history regarding feedback, I ask again, what or where is feedback theory? Of course, the answer depends on how theory is defined. In general, feedback frameworks have identified and developed numerous hypotheses across many theoretical fronts. Obviously, no single theoretical orientation has risen to popularity. This may be due to the subject matter, feedback is an extremely

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[2]The term ecological validity is described by Brunswik (1955). The term references the correlation between how nature actually exists and how it is perceived through cues. In one sense, an ecological validity is a possible measurement technique of external validity. If the experimental variables of any study are treated as cues perceived and then correlated with their original derivation (e.g., some part of an actual natural setting), high correlation would represent high generalization and low correlation low generalization. Brunswik's ecological validity, as an integral component to his lens model and to probabilisitic functionalism, offers many insights into our commonly used and believed notions regarding validity. Interested readers are encouraged to explore Brunswik's approach.

ubiquitous natural process. However, even by narrowing the study of feedback to organizational questions, the field still encompasses a large area of study.

Typically, feedback frameworks have provided an overarching grand perspective, offering numerous hypotheses, covering diverse and different mechanisms: from the importance of attribution formation (e.g., Ilgen & Knowlton, 1980; Ilgen et al., 1981a) to the bi-directionality of influences between supervisors and subordinates (e.g., Herold, 1977). With no single or universal theoretical orientation gaining any long lasting study, the study of feedback may best be described as in the development of middle-range theories (Pinder, 1984). Middle-range theories attempt to explain only parts or segments of the total universe of a phenomenon. However, as Pinder points out, the advancement of middle-range theories to universal ones depends on a science actively seeking the integration and examination of different middle-range theories. Such does not seem to have happened for the study of feedback. Perhaps feedback as a specific phenomenon is embedded in such a complex field that no single theory can begin to map out its existence adequately.

Another reason that the study of feedback has not resulted into a vigorous theoretical field is the lack of conceptual modeling. Typically in other areas of organizational theory feedback is a central or a secondary model component. This is because most human based systems rely on some form of feedback, either for direction or correction in system processes. Yet, the specific study of feedback has generated very few models. One exceptional example was created by Larson (1989), as a means to confront the mixed results concerning the reluctancy/distortion hypothesis. In this model Larson theorized that the use of negative feedback may depend on several variables working in concert. Larson proposed that a threshold must be met before negative feedback would be given. However, the threshold itself was dynamically linked to (a) how severe the poor performance was perceived, (b) role demands of the supervisor, and

(c) the pressures to hold back negative feedback. Feedback was delivered only when the severity of the poor performance crossed the threshold. This "Build-Up" model represents one of the few attempts to construct a theoretical orientation that predicts not only what type of feedback but its timing and delivery. It also renders feedback as a dynamic interplay between three underlying processes including time. Alas, it appears that the Build-Up model has not inspired any continuous empirical research.

The present research also developed a model that predicted not only what type of feedback (i.e., NFB) but its timing and delivery (see Figure 1). Given the many frameworks that have provided intimations regarding the conditions and delivery of feedback, several possible models of feedback delivery can be discerned. These models could then be matched to actual supervisory feedback. Such findings would then help advance the relevance and generality of the model to particular supervisor-subordinate relationships and their conditions and contexts. By extension, several models could be tested or compared against each other so as to identify the appropriate model of prediction and the conditions to which it applies. This process of model testing attempts to advance the development of theory as it applies to informally delivered feedback.

Model testing could be encouraged by using the lens model approach (Brunswik, 1955). The process of testing would follow the lens model application used in policy capturing analyses (Brehmer & Brehmer, 1988). Figure 12 shows the classical illustration of the lens model's features. In general, the central oval of (Cs) represents the subordinate's performance and surrounding conditions (i.e., the independent variables). The (S) indicates the supervisor's (subject) feedback delivery as a consequence of observing the (Cs). The (Ms) represent the specific models of feedback delivery. Looking at each of the three features as columns of data, the lens model works by using regression techniques. First, the column of (Cs) is regressed on the subject (S) column of feedback choices. A regression equation is determined for this regression. This subject

Feedback Theory and Model Testing

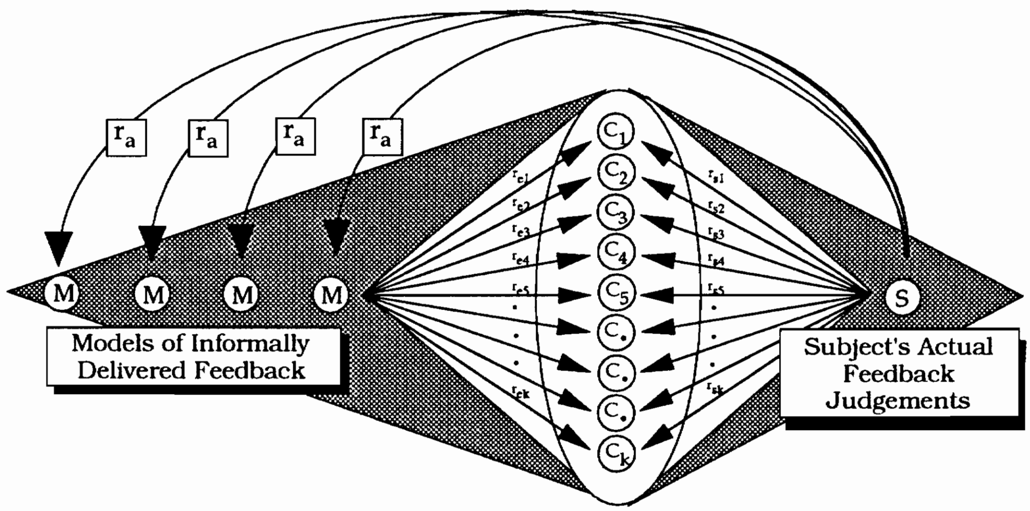

Figure 12. Feedback Theory demonstrated as testing specific feedback delivery models against subject's actual feedback judgements. Process of testing follows the lens model application used in policy capturing analyses.

regression equation represents how actual feedback was delivered as prompted by the subordinate performance (Cs). Second, the column of (Cs) is regressed on each of the models to be tested (Ms). A regression equation is determined for each model. The model regression equations indicate how feedback would be delivered if the model was actively employed. Using Attribute-Treatments-Interactions analysis (see Pedhazur & Schmelkin, 1991) the different models of feedback delivery can be tested for goodness of fit (see the r_as). This regression analysis tests whether the equations, as stated above, have significantly different slopes or intercepts.

Future research may use this analytic approach to discover which models best predict informally delivered feedback as given to subordinate performance However, for such an analysis to begin or remain viable, models of feedback delivery must be constructed or identified. Below I have gleaned from the literature several feedback models. I present these models in brief for the purpose of demonstrating the potential of rejuvenating an interest in feedback theory. They represent only an initial analysis of potential models.

Control Theory Model of feedback delivery (Taylor, Fisher, & Ilgen, 1984). This model agrees with much of the feedback literature, i.e., supervisors give negative feedback to poor performance and positive feedback to good performance. Whether the performance is increasing or decreasing does little to moderate the sign of feedback.

Build-Up Model, as discussed above, predicts the delivery of negative feedback as a function of time and severity of performance that must cross a certain threshold (Larson, 1989).

Relative Standard Model predicts that feedback is determined relative to how subordinate performance compares to a standard or benchmark. Thus, the more extreme the level of performance the greater likelihood that extreme feedback is delivered. However, this model suggests that the direction of performance plays a critical and interactive role with the level of performance.

NFB Model as discussed and modeled in the present experiment, predicts that feedback is conditioned by its results. When supervisors manage inconsistent performance and fail to recognize the natural variation inherent in the performance, they are likely to form a NFB.

In Conclusion

This experiment has shown that variation as information is the "difference that makes the difference" to feedback (cf. Bateson, 1979). NFB was discovered as an emergent process effected by the dynamic interplay between supervisors and subordinates. But as the above discussion testifies, the processes underlying organizational feedback, in general, are far from being understood. Yes, certain principles and hypotheses have been investigated, supported and relied upon. But the field of organizational feedback does not appear at this time, telling by the publication years, to be very active. This is certainly unfortunate since most theorists across organizational science emphasize its importance to motivation, learning, correction and control. Hopefully this experiment and its approach might encourage some new found impetus to explore.

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Appendix A.

Informed Consent Form

TITLE OF EXPERIMENT: Computer-Based Feedback Study Experiment Number: ______

PURPOSE OF EXPERIMENT: To explore the dynamics of computer-assisted feedback systems as used by automated offices, such as telemarketing, credit-card, and phone companies. Participants will be asked to monitor and deliver feedback through a computer module concerning the performance of a secretary's word-processing production.

PROCEDURE TO BE FOLLOWED IN THE STUDY: This study will take approximately 1 hour to complete. To accomplish the goals of the study, you will first be given a tutorial concerning how a computer-assisted feedback program works. Second, you will be asked to monitor the performance of a secretary's word-processing production using a computer-assisted module. During this time you will be asked to present feedback to a secretary to improve his or her production and motivation. And third, at the end of your participation you will be asked to fill out a survey, that asks questions regarding how you felt about the study, your secretary's performance, and the effectiveness of computer-assisted feedback.

PARTICIPATION REQUIREMENTS: Participants must be MALE, 18 years or older, and enrolled in Introductory Psychology 2004.

ANONYMITY OF PARTICIPANTS AND CONFIDENTIALITY OF THE RESULTS:

The results of this study will be kept strictly confidential. At no time will researchers release the results of the study to anyone other than individuals working on the project without your written consent. The information you provide will have your name removed and only a subject number will identify you during analyses and write-up of the research.

DISCOMFORTS AND RISKS FROM PARTICIPATING IN THE STUDY:

There are no apparent risks to you from participation in this study.

EXPECTED BENEFITS: Participants in this experiment will benefit by learning a process by which managerial feedback is delivered.

FREEDOM TO WITHDRAW:

You are free to withdraw from participation in this study at any time without penalty.

EXTRA CREDIT OF FINANCIAL COMPENSATION:

For participation in this study you will receive 1 class credit point.

USE OF RESEARCH DATA: The information from this research may be used for scientific or educational purposes. It may be presented at scientific meetings and/or published and republished in professional journals or books, or used for any other purposes which Virginia Tech's Department of Psychology considers proper in the interest or education, knowledge, or research.

APPROVAL OF RESEARCH:

This research project has been approved by the Human Subjects Committee of the Department of Psychology and by the Institutional Review Board of Virginia Tech.

PARTICIPANTS PERMISSION:

1. **I have read and understand the above description of the study. I have had an opportunity to ask questions and have had them all answered. I hereby acknowledge the above and give my voluntary consent for participation in this study.**

2. **I also understand that if I participate I may withdraw at any time without penalty.**

3. **I also understand that I must be 18 years or older in order to participate in this study.**

4. **I understand that should I have any questions about this research and its conduct, I should contact any of the following:**

Primary Researcher:	Mr. Thomas D. Berry	Phone: 961-1002
Faculty Advisor:	Dr. Roseanne Foti	Phone: 231-5814
Chair, HSC:	Dr. Joseph J. Franchina	Phone: 231-5664
Chair, IRB:	Dr. Janet Johnson	Phone: 231-6077

Subject's Signature: ________________________________ Date: __________

Subject's I.D. Number: ______________________________ Phone: _________

Address: ____ (Optional)

Psych. Teacher: ______________________

Appendix B

The Formal Operation and Analysis of Stochastically Defined and Constructed Time Series

By

Thomas D. Berry

Part One - July, 1993

Part Two - December, 1993

Blacksburg, VA

Table of Contents

PART TWO

"Comparing and Testing"

Executive Summary I: The Pragmatics

As of July 27th, 1993

Commentary regarding my dissertation proposal defense pin-pointed several concerns. These concerns focused on three general areas:

1) The nature of the independent variables (i.e., the stochastically derived time series).

2) The relationship of the different features expressed by the time series (e.g., amplitude, variance, and double ups-downs).

3) The causal mechanisms influencing the emergence of a negative feedback bias (i.e., regression to the mean).

The purpose of following paper addresses directly and in detail the first two areas, but as a consequence answers the third area.

In brief, my dissertation overstates the concept of regression to the mean (RTM) as (a) a description label for the time series used as independent variables, and (b) as "the" source for the emergence of a negative feedback bias (NFB). Obviously, the time series used in my dissertation express a complex assortment of inter-related features, patterns and properties. On examination and further reading it became quite clear that the time series presented in my dissertation defense not only showed regression to the mean tendencies, but also showed egression from the mean (EFM). Thus, causal mechanism(s) in reference to changes in a subject's behavior will be limited to concepts and properties that refer to a time series as a whole (i.e., as in a superordinate system, or mixture of subordinate features.

Simply, the analysis to be presented demonstrates how different mixtures determine the character and form of certain types of time series.

Executive Summary II: Metatheoretical Approach

As of December 12th, 1993

This document represents a mathematical and conceptual framework for generating stochastically defined time series used in my dissertation as the principle independent variables. The original impetus for this document was to satisfy certain dissertation committee questions. In my proposal the "Formal Operation" that defined the stochastic process was not included. However, the primary purpose of this document was to publish one method by which variation could be illustrated and manipulated (see Part One). And, given that each time series realized is but only a single sample from a stochastic population, I presented several criteria (e.g., variance and kurtosis) by which expected time series outcomes could be compared to actually realized time series samples (see Part Two). This process was designed to be easily understood, and thus easily extended or applied.

Another property of the analysis of the Formal Operation was to show how different characteristics that emerge as a time series is realized are interconnected. One of the challenges of the dissertation was to design a complex environment that could be taken as a whole or single-unit system. Argument for a reductionistic approach, that asks what part or characteristic is the essential element (e.g., regression to the mean) for the emergence of NFB, represents for me a misfortunate perspective. The approach used here in one of an ecological approximation, where complexity of an ecology is modeled. My bias is to note: the purpose of examining to what degree specific variables precede in importance over other variables, still must be related back to the system that organized the whole (i.e., Formal Operation). However, like vivisectioning a living system, we must be careful not to let our reductionistic tendencies to grab for final and singular answers that supersede the head over the heart. Yes, we should look for answers, but how often do we take on final arguments because of implicit rules of research justice. How often do we take on the Aristotelian logic in our hunt for the killer, the cause, the guilty, the wrong and the right, or the beautiful, only to find that the subject under study is more fuzzy, more complicated or contextually involved than first impressions warranted.

I preferred to start my explorations by studying the whole "big blooming buzzing confusion" (James, 1911), the fuzziness (Kosko, 1993) and variance (Galton, 1877) for its own sake. I will let the findings dictate whether simplification or elementalism is necessary. Training in traditional experimental psychology has suggested that, if a simple answer suffices than why choose complicated renditions. Well, my simple answer is a warning, if your default conceptions regarding nature, methods and models are geared to locating and confirming the simple and parsimonious, then perhaps you will never need to face the complicated (Berry, 1991). Under these conditions the complicated will most likely not have a chance to express itself or even be heard. I reject prior traditional approaches of experimental science as casting strict moral codes, that serve to direct a scientist's perception to simple models regarding natural phenomena, and then justifies these codes with heavenly goals of order and parsimony (Berry, 1991). I have attempted to start my research with an appreciation for the complex and contextual, and build dynamic models and heuristics that best represent a nature that is full, blown, open, gray, misty, silent, noisy, beautiful and ugly.

Obviously, I take the position that the NFB is the result of many elements playing in concert. As found in the results section, NFB appears determined by a three way interaction. For me the interaction demonstrates the importance of a holistic or ecological approach. To better visualize the complexity modeled by this dissertation Figure 0 was created. Of course, the language that gives this Figure's sterile boxes and arrows life is presented in the main body of the dissertation, on pages 5 - 10.

Figure 0 shows a map of the experimental set-up of the research factors and process. This map illustrates how the independent variables of "subordinate performance" and "information size" are referenced and interconnected to a realized time series. At the left the key experimental elements of the Formal Operation are given and directed toward the stochastic process which ultimately translates into a realized times series. However, each time series illustrated has been related to specific outcomes that describe characteristics of the realized time series. At the top the Supervisor's Context shows key elements describing variables inherent to a supervisor's work situation. The map ends with the "Subject as Supervisor", where each of the dependent variables are indicated: feedback choice, latency, and attributions. Although, the presentation of this map of factors and processes appears well defined and orderly, it represents, in abstract, the complexity and confusion of supervisor-subordinate interactions.

Finally, I need to call attention to some notation changes. Originally, when this framework was devised there was difficulty in naming the different components of the Formal Operation. In the dissertation's Method section a notation is used to refer to key components defining the variation density specific to a time series. Specifically, VAR refers to the variation factor and MRD refers to mean egressive density. In this document VAR is referred to as RD or reciprocal density. The change in designation was made for reasons of clarity and emphasis. I apologize for any confusion regarding this change.

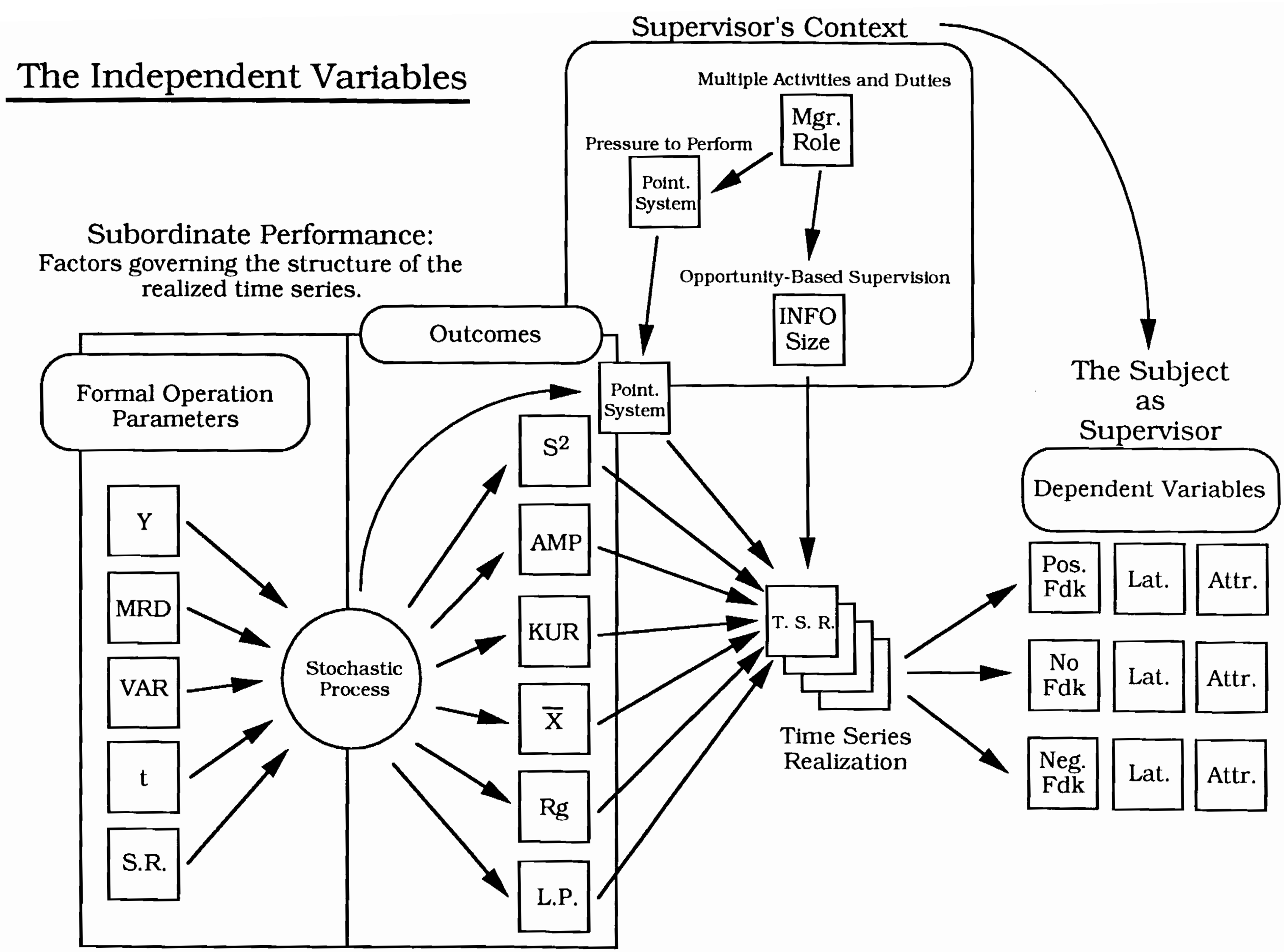

Figure 0. Experimental Set-Up and Model of Research Factors and Processes.

Part One:

Defining and Analyzing

In general, the purpose of the independent variables was to present subjects with a unfolding and dynamic phenomenon expressing relative degrees of consistency and inconsistency. Conceptually, such phenomenological qualities were made important since they modeled what I called in my dissertation the "natural variation" of a phenomenon (e.g., an employee's work behavior over time). The medium chosen to represent "natural variation" was a stochastically determined time series. Thus, a central aim of this research was the development of a framework that would model "natural variation" and generate stochastically governed time series.

Introduction

The following Formal Operation and Analysis is divided into three sections. The first section gives the Formal Operation defining the parameters used to generate stochastically governed time series. These parameters define the discrete probability densities assigned to events or units represented on the y-ordinate axis of the time series run chart. In general, these parameters control two critical components of a time series profile, they are: (a) a static, consistent or time-invariant component, and (b) a dynamic, inconsistent, or time-variant component. Simply, the Formal Operation identifies the defining parameters of a stochastic process that when manipulated and executed composes a time series with specific consistency-inconsistency properties.

In the second section a Molar Analysis is conducted. Here the molar analysis shows how the parameters can be integrated and used as a heuristic framework for describing and comparing different operationally specified time series. One consequence of this section is the creation of what I call the Psi Coefficient. The Psi Coefficient is another way of discerning the consistency-inconsistency properties of a time series. Furthermore, once parameters have been defined additional descriptor properties emerge that are consistent with the parametric values specified (e.g., the variance of a time series). From a systems approach the Formal Operation and the molar analysis act to define, describe and generate the superordinate characteristics of a time series.

In the third section, a Micro Analysis in conducted on the subordinate characteristics of the parametrically specified time series. By subordinate characteristics I mean the analysis of local patterns or micro features of a time series. Examples of such patterns or features include the number and types of amplitude changes between events, the expected probabilities of certain local event patterns, such as double up or down sequences or the auto-egressive or regressive tendencies of events.

Goals of Formal Analysis

First-and-for-most, this analysis of my independent variables has been approached by an ecological and systems perspective. These perspectives were encouraged by my essential question, that is: "*how nature (read variation) operates as a whole and how people respond to this nature.*" Thus, a major goal for me was the creation of a Formal Operation that could describe, model and generate a dynamic range of time series phenomena. The Formal Operation and analysis places my independent variables, as mentioned in my dissertation, into a broader parametric and numerated context. A second, but important goal is to demonstrate that superordinate and subordinate qualities and characteristics are themselves a function of the Formal Operation and are not merely random or transient features of the random process.

In addition, I would like to mention the practical goals of the following Formal Operation, that is, to conceive of a fairly easy method to:

a. model variation ,
b. construct a variety of different types of time series,
c. promote replication, and
d. build a base for future research.

The Formal Operation

The following Formal Operation presents the steps whereby superordinate parameters are defined and thus the means for constructing and describing the time series used in my dissertation:

(Step 1) **Define y.** Parameter y defines the number of y-ordinate axis levels, intervals or units of a time series. This parameter represents the limits and units (ceiling to floor) by which events (data) may vary, change or range over time. Specifically for this research, y is defined as any odd "natural" number greater than or equal to 3. Once y is defined probabilities are then assigned to each y-ordinate level. There are two types of probabilities, the Mean Regressive and Reciprocal Density probabilities.

(Step 2) **Define the Mean Regressive Density (MRD).** The MRD is the probability given to a time series average value, where:

$$p(\boldsymbol{MRD}) = 0 < \boldsymbol{MRD} \leq 1.00$$

(Step 3) **Define Reciprocal Density (RD).** The RD is the probability given to that portion of the time series defined by those y-ordinate levels minus the probability of the MRD level. Thus:

$$p(\boldsymbol{RD}) = 1.00 - p(\boldsymbol{MRD})$$

where

$$p(\boldsymbol{RD}) = 0 \leq \boldsymbol{RD} < 1.00$$

(Step 4) **Define the ith Reciprocal Density ($\mathbf{RD_i}$).** The RD_i is that portion of the RD probability assigned to each individual y level given a specific jth MRD probability, and the number of y-ordinate levels minus one (i.e., minus the MRD level). In the case below, each RD_i is given an equivalent probability, such that,

IF:

$$f(\boldsymbol{RD_i}) = y - 1$$

THEN:

$$p(\boldsymbol{RD_i}) = \frac{1.00 - p(\boldsymbol{MRD_j})}{y-1} = \frac{p(\boldsymbol{RD})}{y-1} = \frac{p(\boldsymbol{RD})}{f(\boldsymbol{RD_i})}$$

Computer Application of the Formal Operation and Special Requirements. Time series were constructed using Minitab's Discrete random data generator. Thus, sample records are constructed when values are assigned to the parameters above and the computer command is executed. In addition, two special requirements had to be met as the sample records were generated:

(1) the middle y-ordinate level was always considered the mean value and thus always assigned the MRD value. Remember above - that y was defined as any odd natural number greater than or equal to 3. Thus, the y-ordinate value assigned the mean value was equal to

$$\bar{y} = \frac{\sum_{y=1}^{y=n} y_i}{y}$$

Where y is an odd natural number greater than or equal to 3.

(2) the only event that could repeat in successive moments was the mean value. Values above or below the mean value could not repeat in succession but had to change. This later requirement I refer to as "idealizing" the stochastic process and will be mentioned in future sections and analyses.

Note that in addition to these requirements the time series used in the dissertation were scrutinized for asymmetries and balance **(See Appendix XX).**

Molar Analysis of the Superordinate System Parameters

Since the MRD and RD parameters represent specified regions of a time series distribution, they also can be used as overall descriptors for accessing a sample records probable consistency and inconsistency. When integrated as a ratio the dividend can represent a coefficient delineating the relative variation to be expected when specific MRDs and RDs are used to construct a time series sample record. Below the Psi coefficient describes such a case. The Psi coefficient is defined as the probability of the MRD divided by its reciprocal probability (RD).

$$\Psi_{Coefficient} = \frac{p(MRD)}{p(RD)}$$

Note that the parameters and the Psi coefficient are essentially population descriptors, that once the Formal Operation and Mintab's discrete command are executed, the time series' generated represent sample records. Such sample records, therefore, approximate the defining parameters of the Formal Operation as t-sizes increase and approach infinity.

Psi Coefficient and Function

Given the defining features of MRD and RD as discussed in the Formal Operation and taking all possible values for MRD into account, a Psi Function curve can be plotted. A Psi Function curve is made up of all possible Psi coefficient values and is the ratio between MRD and its reciprocal value RD. Figure 1 below shows two lines: (a) the straight line illustrates the ratio of MRDs and RDs as coordinates (see the abscissa label and the left ordinate label), and (b) the curved line represents the Psi Function as coefficients plotted against their MRD values (see right ordinate label and abscissa label). Note, if the graph is tilted up on its bottom right corner the figure formed by the two lines resembles the Psi character.

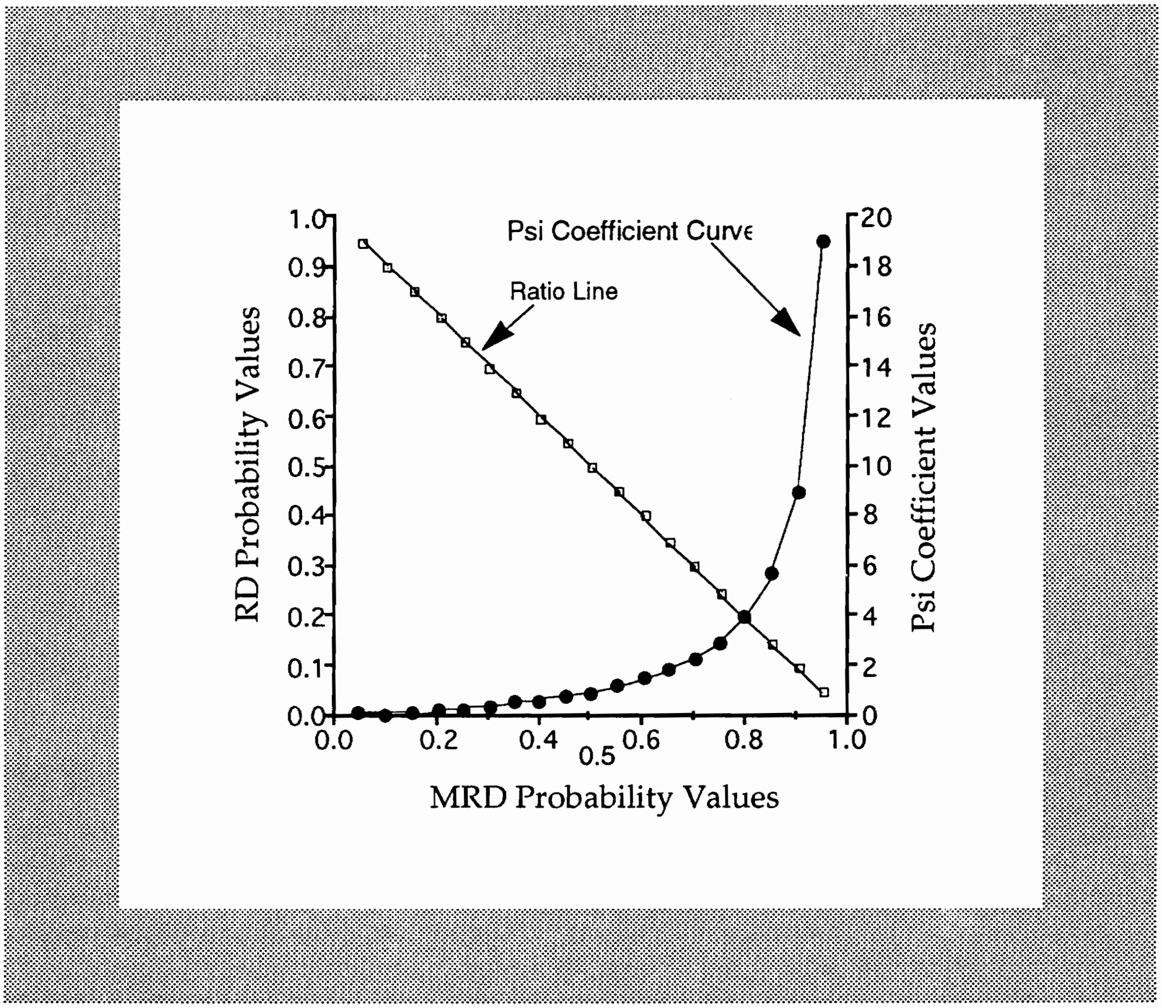

Figure 1:

- The Psi Function shows a Psi Coefficient Curve (solid circles) as a function of the ratio of p(MRD) over p(RD) line (open boxes).

- A Psi coefficient is a value indicating the probability ratio, that any given event of a Time Series distribution will be included within the "mean" of that distribution. Therefore, a Psi coefficient of P = .75/.25 = 3.0; indicates that for any given event -- "*it is 3 times more likely to be within the distribution's mean, than outside the mean value*"

TABLE 1 presents a list of probability ratios across 19 sample Psi coefficient values.

Psi Coefficient Values	Probability Ratio's	p(MRD) Values	For any given event, the:
19.0000	19 : 1	.95	Number Times Likely to be Within the "mean" of a distribution.
9.0000	9.0 : 1	.90	
5.6667	5.7 : 1	.85	
4.0000	4.0 : 1	.80	
3.0000	3.0 : 1	.75	
2.3333	2.3 : 1	.70	
1.8571	1.9 : 1	.65	
1.5000	1.5 : 1	.60	
1.2222	1.2 : 1	.55	Point of Intermittency
1.0000	1: 1	.50	
0.8182	1.2 : 1	.45	
0.6667	1.5 : 1	.40	
0.5385	1.9 : 1	.35	Number Times Likely to be Outside in the "mean".
0.4286	2.3 : 1	.30	
0.3333	3.0 : 1	.25	
0.2500	4.0 : 1	.20	
0.1765	5.7 : 1	.15	
0.1111	9.0 : 1	.10	
0.0526	19 : 1	.05	

In Figure 2 the arbitrary sectioning of the Psi Function is conducted.

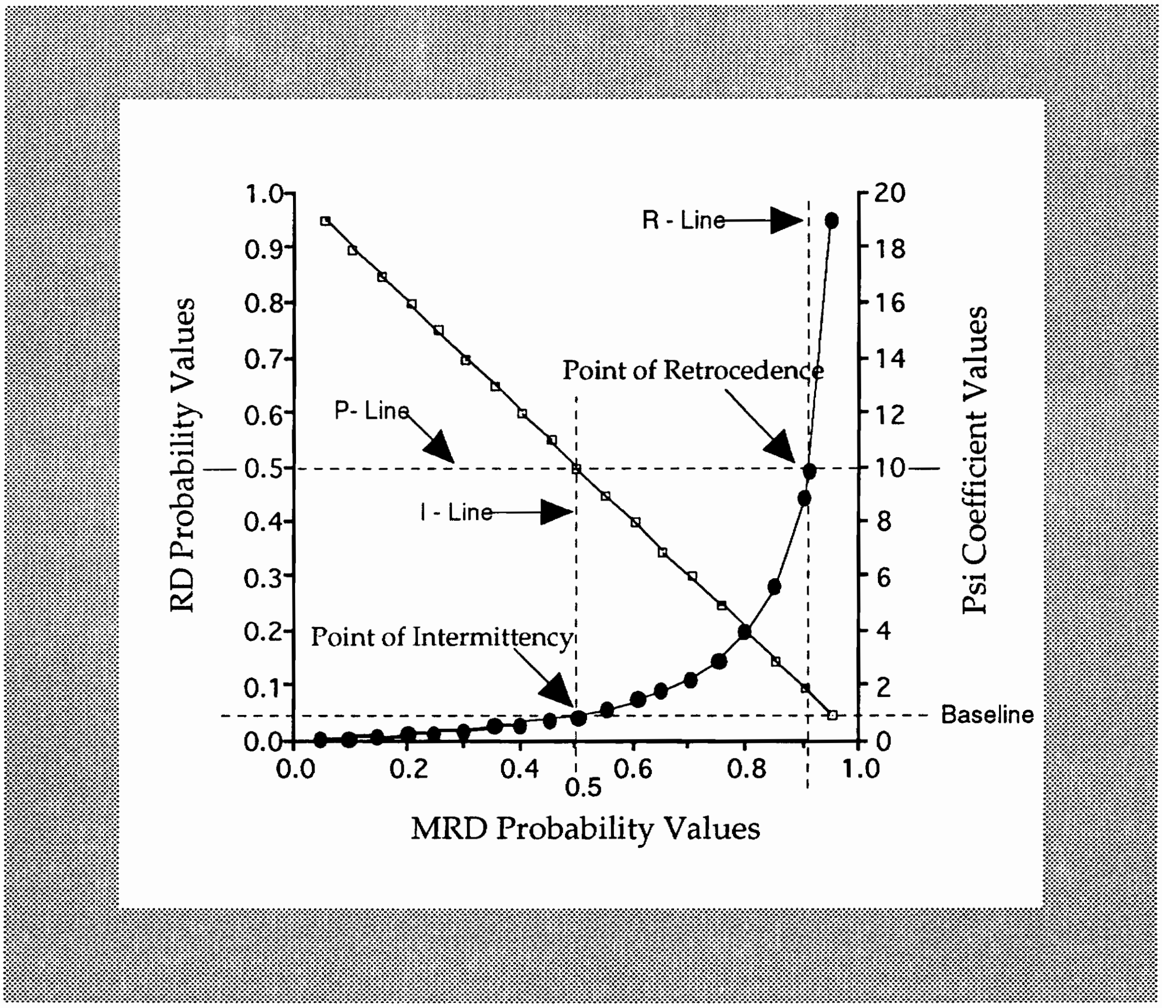

Figure 2:

The Psi Function is further defined by drawing four lines: (a) the P - Line, (b) the I - Line, (c) the R - Line, and (d) the Baseline. The P and I Lines are positioned at both x and y probability values of .50. They intersect where the Psi coefficient probability ratio is equal to .50/.50. In other words, there is a 50/50 chance that any given event in a 1.0 Psi coefficient distribution will lie on the mean or in its tails. This Psi coefficient (i.e., ψ *coef.* = 1.0) is called the "**Point of Intermittency**" and defines the horizontal Baseline. Where the P - Line intersects the Psi Coefficient curve (i.e., ψ *coef.* = 10.0), defines the "**Point of Retrocedence**", and the R - Line.

In Figure 3 zone membership across Psi coefficients is illustrated.

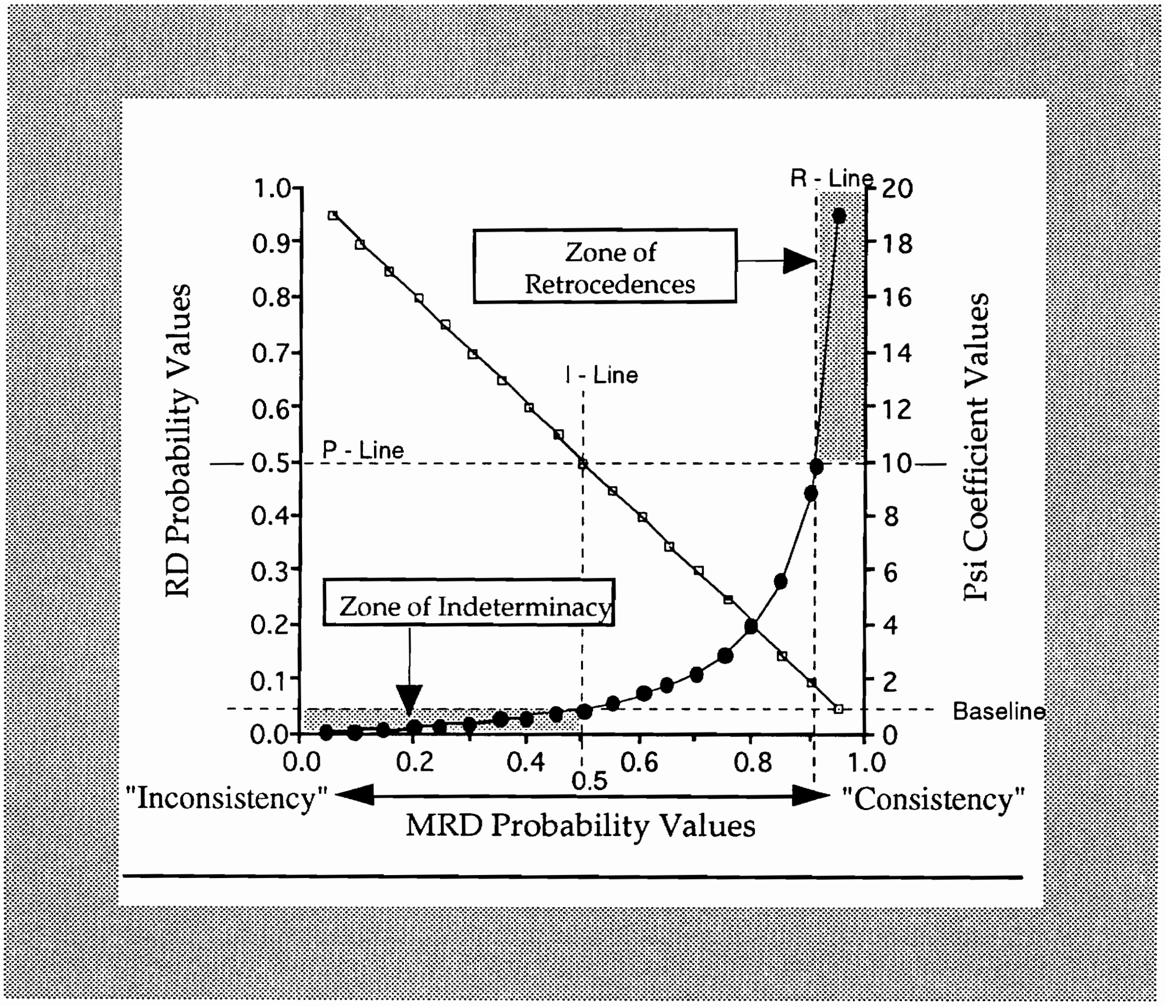

Figure 3:

By sectioning the Psi Function, "Zones" are circumscribed that define the general consistency-inconsistency of time series. In general, these zones define the extreme ends of the Psi coefficient curve, and the certainty and uncertainty that any given event will end up as the mean value. The "**Zone of Indeterminacy**" circumscribes a Class of Psi coefficients (i.e., ≤ 1.0), indicating the low probability that any given event will represent the mean of the distribution. The "**Zone of Retrocedence**" circumscribes a Class of Psi coefficients (i.e., ≥ 10.0) indicating a high probability that any given event will represent the mean of the distribution.

Expecteds

Given that the Formal Operation parameters define probability distributions over a range of y-ordinate events across time, other distribution statistics can be determined. Using the "general argument":

$$E[g(y)] = \sum_{y} g(y)p(y)$$

and substituting for some function (g) and the appropriate (p) probability both the expected variances and kurtosis values can be calculated for any particular time series with y-ordinate levels and MRD and RD values. This argument is given by Mendenhall, 1975, p. 107.

Note on Mathematical Aesthetics. Most statistics use summation symbol Sigma (Σ) as a function for manipulating the addition of numbers and relationships. Although widely used and understood by statisticians and psychologists, mathematicians prefer the elegance and ease of polynomials. Given the nature of the Formal Operation and its basic foundation of assigning probabilities and determining y-ordinate levels, it seems reasonable to ascertain formulas that would necessitate the fewest steps. Therefore, buying into this mathematical imperative, I have converted traditional summation statistics into y-based polynomials. Thus, an individual need only know the y number of levels and the appropriate probability term(s) to ascertain a specified statistic or expected.

I have not included the math behind the conversions that translated summated equations into polynomial equations. If curious I will produce them.

Expected Variance Using general argument above, and substituting the summation of the deviation square term times the probability assigned to each deviation, the expected variance can be computed. Therefore:

Summation Formula.

$$\sigma^2 = E\left[(y - \upsilon)^2\right] = \sum_y (y - \upsilon)^2 p(y)$$

$$\mathrm{E}(\boldsymbol{Variance}) = \sigma^2 = \sum_{i=1}^{i=y} \left(y_i - \bar{y}_j\right)^2 \cdot p(RD_i)$$

Polynomial Formula.

$$\mathrm{E}(\boldsymbol{Variance}) = \sigma^2 = \frac{y\left(y^2 - 1\right)}{12} \cdot p(RD_i)$$

Variances. Figure 4 gives the expected variances for time series with specified MRDs and y-ordinate levels. This figure shows 10 variance curves for time series with y-ordinate levels between 3 and 21 as influenced by nine MRDs ranging between .2 - .9.

Again parameter y is defined as any odd natural number greater than or equal to three (i.e., $y \geq 3$).

Standard Deviations. Figure 5 gives the square root of the variances shown in Figure 4. These expected standard deviations are then used to calculate the Coefficient of Variations.

Coefficient of Variation. This statistic is not often used or widely known about and sometimes referred to as the "relative standard deviation" (see Howell, 1992; Wallis & Roberts, 1956). The Coefficient of Variation (CV) expresses a relationship between a standard deviation and its mean. Its utility is based on the problem of comparing standard deviations from distributions that differ in mean values.

$$CV = \frac{S_x}{\overline{X}}$$

Therefore, to compare time series with different means and y-ordinate levels the Coefficient of Variation provides a way of controlling for different mean values. The Coefficient of Variation thus scales the standard deviation by the magnitude of the mean (Wallis & Roberts, 1956, p. 256).

Figure 6 shows the expected Coefficient of Variations as a function of MRD and y-ordinate levels.

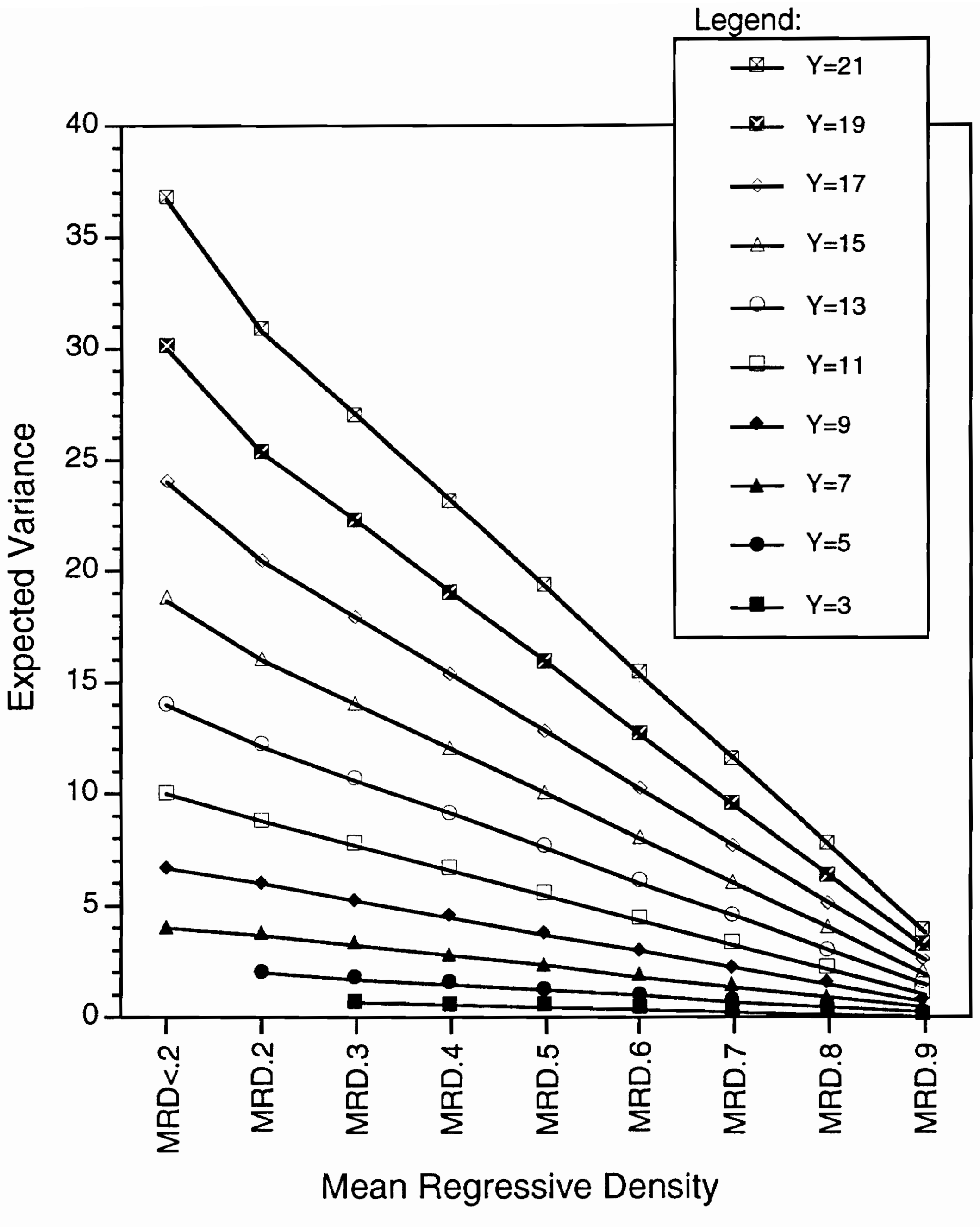

FIGURE 4: The Expected Variances are presented as a function of MRD and the y-ordinate levels given the formulas expressed above.

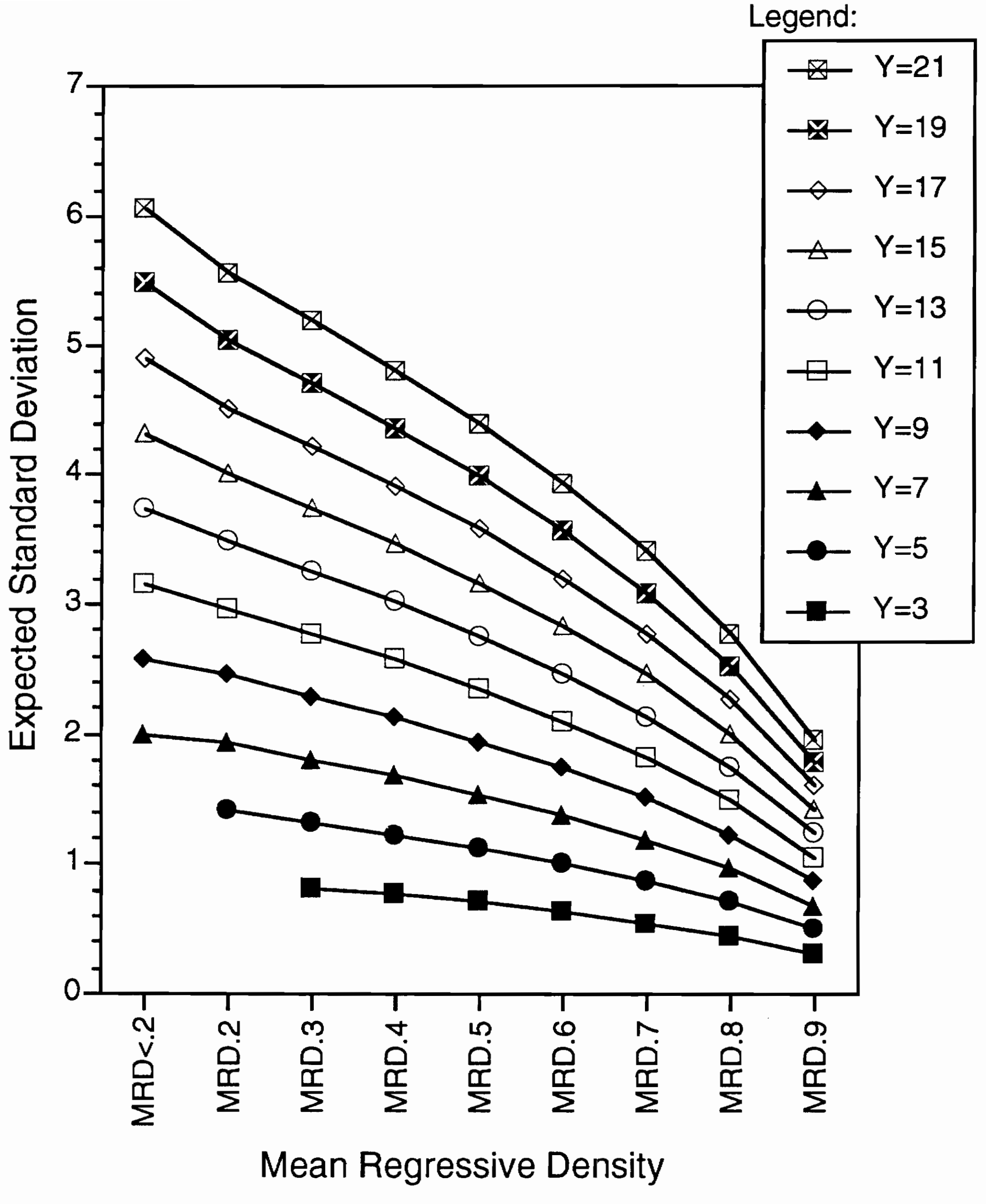

FIGURE 5: The Expected Standard Deviations are presented as a function of MRD and y-ordinate levels given the square-root of the formulas expressed above.

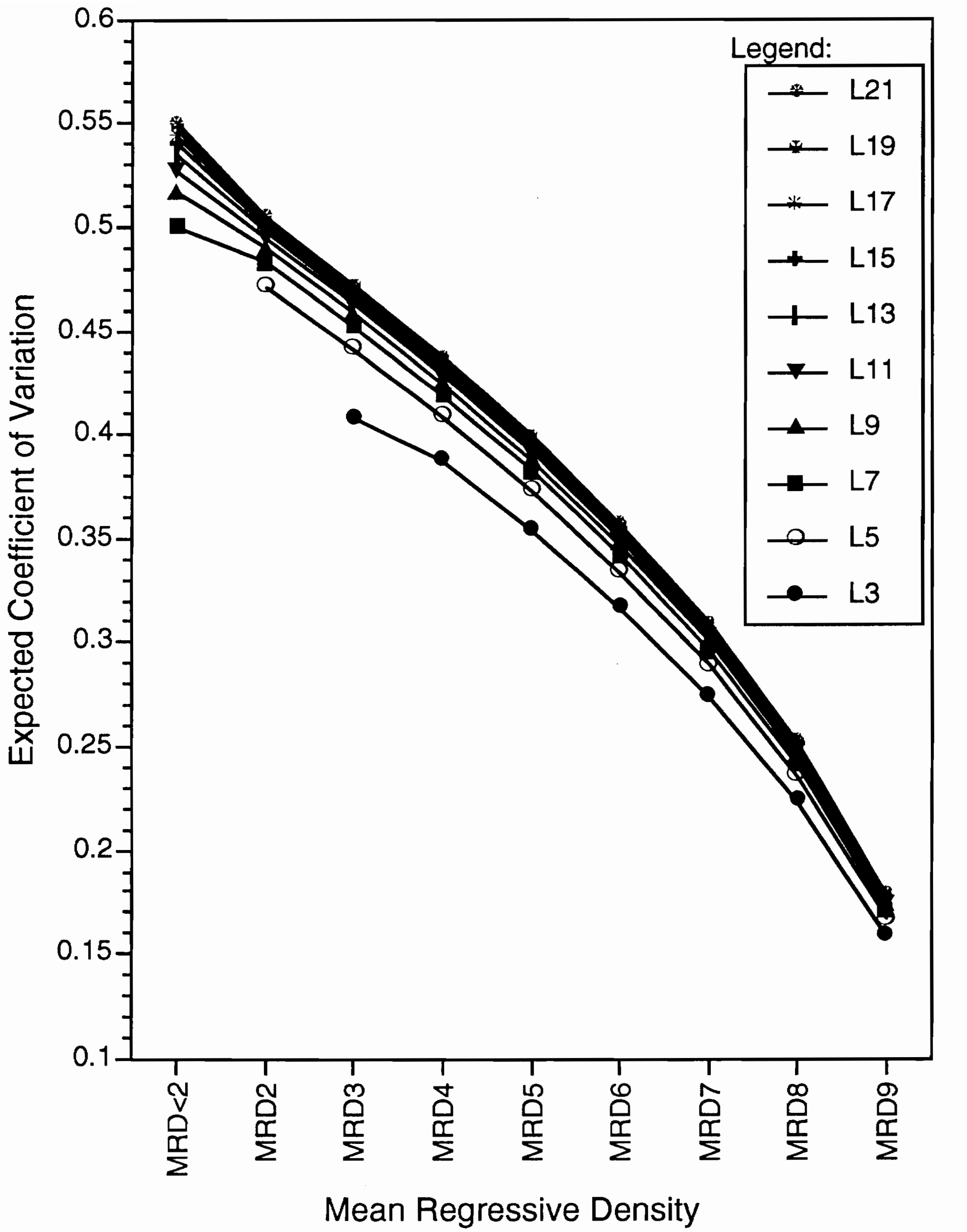

FIGURE 6: The Coefficient of Variations are presented as a function of MRD and y-ordinate levels given the Coefficient of Variation formula stated above.

Amplitudes (sampled data) Because their was some discussion regarding amplitude differences between the time series distributions among my independent variables, I have sampled 10 distributions with n = 400 and counted amplitude sizes. Each time series distribution was defined by a different MRD (i.e., .2 - .9) and the y-ordinate level was equal to 5. I discuss amplitude in the present context because of its close relationship to variance. As shown in Table 2, as MRD decreases a shift in the distribution of amplitudes occurs, that is: the number of high amplitude events increase while low amplitude events tend to decrease. Similarly, as MRD values decrease so does the expected variance of a distribution increase. This inverse relationship between amplitude (variance) and MRD values is illustrated best when considering the far left column (Amp. 4). As shown, when the MRD value is .9 the number of four amplitude events observed was zero, while a MRD of .2 indicates that 41 four amplitude events were observed.

TABLE 2: The number of and degree of amplitude is recorded as a function of MRD. Each MRD represents a sampled distribution of n = 400 with y = 5.

MRD	Amp. 4	Amp. 3	Amp. 2	Amp. 1	Amp. 0	Average AMP.
0.9	0	1	51	47	300	0.38
0.8	2	3	63	59	272	0.51
0.7	6	11	92	99	191	0.78
0.6	5	21	112	139	122	1.12
0.5	5	29	124	150	91	1.27
0.4	32	43	125	145	54	1.63
0.3	35	54	113	171	26	1.75
0.2	41	89	106	154	9	2.00

Expected Kurtosis

Psi coefficients basically describe at a rudimentary level the form of a probability distribution given the rules of the Formal Operation. One way of viewing MRD probability values is to consider them as portraying the peakedness of a probability distribution, while the y-parameter defines the stretch of the tails. One conventional way of indexing the form of a distribution is to calculate its kurtosis. The formula often used to compute kurtosis was first formulated by Pearson (see Kirk, 1984).

$$Kurtosis = \frac{\dfrac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^4}{n}}{\left[\dfrac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}{n}\right]^2} - 3$$

By using the "general argument" given above we can through substitution construct a formula that will give the expected kurtosis of any time series distribution given the parameters of the Formal Operation section. Below the formulas are in terms of the y parameter and p(RD) or p(RD_i).

Summation Formula.

$$E(Kurtosis) = \frac{\dfrac{\sum_{i=1}^{i=y}\left(y_i - \overline{y}\right)^4 \cdot p(RD_i)}{y-1}}{\left[\dfrac{\sum_{i=1}^{i=y}\left(y_i - \overline{y}\right)^2 \cdot p(RD_i)}{y-1}\right]^2} - 3$$

Polynomial Formula.

$$E(Kurtosis) = \frac{\frac{1}{72}\left[y^2\left(y^2 - 1\right) \cdot p(RD)\right]}{\left[\frac{1}{12}y(y+1) \cdot p(RD)\right]^2} - 3$$

Figure 7 shows the expected kurtosis values as a function of y ordinate level and p(MRD) values.

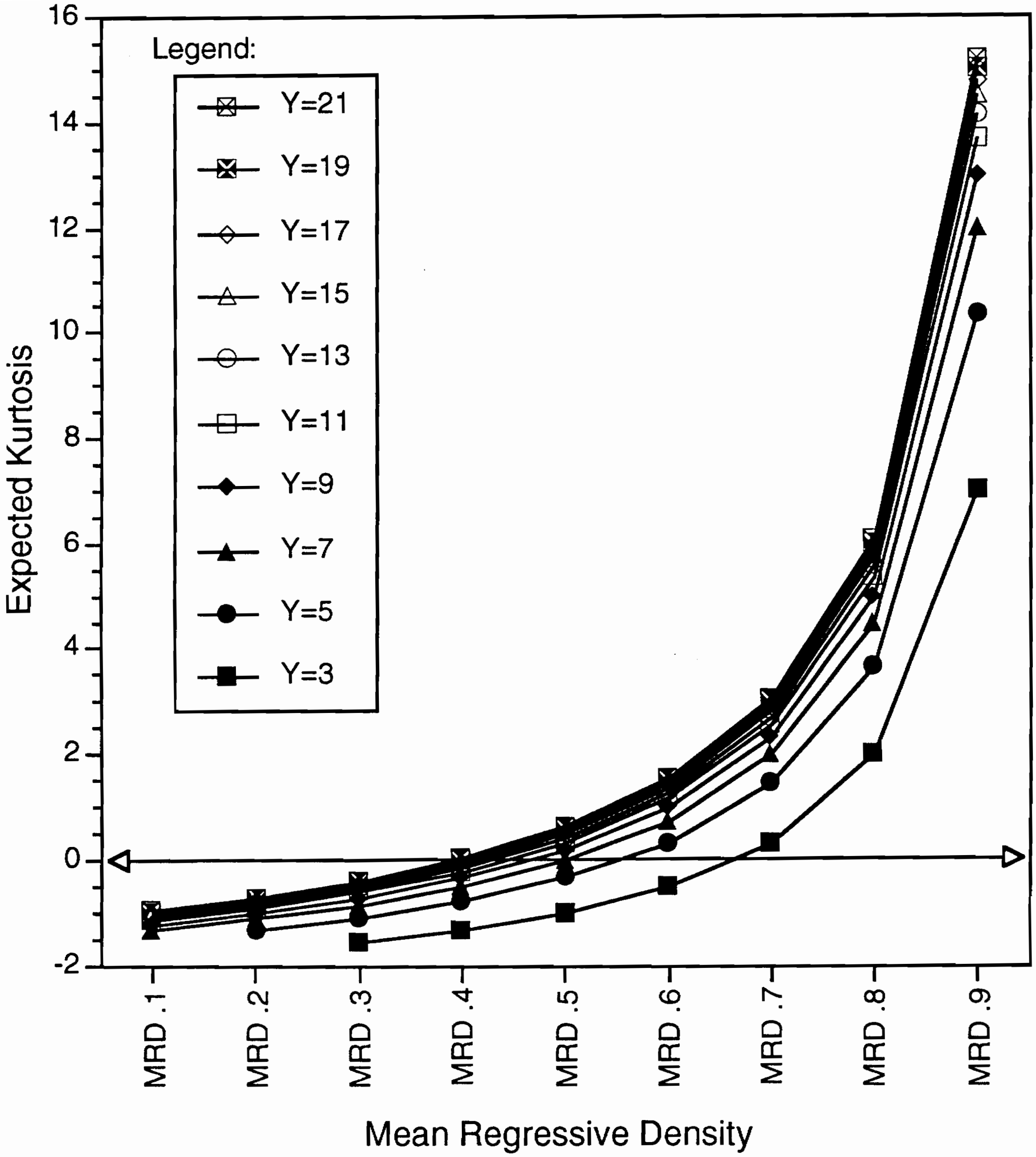

FIGURE 7: The Expected Kurtosis' are presented as a function of MRD and y-ordinate levels given the Kurtosis' formula expressed above. Note that values above zero represent distributions which are leptokurtic (pecked), near zero values indicate mesokurtic distributions (normal), and below zero values are platykurtic (flat) distributions.

In summary, the above molar analysis attempted to integrate the parameters of the Formal Operation. The integration served to assist in the description of time series that are constructed using the Formal Operation. In general, the descriptors represent what I call the superordinate characteristics that sample generated time series approximate as t-sizes increase to infinity. Foremost, the Psi coefficient was discussed as a way of differentiating the relative and expected consistency-variation dynamics of a sample recorded time series (using the ratio of the parameters MRD and RD). However, other statistics were also calculated that helped to identify the "expected" variation and distribution form given the parameters defined in the Formal Operation.

Micro Analysis of the Subordinate System Features

As the macro analysis attempted to examine the overall time-invariant characteristics of the Formal Operation, the micro analysis attempts to inspect the time-dependent features that are a consequence of generating individual time series. Specifically, these time-dependent features are portrayed as local and micro patterns, that are a function of the stochastic process and the Formal Operation. Thus, the purpose of this section is to demonstrate that these local patterns are themselves related and influenced by the Formal Operation and are not merely transient or fortuitous occurrences.

As a consequence of my dissertation proposal defense two local patterns were identified. These patterns are labeled as (a) "double ups and downs" and (b) "auto-regressives and egressives". In the former this pattern describes a double sequence trend where three events show either a repeated increase or decrease. The latter is represented as a pattern of three events which turn or change in direction, either toward or away from the mean value.

There are several methods by which these analyses could proceed (e.g., a mathematical proof). I have chosen to find the expected probability of these two time dependent patterns. I have used a "geometric approach" to finding the expecteds. Finding the expected probability of event sequences demands that one has two values, the expected frequency of the pattern targeted and the overall number of all possible patterns or the probabilities associated with the events making up the specific pattern. Briefly, in my analysis of the event patterns I noticed, to my surprise, that the patterns found within the "Path Coordinate Matrixes" (to be discussed below) followed Pascal triangle series and geometry.

The analyses below are based on:

(1) all possible 3 event sequences for any given number of y-ordinate levels.

(2) *p*(MRD) and *p*(RD) values.

(3) the Formal Operation restrictions and special requirements concerning y (see page 7), that is, only the y mean value is allowed to repeat in succession.

The following steps were used in computing the expected probabilities for the local patterns of "double ups and downs" (DD) and "auto-regressives and egressives" (ARE).

(1) Constructing "Path Maps" and "Path Coordinate Matrixes". A path map identifies and numbers all possible two event sequences (T_0 - T_1). Figure 8 shows four path maps for y = 3, 5, 7, and 9. These numbered paths are then used to generate a path coordinate matrix, where the path matrix portrays all possible sequences of events that make up the path patterns of interest (as t increases). Figure 9 shows the path matrixes for all possible three event sequences or two path patterns given the path maps in Figure 8.

(2) From these path maps and matrixes specific patterns then can be identified and counted.

(3) Finding the expected frequency of certain patterns allows for the calculation of expected probabilities. However, before the probabilities can be computed one needs to determine the underlying model of the probability distribution. Model recognition is basically important for identifying assumptions or features about the phenomenon being studied.

Zero-Order Model

The simplest model is the zero-order or "equiprobable" model, where all paths or events are treated with equal likelihood. Such a case would mean that each y-ordinate level including the MRD level would be assigned an equivalent discrete probability.

$$zero-order = p(y_i) = \frac{p(RD)+p(MRD)}{y} = \frac{1.00}{y}$$

In terms of expected frequency counts, a particular pattern of paths (e.g., A) would be calculated and divided by the total number of possible paths.

$$p(A) = \frac{f(A)}{f(A+N)}$$

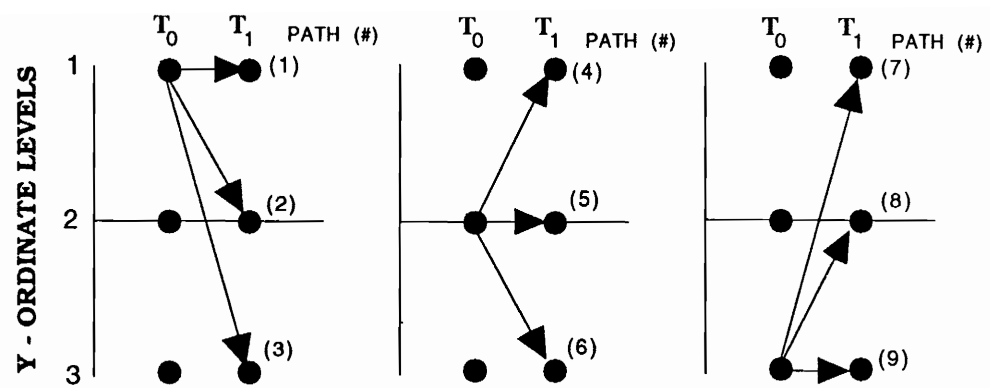

FIGURE 8 (A): Path map for all possible time series paths for Y - Ordinate Levels = 3.

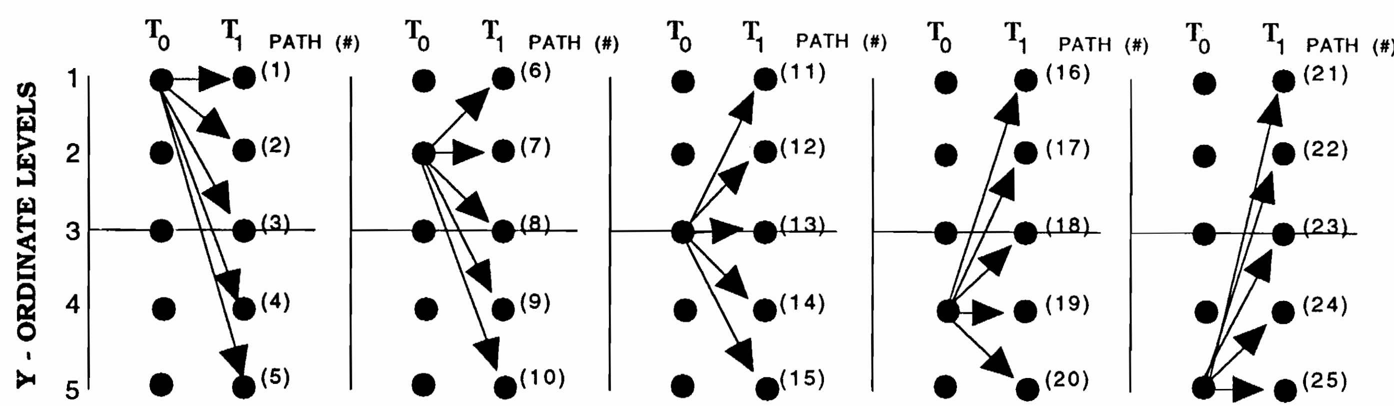

FIGURE 8 (B): Path map for all possible time series paths for Y - Ordinate Levels = 5.

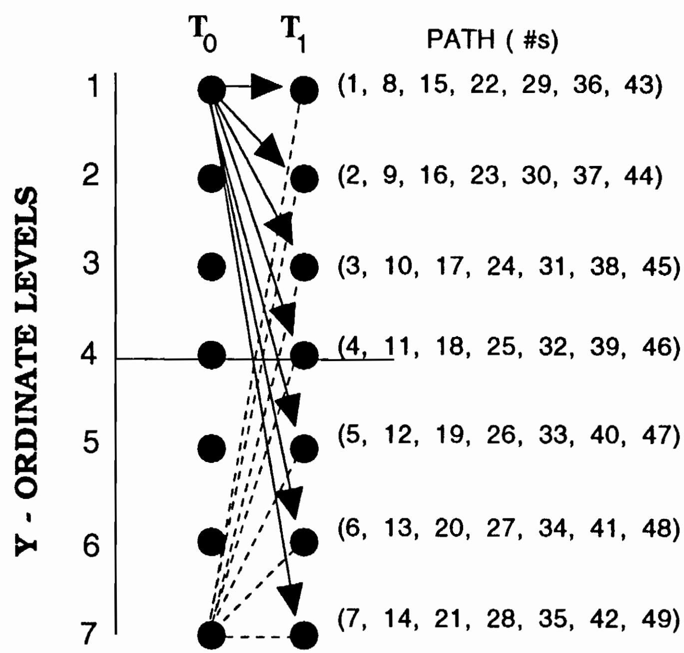

FIGURE 8 (C): Path map for all possible time series paths for Y - Ordinate Levels = 7.

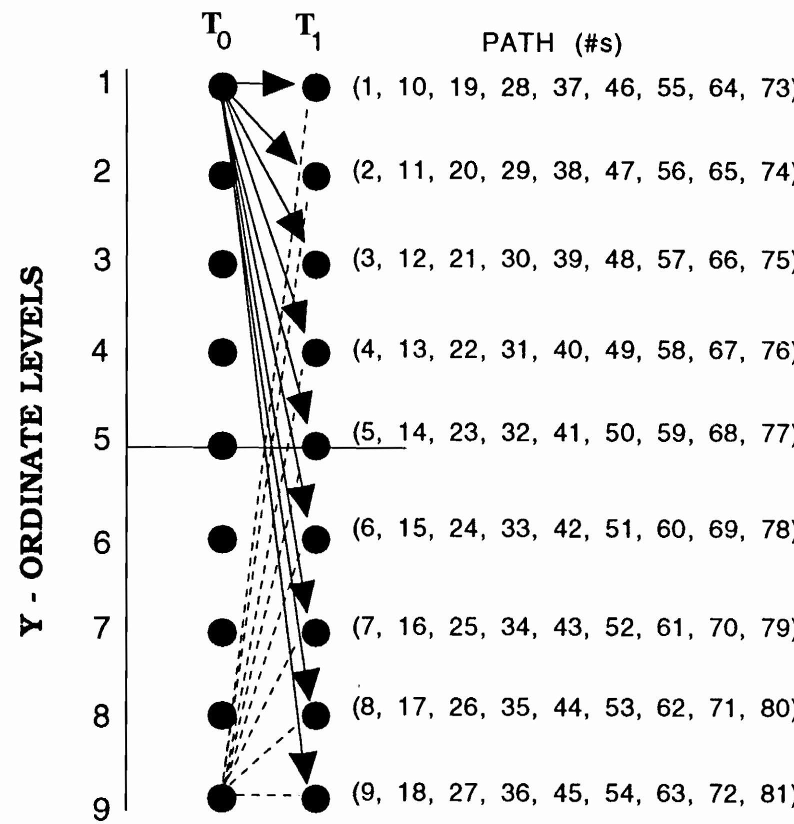

FIGURE 8 (D): Path map for all possible time series paths for Y - Ordinate Levels = 9.

(A)

1	1	4	1	7	1
1	2	4	2	7	2
1	3	4	3	7	3
2	4	5	4	8	4
2	5	5	5	8	5
2	6	5	6	8	6
3	7	6	7	9	7
3	8	6	8	9	8
3	9	6	9	9	9

FIGURE 9 (A): A path coordinate matrix for y = 3. Each entry within the three columns represents a path pattern of a sequence of three events or two paths. The numbers themselves are given in the path maps in Figure 8 (A)

(B)

1	1	6	1	11	1	16	1	21	1
1	2	6	2	11	2	16	2	21	2
1	3	6	3	11	3	16	3	21	3
1	4	6	4	11	4	16	4	21	4
1	5	6	5	11	5	16	5	21	5
2	6	7	6	12	6	17	6	22	6
2	7	7	7	12	7	17	7	22	7
2	8	7	8	12	8	17	8	22	8
2	9	7	9	12	9	17	9	22	9
2	10	7	10	12	10	17	10	22	10
3	11	8	11	13	11	18	11	23	11
3	12	8	12	13	12	18	12	23	12
3	13	8	13	13	13	18	13	23	13
3	14	8	14	13	14	18	14	23	14
3	15	8	15	13	15	18	15	23	15
4	16	9	16	14	16	19	16	24	16
4	17	9	17	14	17	19	17	24	17
4	18	9	18	14	18	19	18	24	18
4	19	9	19	14	19	19	19	24	19
4	20	9	20	14	20	19	20	24	20
5	21	10	21	15	21	20	21	25	21
5	22	10	22	15	22	20	22	25	22
5	23	10	23	15	23	20	23	25	23
5	24	10	24	15	24	20	24	25	24
5	25	10	25	15	25	20	25	25	25

FIGURE 9 (B): A path coordinate matrix for y = 5. Each entry within the five columns represents a path pattern of a sequence of three events or two paths. The numbers themselves are given in the path maps in Figure 8 (B)

(C)

1	1	8	1	15	1	22	1	29	1	36	1	43	1
1	2	8	2	15	2	22	2	29	2	36	2	43	2
1	3	8	3	15	3	22	3	29	3	36	3	43	3
1	4	8	4	15	4	22	4	29	4	36	4	43	4
1	5	8	5	15	5	22	5	29	5	36	5	43	5
1	6	8	6	15	6	22	6	29	6	36	6	43	6
1	7	8	7	15	7	22	7	29	7	36	7	43	7
2	8	9	8	16	8	23	8	30	8	37	8	44	8
2	9	9	9	16	9	23	9	30	9	37	9	44	9
2	10	9	10	16	10	23	10	30	10	37	10	44	10
2	11	9	11	16	11	23	11	30	11	37	11	44	11
2	12	9	12	16	12	23	12	30	12	37	12	44	12
2	13	9	13	16	13	23	13	30	13	37	13	44	13
2	14	9	14	16	14	23	14	30	14	37	14	44	14
3	15	10	15	17	15	24	15	31	15	38	15	45	15
3	16	10	16	17	16	24	16	31	16	38	16	45	16
3	17	10	17	17	17	24	17	31	17	38	17	45	17
3	18	10	18	17	18	24	18	31	18	38	18	45	18
3	19	10	19	17	19	24	19	31	19	38	19	45	19
3	20	10	20	17	20	24	20	31	20	38	20	45	20
3	21	10	21	17	21	24	21	31	21	38	21	45	21
4	22	11	22	18	22	25	22	32	22	39	22	46	22
4	23	11	23	18	23	25	23	32	23	39	23	46	23
4	24	11	24	18	24	25	24	32	24	39	24	46	24
4	25	11	25	18	25	25	25	32	25	39	25	46	25
4	26	11	26	18	26	25	26	32	26	39	26	46	26
4	27	11	27	18	27	25	27	32	27	39	27	46	27
4	28	11	28	18	28	25	28	32	28	39	28	46	28
5	29	12	29	19	29	26	29	33	29	40	29	47	29
5	30	12	30	19	30	26	30	33	30	40	30	47	30
5	31	12	31	19	31	26	31	33	31	40	31	47	31
5	32	12	32	19	32	26	32	33	32	40	32	47	32
5	33	12	33	19	33	26	33	33	33	40	33	47	33
5	34	12	34	19	34	26	34	33	34	40	34	47	34
5	35	12	35	19	35	26	35	33	35	40	35	47	35
6	36	13	36	20	36	27	36	34	36	41	36	48	36
6	37	13	37	20	37	27	37	34	37	41	37	48	37
6	38	13	38	20	38	27	38	34	38	41	38	48	38
6	39	13	39	20	39	27	39	34	39	41	39	48	39
6	40	13	40	20	40	27	40	34	40	41	40	48	40
6	41	13	41	20	41	27	41	34	41	41	41	48	41
6	42	13	42	20	42	27	42	34	42	41	42	48	42
7	43	14	43	21	43	28	43	35	43	42	43	49	43
7	44	14	44	21	44	28	44	35	44	42	44	49	44
7	45	14	45	21	45	28	45	35	45	42	45	49	45
7	46	14	46	21	46	28	46	35	46	42	46	49	46
7	47	14	47	21	47	28	47	35	47	42	47	49	47
7	48	14	48	21	48	28	48	35	48	42	48	49	48
7	49	14	49	21	49	28	49	35	49	42	49	49	49

FIGURE 9 (C): A path coordinate matrix for y = 7. Each entry within the seven columns represents a path pattern of a sequence of three events or two paths. The numbers themselves are given in the path maps in Figure 8 (C).

(D)

1	1	10	1	19	1	28	1	37	1	46	1	55	1	64	1	73	1
1	2	10	2	19	2	28	2	37	2	46	2	55	2	64	2	73	2
1	3	10	3	19	3	28	3	37	3	46	3	55	3	64	3	73	3
1	4	10	4	19	4	28	4	37	4	46	4	55	4	64	4	73	4
1	5	10	5	19	5	28	5	37	5	46	5	55	5	64	5	73	5
1	6	10	6	19	6	28	6	37	6	46	6	55	6	64	6	73	6
1	7	10	7	19	7	28	7	37	7	46	7	55	7	64	7	73	7
1	8	10	8	19	8	28	8	37	8	46	8	55	8	64	8	73	8
1	9	10	9	19	9	28	9	37	9	46	9	55	9	64	9	73	9
2	10	11	10	20	10	29	10	38	10	47	10	56	10	65	10	74	10
2	11	11	11	20	11	29	11	38	11	47	11	56	11	65	11	74	11
2	12	11	12	20	12	29	12	38	12	47	12	56	12	65	12	74	12
2	13	11	13	20	13	29	13	38	13	47	13	56	13	65	13	74	13
2	14	11	14	20	14	29	14	38	14	47	14	56	14	65	14	74	14
2	15	11	15	20	15	29	15	38	15	47	15	56	15	65	15	74	15
2	16	11	16	20	16	29	16	38	16	47	16	56	16	65	16	74	16
2	17	11	17	20	17	29	17	38	17	47	17	56	17	65	17	74	17
2	18	11	18	20	18	29	18	38	18	47	18	56	18	65	18	74	18
3	19	12	19	21	19	30	19	39	19	48	19	57	19	66	19	75	19
3	20	12	20	21	20	30	20	39	20	48	20	57	20	66	20	75	20
3	21	12	21	21	21	30	21	39	21	48	21	57	21	66	21	75	21
3	22	12	22	21	22	30	22	39	22	48	22	57	22	66	22	75	22
3	23	12	23	21	23	30	23	39	23	48	23	57	23	66	23	75	23
3	24	12	24	21	24	30	24	39	24	48	24	57	24	66	24	75	24
3	25	12	25	21	25	30	25	39	25	48	25	57	25	66	25	75	25
3	26	12	26	21	26	30	26	39	26	48	26	57	26	66	26	75	26
3	27	12	27	21	27	30	27	39	27	48	27	57	27	66	27	75	27
4	28	13	28	22	28	31	28	40	28	49	28	58	28	67	28	76	28
4	29	13	29	22	29	31	29	40	29	49	29	58	29	67	29	76	29
4	30	13	30	22	30	31	30	40	30	49	30	58	30	67	30	76	30
4	31	13	31	22	31	31	31	40	31	49	31	58	31	67	31	76	31
4	32	13	32	22	32	31	32	40	32	49	32	58	32	67	32	76	32
4	33	13	33	22	33	31	33	40	33	49	33	58	33	67	33	76	33
4	34	13	34	22	34	31	34	40	34	49	34	58	34	67	34	76	34
4	35	13	35	22	35	31	35	40	35	49	35	58	35	67	35	76	35
4	36	13	36	22	36	31	36	40	36	49	36	58	36	67	36	76	36
5	37	14	37	23	37	32	37	41	37	50	37	59	37	68	37	77	37
5	38	14	38	23	38	32	38	41	38	50	38	59	38	68	38	77	38
5	39	14	39	23	39	32	39	41	39	50	39	59	39	68	39	77	39
5	40	14	40	23	40	32	40	41	40	50	40	59	40	68	40	77	40
5	41	14	41	23	41	32	41	41	41	50	41	59	41	68	41	77	41
5	42	14	42	23	42	32	42	41	42	50	42	59	42	68	42	77	42
5	43	14	43	23	43	32	43	41	43	50	43	59	43	68	43	77	43
5	44	14	44	23	44	32	44	41	44	50	44	59	44	68	44	77	44
5	45	14	45	23	45	32	45	41	45	50	45	59	45	68	45	77	45
6	46	15	46	24	46	33	46	42	46	51	46	60	46	69	46	78	46
6	47	15	47	24	47	33	47	42	47	51	47	60	47	69	47	78	47
6	48	15	48	24	48	33	48	42	48	51	48	60	48	69	48	78	48
6	49	15	49	24	49	33	49	42	49	51	49	60	49	69	49	78	49
6	50	15	50	24	50	33	50	42	50	51	50	60	50	69	50	78	50
6	51	15	51	24	51	33	51	42	51	51	51	60	51	69	51	78	51
6	52	15	52	24	52	33	52	42	52	51	52	60	52	69	52	78	52
6	53	15	53	24	53	33	53	42	53	51	53	60	53	69	53	78	53
6	54	15	54	24	54	33	54	42	54	51	54	60	54	69	54	78	54
7	55	16	55	25	55	34	55	43	55	52	55	61	55	70	55	79	55
7	56	16	56	25	56	34	56	43	56	52	56	61	56	70	56	79	56
7	57	16	57	25	57	34	57	43	57	52	57	61	57	70	57	79	57
7	58	16	58	25	58	34	58	43	58	52	58	61	58	70	58	79	58
7	59	16	59	25	59	34	59	43	59	52	59	61	59	70	59	79	59
7	60	16	60	25	60	34	60	43	60	52	60	61	60	70	60	79	60
7	61	16	61	25	61	34	61	43	61	52	61	61	61	70	61	79	61
7	62	16	62	25	62	34	62	43	62	52	62	61	62	70	62	79	62
7	63	16	63	25	63	34	63	43	63	52	63	61	63	70	63	79	63
8	64	17	64	26	64	35	64	44	64	53	64	62	64	71	64	80	64
8	65	17	65	26	65	35	65	44	65	53	65	62	65	71	65	80	65
8	66	17	66	26	66	35	66	44	66	53	66	62	66	71	66	80	66
8	67	17	67	26	67	35	67	44	67	53	67	62	67	71	67	80	67
8	68	17	68	26	68	35	68	44	68	53	68	62	68	71	68	80	68
8	69	17	69	26	69	35	69	44	69	53	69	62	69	71	69	80	69
8	70	17	70	26	70	35	70	44	70	53	70	62	70	71	70	80	70
8	71	17	71	26	71	35	71	44	71	53	71	62	71	71	71	80	71
8	72	17	72	26	72	35	72	44	72	53	72	62	72	71	72	80	72
9	73	18	73	27	73	36	73	45	73	54	73	63	73	72	73	81	73
9	74	18	74	27	74	36	74	45	74	54	74	63	74	72	74	81	74
9	75	18	75	27	75	36	75	45	75	54	75	63	75	72	75	81	75
9	76	18	76	27	76	36	76	45	76	54	76	63	76	72	76	81	76
9	77	18	77	27	77	36	77	45	77	54	77	63	77	72	77	81	77
9	78	18	78	27	78	36	78	45	78	54	78	63	78	72	78	81	78
9	79	18	79	27	79	36	79	45	79	54	79	63	79	72	79	81	79
9	80	18	80	27	80	36	80	45	80	54	80	63	80	72	80	81	80
9	81	18	81	27	81	36	81	45	81	54	81	63	81	72	81	81	81

FIGURE 9 (D): A path coordinate matrix for y = 9. Each entry within the five columns represents a path pattern of a sequence of three events or two paths. The numbers themselves are given in the path maps in Figure 8 (D)

Given the Formal Operation the formulas that calculate the zero-order expected probabilities for DD and ARE are:

Summation Formulas	Polynomial Formulas
$\mathrm{E}(p(DD)) = \frac{1}{y^3}\sum_{i=0}^{y-2} y_i(y_i+1)$	$\mathrm{E}(p(DD)) = \frac{(y-1)(y-2)}{3y^2}$
$\mathrm{E}(p(ARE)) = 2\frac{1}{y^3}\sum_{i=0}^{y-1} y_i^2$	$\mathrm{E}(p(ARE)) = \frac{(2y-1)(y-1)}{3y^2}$

Notice in the denominators the terms y^3 and $3y^2$, they represent the total number of possible 3 event paths. Notice that if you multiply the height and width of a path coordinate matrix you will compute the y^3.

First-Order Model

Unfortunately, the zero-order model doesn't approximate the parametric possibilities described in the Formal Operation. In the Formal Operation the *p*(MRD) and *p*(RD) are not always equivalent. To account for the increased density of the MRD a first-order model must be assumed. A first-order model assumes that events occur as often as they are observed, but the events themselves occur randomly. Thus, to calculate the expected probabilities of the DD and ARE patterns the terms of the formulas (given above) need to be modified. Therefore, the formulas must incorporate probability terms to account for the non-equivalency between MRD and RD events. This is possible since the Formal Operation gives the expected probabilities for each individual event of a time series by definition (i.e., the MRD and RD probability values). In general, the form of the computation is as such:

$$E[p(A)] = f(A)\cdot p(e_1)p(e_2)p(e_3)\cdot\ldots\cdot p(e_{n+1})$$

The expected probability is, therefore, a function of the expected frequency of the path pattern multiplied by the individual event probabilities (e.g., $p(e_1)$) associated with the path pattern.

Given the above, the formulas that describe the expected probabilities of DDs and AREs as a function of their expected frequency, y-ordinate levels, p(MRD) and p(RD) are presented below:

DD Summation and Polynomial Formulas

$$\mathrm{E}(p(DD)) = p\left(RD_i^3\right)\cdot\sum_{i=0}^{y-3} y_i(y_i+1) + p\left(RD_i^2\right)\cdot p\left(MRD_j\right)\cdot 2\sum_{i=0}^{y-2} y_i$$

$$\mathrm{E}[p(DD)] = p\left(RD_i^3\right)\cdot\left(\tfrac{1}{3}(y-1)(y-2)(y-3)\right) + p\left(RD_i^2\right)\cdot p\left(MRD_j\right)\cdot(y-1)(y-2)$$

ARE Summation and Polynomial Formulas

$$\begin{aligned}\mathrm{E}(p(ARE)) = {} & 2\sum_{i=0}^{y-2} y_i^2\cdot p\left(RD_i^3\right)+\ldots \\ & \ldots+p\left(RD_i^2\right)\cdot p\left(MRD_j\right)\cdot(2y-3)(y-1)+\ldots \\ & \ldots+p\left(RD_i\right)\cdot p\left(MRD_j^2\right)\cdot(y-1)\end{aligned}$$

$$\begin{aligned}\mathrm{E}[p(ARE)] = {} & p\left(RD_i^3\right)\cdot\left(\tfrac{1}{3}(y-1)(y-2)(2y-3)\right)+\ldots \\ & \ldots+p\left(RD_i^2\right)\cdot p\left(MRD_j\right)\cdot(2y-3)(y-1)+\ldots \\ & \ldots+p\left(RD_i\right)\cdot p\left(MRD_j^2\right)\cdot(y-1)\end{aligned}$$

The summation and polynomial terms represent the expected frequency of the patterns associated with whether the path passed through the MRD event or not. For instance, for the DD formulas the $p(\mathrm{RD}^3)$ term signifies that the path pattern did not include events passing through the MRD event. The $p(\mathrm{RD}^3)$ is then multiplied by that frequency associated with that particular path pattern . It is RD cubed that describes the three events (in terms of their probabilities) making up the particular pattern being analyzed. The $p(\mathrm{RD}^2)$ and $p(\mathrm{MRD})$ terms represent those patterns that pass through MRD once.

Idealized First-Order Model

Although the first-order model approximated the Formal Operation, it still overlooks the restriction that only events associated with the MRD can repeat in succession. What this means is that the $p(\mathrm{RD}_i)$ must be adjusted to recognize this special requirement. I call this adjustment process the "idealization" of the Formal Process. The adjustment is as follows:

Given $p(RD) = 1.00 - p(MRD)$

$$p(RD_i) = \frac{1.00 - p(MRD_j)}{y-1} = \frac{p(RD)}{y-1}$$

Then

$$RD(Adjusted) = p(RD_A) = \frac{p(RD)}{y-2}$$

It is the y - 2 that subtracts those paths associated with a particular RD_i event that repeats in succession and violates the special requirement on page 7.

Given the adjustment of the RD_i, the following formulas represent the idealization of the expected probabilities regarding DD and ARE path patterns. Note that only the polynomial forms are given.

$$E[p(DD)] = p(RD_i)\cdot p(RD_A^2)\cdot\left(\tfrac{1}{3}(y-1)(y-2)(y-3)\right)+\ldots$$

$$\ldots+p(RD_i^2)\cdot p(MRD_j)\cdot\left(\tfrac{1}{2}(y-1)(y-1)\right)+\ldots$$

$$\ldots+p(RD_i)\cdot p(RD_A)\cdot p(MRD_j)\cdot\left(\tfrac{1}{2}(y-1)(y-3)\right)$$

$$E[p(ARE)] = p(RD_i)\cdot p(RD_A^2)\cdot\left(\tfrac{1}{3}(y-1)(y-2)(2y-3)\right)+\ldots$$

$$\ldots+p(RD_i^2)\cdot p(MRD_j)\cdot\left(\tfrac{1}{2}(y-1)(y-1)\right)+\ldots$$

$$\ldots+p(RD_i)\cdot p(RD_A)\cdot p(MRD_j)\cdot\left(\tfrac{1}{2}(y-1)(3y-5)\right)+\ldots$$

$$\ldots+p(RD_i)\cdot p(MRD_j^2)\cdot(y-1)$$

Figures 10 and 11 present the "idealized" expected probabilities of DD and ARE as a function of y-ordinate levels and MRD values. Note that the lowest MRD values of each y-ordinate level represent those time series where each level of y has an equal probability (i.e., a zero-order probability).

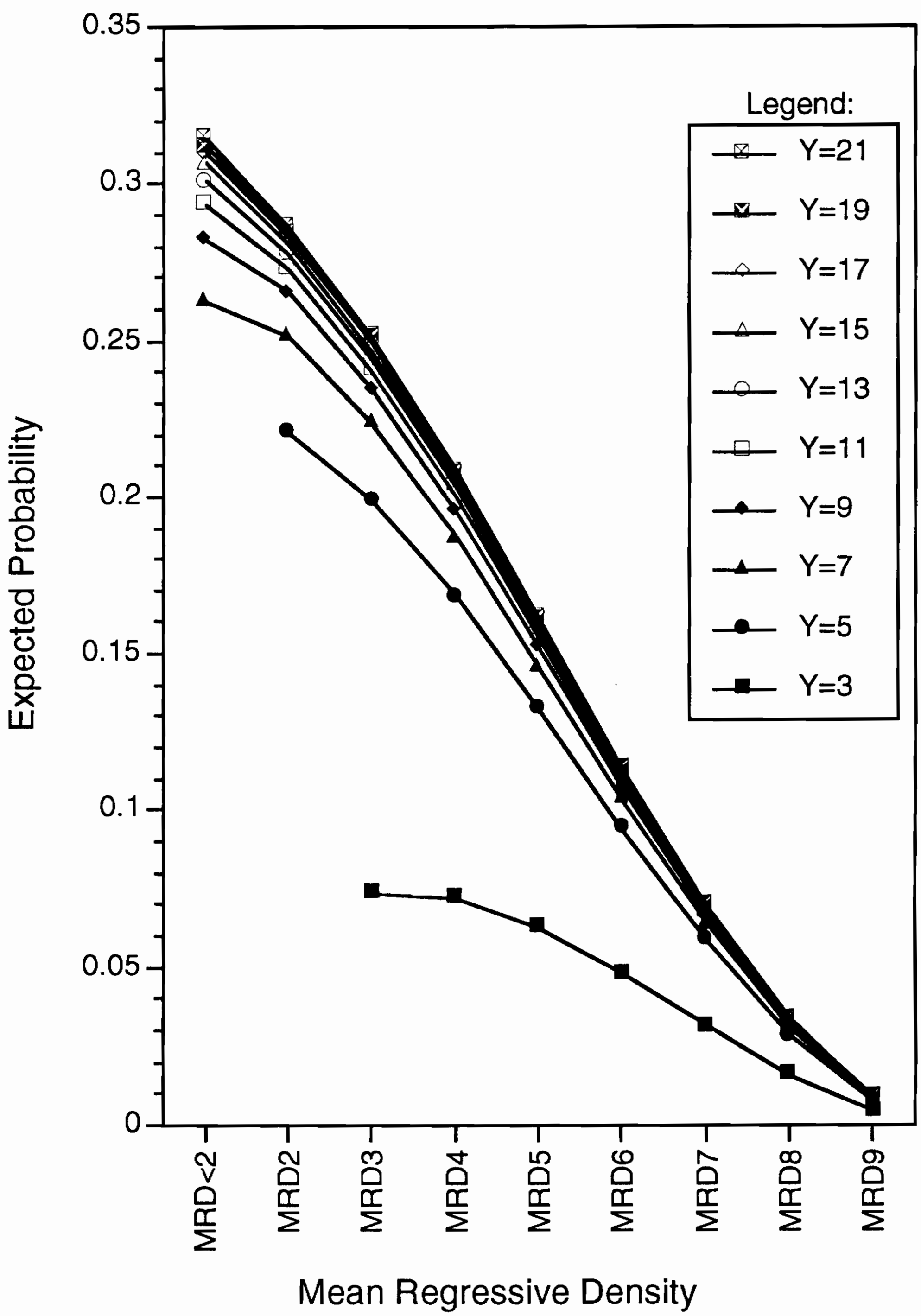

FIGURE 10: The "idealized" Expected Probability of DDs are illustrated as a function MRDs and y-ordinate levels.

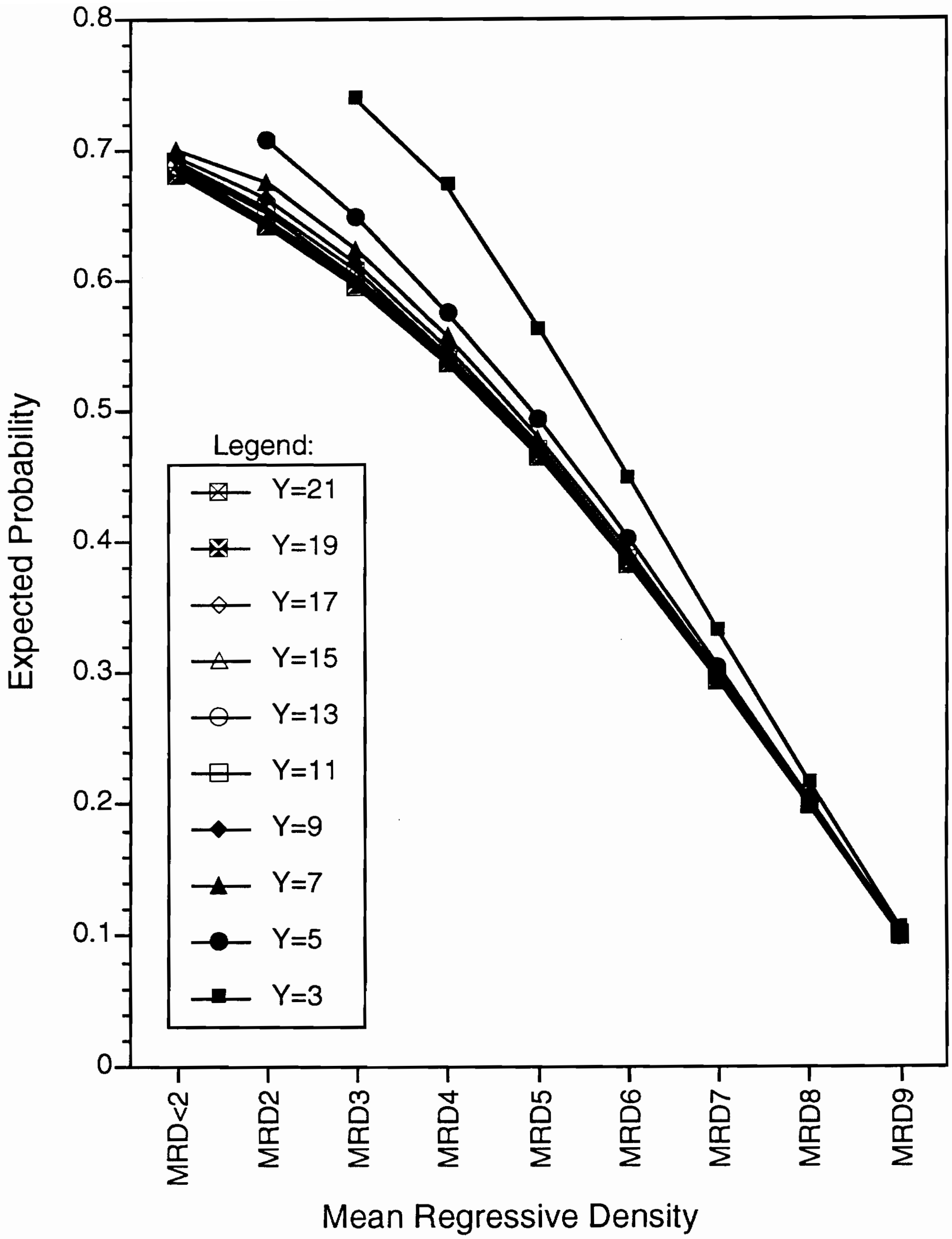

FIGURE 11: The "idealized" Expected Probability of AREs are illustrated as a function MRDs and y-ordinate levels.

Conclusion

One goal of this analysis was to demonstrate the connectedness of the different features and properties of a time series so defined by the Formal Operation. In addition, the Formal Operation defines a framework by which time series systems are generated and described. These systems have characteristics which are tied to the operation and parameters that construct them. Table 3 shows a correlation matrix of the different parameters, statistics and expecteds discussed in this analysis. As revealed, the correlations among the categories are very high. Table 4 gives the bivariate correlational significance (against zero) for each cell of the correlation matrix. Note that each correlation is statistically significant at the $\propto < .01$.

Another reason for portraying the parameters, statistics, and expecteds within a correlation matrix is to underscore that the time series generated by the Formal Operation constitute a mixture of related features and characteristics. I maintain that the independent variables used in my dissertation represent a system of events, patterns and properties associated with the construction of a formally defined time series. Thus, I assume, that subjects given differently defined time series (i.e., time series with different Psi coefficients) are responding to each time series system as a whole, as a mixture of inter-related features and properties.

TABLE 3: A correlation matrix of each of the parameters, statistics, and expecteds discussed in this Formal Analysis.

	MRD	RD	PSI-Coef.	Coef-VAR.	KURTOSIS	DD	ARE	AMPLITUDE
MRD	1.000	-1.000	.840	-.990	.840	-.997	-.997	-.995
RD	-1.000	1.000	-.840	.990	-.840	.997	.997	.995
PSI-Coef.	.840	-.840	1.000	-.904	1.000	-.818	-.871	-.824
Coef-VAR.	-.990	.990	-.904	1.000	-.904	.985	.997	.985
KURTOSIS	.840	-.840	1.000	-.904	1.000	-.818	-.871	-.824
DD	-.997	.997	-.818	.985	-.818	1.000	.995	.996
ARE	-.997	.997	-.871	.997	-.871	.995	1.000	.994
AMPLITUDE	-.995	.995	-.824	.985	-.824	.996	.994	1.000

TABLE 4: The statistical significance of every possible bivariate combination shown in the correlation matrix above is presented below (i.e., for the parameters, statistics, and expecteds discussed in this Formal Analysis).

	Correlation	P-Value	95% Lower	95% Upper
MRD, RD	-1.000	¥	¥	¥
MRD, PSI-Coef.	.840	.0063	.331	.970
MRD, Coef-VAR.	-.990	<.0001	-.998	-.946
MRD, KURTOSIS	.840	.0063	.331	.970
MRD, DD	-.997	<.0001	-1.000	-.985
MRD, ARE	-.997	<.0001	-.999	-.980
MRD, AMPLITUDE	-.995	<.0001	-.999	-.973
RD, PSI-Coef.	-.840	.0063	-.970	-.331
RD, Coef-VAR.	.990	<.0001	.946	.998
RD, KURTOSIS	-.840	.0063	-.970	-.331
RD, DD	.997	<.0001	.985	1.000
RD, ARE	.997	<.0001	.980	.999
RD, AMPLITUDE	.995	<.0001	.973	.999
PSI-Coef., Coef-VAR.	-.904	.0008	-.983	-.549
PSI-Coef., KURTOSIS	1.000	<.0001	1.000	1.000
PSI-Coef., DD	-.818	.0100	-.966	-.268
PSI-Coef., ARE	-.871	.0027	-.976	-.432
PSI-Coef., AMPLITUDE	-.824	.0089	-.967	-.285
Coef-VAR., KURTOSIS	-.904	.0008	-.983	-.549
Coef-VAR., DD	.985	<.0001	.916	.997
Coef-VAR., ARE	.997	<.0001	.985	1.000
Coef-VAR., AMPLITUDE	.985	<.0001	.917	.997
KURTOSIS, DD	-.818	.0100	-.966	-.268
KURTOSIS, ARE	-.871	.0027	-.976	-.432
KURTOSIS, AMPLITUDE	-.824	.0089	-.967	-.285
DD, ARE	.995	<.0001	.970	.999
DD, AMPLITUDE	.996	<.0001	.979	.999
ARE, AMPLITUDE	.994	<.0001	.964	.999

Part Two:

Comparing and Testing

Introduction

The purpose of the above system analysis was to quantify outcome characteristics that emerge from realizing a time series. The system was developed in order to compare expected outcomes with actual realizations. If the comparsion was great or significantly different, then the realization can be said to represent a sport or an unusual sample. Below , I compare the outcome charateristics of the realized time series, used in this dissertation, with their expecteds.

Comparison between Expecteds and Observed Time Series

First, chi square analysis of local patterns were conducted: autoregressive egressive patterns (ARE), double up and down patterns (DD), and amplitude patterns. Each analysis is divided into three, indicating each type of variation density (VAR). In each Table (5, 6, and 7) none of the tests were significant save one. The DD test for VAR .50 shows a significantly different pattern than should be expected. Reviewing the the realized time series shows that it displayed the same number of DDs as the VAR .80 time series (i.e, 16 DDs). At one level, the similarity between the two conditions acts to block this variable. Therefore, we can speculate that DDs had little effect on the emergence of NFB by itself.

Second, visual comparison of three descriptive statistics were conducted, they were: kurtosis, standard deviation, and variance. Table 8 shows the three time series VAR densities studied and two columns representing realized and expected characteristics. As can be seen, each of the comparisons is very close, if not exact. Statisitcal tests were not performed since no available variance term could be determined at this time, and the properties of the numbers did not lend themselves to chi square assumptions.

Conclusion

The results of this analysis indicate that the realized time series, used in this dissertation, matched well the expected time series. The formulas given in Part One may be used in future research so as to check whether the time series tested, as subordinate performance have the properties expected and not some unknown deviation. The formulas provide a way of calibrating the independent variable, as one checks the accuracy of any device that purports to function in a certain manner, be it a tool or stimulus. On another level, the Formal Operation was designed so that random variation (i.e., inconsistency vs. consistency) could be quantified, manipulated and therefore replicated. I hope this document serves as some support for future research, or a place where new ideas regarding the modelling and analysis of time series is assisted and perhaps inspired.

Table 5. For AREs, three chi square "goodness of fit" tests indicate no differences were found across each VAR condition.

VAR = .8	f(O)	f(E)	f(O)-f(E)	^2	/f(E)	
ARE	60.000	55.000	5.000	25.000	0.455	
NOT ARE	18.000	23.000	-5.000	25.000	1.087	
Total				CHI Sqr =	1.542	p = .21

VAR = .5	f(O)	f(E)	f(O)-f(E)	^2	/f(E)	
ARE	36.000	38.000	-2.000	4.000	0.105	
NOT ARE	42.000	40.000	2.000	4.000	0.100	
Total				CHI Sqr =	0.210	p = .65

VAR = .2	f(O)	f(E)	f(O)-f(E)	^2	/f(E)	
ARE	16.000	16.000	0.000	0.000	0.000	
NOT ARE	62.000	62.000	0.000	0.000	0.000	
Total				CHI Sqr =	0.000	p = 1.00

Table 6. For DDs, three chi square "goodness of fit" tests indicate no differences were found across each VAR condition except for VAR .5.

VAR = .8	f(O)	f(E)	f(O)-f(E)	^2	/f(E)	
DD	16.000	17.000	-1.000	1.000	0.059	
NOT DD	62.000	61.000	1.000	1.000	0.016	
Total				CHI Sqr =	0.080	$p = .78$

VAR = .5	f(O)	f(E)	f(O)-f(E)	^2	/f(E)	
DD	16.000	10.000	6.000	36.000	3.600	
NOT DD	62.000	68.000	-6.000	36.000	0.529	
Total				CHI Sqr =	4.130	$p = .04$

VAR = .2	f(O)	f(E)	f(O)-f(E)	^2	/f(E)	
DD	2.000	2.000	0.000	0.000	0.000	
NOT DD	76.000	76.000	0.000	0.000	0.000	
Total				CHI Sqr =	0.000	$p = 1.00$

Table 7. Testing whether significant differences exist between expected amplitude counts and realized counts indicate no differences were found across each VAR condition.

VAR .80

Amplitude	f(O)	f(E)	f(O)-f(E)	^2	/f(E)
4.000	10.000	8.118	2.000	4.000	0.500
3.000	18.000	17.622	0.000	0.000	0.000
2.000	28.000	20.987	7.000	49.000	2.333
1.000	22.000	30.491	-8.000	64.000	2.133
0.000	1.000	1.782	-1.000	1.000	0.500
Total					5.466

$p = .24$

VAR .50

Amplitude	f(O)	f(E)	f(O)-f(E)	^2	/f(E)
4.000	0.000	0.000	0.000	0.000	0.000
3.000	6.000	6.000	0.185	0.034	0.000
2.000	32.000	25.000	7.138	49.000	1.960
1.000	26.000	30.000	-4.075	16.000	0.533
0.000	15.000	18.000	-3.246	9.000	0.500
Total					2.993

$p = .53$

VAR .20

Amplitude	f(O)	f(E)	f(O)-f(E)	^2	/f(E)
4.000	0.000	0.406	0.594	0.353	0.000
3.000	0.000	0.609	0.391	0.153	0.000
2.000	16.000	12.789	3.211	9.000	0.692
1.000	16.000	11.977	4.023	16.181	1.333
0.000	47.000	55.218	-8.218	64.000	1.163
Total					3.188

$p = .34$

Table 8. A comparison of expected summary statistics with actual realized statistics describing time series used as the indenpendent variables.

		Expected Statistics	Actual Statistics
VAR .80			
	Kurtosis	-1.300	-1.330
	Std. Deviation	1.423	1.420
	Variance	2.025	2.000
VAR .50			
	Kurtosis	-0.280	-0.333
	Std. Deviation	1.125	1.120
	Variance	1.266	1.250
VAR .20			
	Kurtosis	3.800	3.660
	Std. Deviation	.7116	.7100
	Variance	.5063	.5000

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Appendix C.

Draw and Quarter and Balancing Bounces Procedure

"Draw and Quarter" and "Balancing Bounces" Procedures

In the construction of each time series a "Draw and Quarter" and "Balancing Bounces" procedure was used to correct for nonobvious trends or asymmetries that might systematically effect a subject's responding . Although random generators may be unbiased in the construction of a "population" distribution, implying very large samples. Unfortunately, smaller samples or local clusters within a randomly generated time series sample may contain trends or skewed distributions. To mitigate such occurences and to further model a distribution representative of a regression to the mean stochastic a "Draw and Quarter" and "Balancing Bounces" procedure was employed. These procedures were designed by the author to: (a) reduce unwanted trends, (b) to even out the time series distribution proportionally over its temporal duration, and (c) model some assumed characteristics of regression to the mean stochastic. Below are the steps of each procedure. These procedures were used on distributions shown in Figure 3, Panel A.

Draw and Quarter Procedure

Purpose: to even out the distribution across time (i.e., the abscissa) and levels (i.e., the ordinate).

1. Split the time series into quarter section along abscissa.
2. Note the predefined average or mean level.
3. Note how many levels along ordinate that define the time series distribution.
4. Note the probability density of each level along the ordinate.
5. Determine within each quarter section:
    a. the number of events (points) at each level along the ordinate.
    b. if asymmtries or trends exists
    c. if trends exists, adjust time series distribution so that an equal or similar number of events (points) at each level along the ordinate within each quarter section exists, while maintaining the probability densities defining the original time series.

Balancing Bounces Procedure

Purpose: to even out the observed variation (i.e., magnitude of change) across the abscissa between succesive two point line segments, making up the time series distribution.

1. Using the quarter sections used above:
    a. Categorize each two point line segment in terms of its magnitude of change (refered as the bounce) for each quarter section.
    b. Count the number up, down and no bounce lines within their respective magnitude categories for each quarter section.
    c. Count the number of lines crossing the average or mean level for each quarter section.
2. Note trends and asymmetries among the quarter sections.
3. Adjust the number of bounces crossing the mean level and their magnitude and direction so that equal or similar proportions exist among the quarter sections.

Appendix D.

Demographic, Attribution and Manipulation-Check (DAM) Survey

The DAM Survey

PURPOSE OF SURVEY.

This survey asks questions regarding how you felt about (a) giving performance feedback, (b) your secretary's performance, and (c) what you thought may have influenced your secretary's performance.

INSTRUCTIONS.

Please read the following instructions carefully. If you have any questions please ask for assistance.

There are two sections to this survey.

The first section asks demographic and history questions. On the sheet provided, please answer the questions by circling your answers and filling in the blanks.

The second section asks questions regarding the study. Please use the opscan provided in answering these questions. Please do not write on this section of the survey.

Most questions in this section give a seven point scale (1 through 7). Please, indicate on your opscan which of these seven points best characterize your answer.

Select only one response for each question. Check frequently to ensure that the number on your answer sheet matches the number on the survey question. Never darken the numbers 8 through 10.

Please answer each question carefully and thoughtfully.

••• THE ANSWERS TO ALL QUESTIONS ARE STRICTLY CONFIDENTIAL.

First Section: Demographics and History

PARTICIPANT'S EXPERIMENT I.D. NUMBER: ___________

Instructions: Circle and fill in your answers.

1. Age? _______
2. Race? _______
3. Class Level? _________
4. Degree Major and Minor? ___________________ - _______________
5. Course Giving Credit? ______________________
6. Do you have any computer experience? (1) Yes (2) No (3) Some
7. Number of years and type of computer experience? _______ Years

____

8. Have you ever used a Macintosh computer before? (1) Yes (2) No (3) Some

9. Are you right or left handed? (1) Right (2) Left (3) Both

10. Have you ever been employed as a manager and supervised employees?

    (1) Yes (2) No

11. If yes to question 11, how large of a staff did you supervise?

____

SECOND SECTION

OPSCAN QUESTIONS

Instructions:

Please,

(a) Answer each question carefully by darkening the matching number on your opscan.

(b) Use a No. 2 pencil.

(c) Do not write on this survey.

SECOND SECTION: OPSCAN QUESTIONS

Instructions: Answer each question by darkening the matching number on your opscan. Please, use a No. 2 pencil and do not write on this survey.

1. In your opinion, to what extent was your secretary's overall typing performance due to his/her "effort"?

No Effort Involved — **Average** — **Lots of Effort Involved**

(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

2. How much feedback did you give to your secretary?

Not Much Feedback Given — **Average** — **Feedback Given Continuously**

(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

3. In your opinion, to what extent did your secretary enjoy working with you?

Not Much — **Average** — **Very Much**

(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

4. In your opinion, to what extent did your secretary enjoy working on this particular typing task?

Did Not Enjoy — **Average** — **Did Enjoy**

(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

5. How compliant was your secretary to your negative feedback requests?

Not Compliant — **Average** — **Very Compliant**

(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

6. To what extent was your secretary's overall typing performance due to his/her "ability"?

No Ability Involved — **Average** — **Lots of Ability Involved**

(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

7. How often would you say your secretary needs supervision?

No Supervision — **Average** — **Constant Supervision**

(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

8. How would you rate your performance as a manager?

Poor — **Average** — **Good**

(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

9. In your opinion, was the amount of information as seen during each performance window adequate enough for you to give accurate feedback?

Not Adequate **Average** **Very Adequate**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

10. In your opinion, to what extent was your secretary's overall typing performance due to the "difficulty" of the typing task?

No Task Difficulty Involved **Average** **Lots of Task Difficulty Involved**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

11. How much influence did your secretary's behavior (that is, their "good", "average" or "poor" performance) have on your feedback choice?

Not Much **Average** **Very Much**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

12. How much influence did you personally have in motivating and directing your secretary's overall typing performance?

Not Much **Average** **Very Much**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

13. How would you rate the quality of feedback between you and your secretary?

Feedback Given Was Mostly Negative **Average** **Feedback Given Was Mostly Positive**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

14. How would you rate your secretary's effort toward his/her typing and word-processing?

Poor **Average** **Good**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

15. How would you characterize your managerial style?

Very Critical **Average** **Very Encouraging**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

16. How likely would it be that your secretary would be selected for a pay increase based on her overall typing performance?

Not Likely **Average** **Very Likely**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

17. How would you rate your secretary's ability to type and word-process?

Poor **Average** **Good**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

18. In your opinion, did your secretary accept negative feedback well?

Not Very Well **Average** **Very Well**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

19. In your opinion, how would your secretary characterize your managerial style?

Very Critical **Average** **Very Encouraging**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

20. How much control did your secretary have over his/her "good" typing performance?

No Control **Average** **Complete Control**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

21. How likely would it be that your secretary would be selected for special training or schooling based on her overall typing performance?

Not Likely **Average** **Very Likely**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

22. How comfortable did you feel about giving positive feedback?

Not Comfortable **Average** **Very Comfortable**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

23. How much control did your secretary have over his/her "poor" typing performance?

No Control **Average** **Complete Control**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

24. How much influence did you personally have in motivating and directing, **at any one time**, your secretary's typing performance?

Not Much **Average** **Very Much**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

25. How consistent was your managerial style?

Not Consistent **Average** **Very Consistent**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

26. In reviewing your motivation and decision to use feedback (positive vs. negative), which of the below best characterizes your use of feedback?

(1) To Reward and Punish Past Performance

(2) To Prompt and Prod Future Performance

27. To what extent was your secretary's overall typing performance due to "luck"?

No Luck Involved **Average** **Lots of Luck Involved**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

28. During the beginning of this study, did you find the feedback task to be difficult or easy?

Very Difficult **Average** **Very Easy**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

29. How would you rate your own effort toward managing your secretary's typing and word-processing?

Poor **Average** **Good**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

30. How much control did your secretary have over his/her overall typing performance?

No Control **Average** **Complete Control**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

31. How consistent was your secretary's overall typing performance?

Not Consistent **Average** **Very Consistent**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

32. How likely would it be that your secretary would be recommended for promotion based on her overall typing performance?

Not Likely **Average** **Very Likely**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

33. How would you rate your own ability to manage your secretary's typing performance?

Poor **Average** **Good**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

34. How likely would it be that your secretary would be selected for special recognition based on her overall typing performance?

Not Likely **Average** **Very Likely**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

35. At the end of this study, did you find the feedback task to be more or less difficult or easy?

More Difficult **LESS** **More Easy**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

36. Of the two feedback options (positive vs. negative) which improved secretarial performance best?

Positive Feedback **Both** **Negative Feedback**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

37. If you were to participate in this study again, would you be willing to supervise this same secretary or prefer a different secretary?

(1) I would prefer the SAME secretary.

(2) I would prefer a DIFFERENT secretary.

38. In your opinion, to what extent was your secretary interested in performing well on the "Performance Feedback Program"?

Not Very Interested **Average** **Very Interested**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

39. How comfortable did you feel about giving negative feedback?

Not Comfortable **Average** **Very Comfortable**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

40. How would you characterize the overall performance of your secretary?

Poor **Average** **Good**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

41. How responsive was your secretary to your positive feedback requests?

Not Encouraged **Average** **Very Encouraged**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

42. To what extent did you enjoy working with your secretary?

Not Much **Average** **Very Much**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

43. To what extent did you enjoy working as a manager and presenting performance feedback?

Did Not Enjoy **Average** **Did Enjoy**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

44. In your opinion, did your secretary accept positive feedback well?

Not Very Well **Average** **Very Well**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

45. How serious did you take your role as a manager using "Computer-Assisted Feedback"?

Not Very **Very**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

The following questions concern your impressions of the system of "Computer-Assisted Feedback". Please, consider these questions as if you were a designer/consultant to the implementation of a feedback system to be used by business and industry.

46. Do you think managers (in general) will take this type of "Computer-Assisted Feedback" system seriously?

Not Very **Very**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

47. Will mangers (in general) consider this process of giving feedback a credible alternative?

Not Very **Very**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

48. How credible did you think this "Computer-Assisted Feedback" program and simulation was?

Not Very **Very**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

49. In your opinion, do you think "Computer-Assisted Feedback" is a promisng substitute to directly giving feedback in person?

Not Very **Very**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

50. Would you have given the same types of feedback if you had to give it in person?

Not Likely **Very Likely**
(1) ---------- (2) ---------- (3) ---------- (4) ---------- (5) ---------- (6) ---------- (7)

In Conclusion:

If you have any suggestion that may advance our understanding of computer-assisted feedback and monitoring, please let us know. We welcome all comments.

Appendix E

Percent Difference Scores

Percent Difference Scores

The flow of decisions regarding how responses are measured, integrated and finally analyzed are critical to how results will be eventually interpreted. The information context created by the measurement process should at some level reflect the overarching conceptual framework precipitating research. In other words, methods should be relatively isomorphic with theory. For instance, if a developmentalist claims that time is critical to the formation of structure, then a temporal componet or measure (repeated measures design) is strongly encourged. Anything less, brings on sincere criticisms and questions.

Given the above, a negative feedback bias (NFB) was assumed to represent an imbalance between positive and negative feedback. The question was how to characterize the relationship of feedback allocations. Several apriori assumptions were made that guided the decision on which formula was best. First, it was decided that the two response measures would be integrated into a single measure, since feedback bias was considered as a relationship of proportion. Second, absolute quanties of feedback responses were not emphasized, since again, a bias was thought to exist regardless of actual amounts. Conceptual, it was thought a bias exists even when very few positive and negative feedback responses were observed since they represented a sample taken during one interval of time. What was emphasized was the relationship and not relative absolute quantities of feedback.

Several formulas were considered. First, the "Ratio Method" would record the number of positive and negative responses, and then dividing the number of positive feedback responses by the number of negative feedback responses. Ratio numbers above 1.00 mean more positive feedback responses were emitted. Ratios below 1.00 mean more negative feedback responses were given. Ratios equal to 1.00 represent no feedback bias was present. Therefore, a positive feeback or negative feedback bias is referenced against the number 1.00. This formulation was not used since the possible ratio numbers would potentially vary widely and have no easily understood metric, such as a percent.

Second, the "Absolute Differencing Method" measured bias by initially recording the number of positive and negative responses. Subsequently, the number of negative feedback responses were subtracted from the number of positive feedback responses. Depending on the sign of the answer would indicate the sign of the bias. A positive number would represent a positive feedback bias. A negative number would indicate a negative feedback bias. A zero number would indicate a no feedback bias. Therefore, a positive or negative feedback bias is referenced against zero.

This formulation was not used since it carries an absolute quantity dimension which adds a difficulty when comparing across individuals. For instance, supervisor (A), gives 10 positive feedback responses and 5 negative feedback responses, and thus has a 5 point positive feeback bias. However, supervisor (B), in the same time interval, gives 50 positive feedback responses and 25 negative feedback responses, and has a 25 point positive feeback bias. Given this senario supervisor (B) appears to have a greater positive feedback bias. I presumed from the beginning that feedback bias should be conceptualized as relative to an individual's style of management. However, it was important not to let style alone to obscure the general feedback process. In other words, some supervisors may naturally give more feedback than other who are more reserved. The Absolute Differencing Method unfortunately is a method where individual styles could mask other styles of managment which were equally biased when viewed as relative to the individual (e.g., 10 is to 5 as 50 is to 25).

Third, the "Relative Differencing Method" which is used in the dissertation combines the above two approaches so as to construct a formula that gives a ratio with a standard and well understood metric (i.e., percentage). The formula begins by recording the number of positive (P) and negative (N) responses. A fraction is then used with the denominator including the Absolute Differencing Method formula, and the numerator calculates the total number of feedback responses delivered.

Altogether, the final ratio gives a percent of difference between positive and negative feedback. The denominator determines the sign of the bias, with positive percents indicating a positive feedback bias and negative percents indicating negative feedback bias. The totalling of the positive and negative feedback responses in the denominator creates the overall ratio percent term. The percents themselves represent that percent of feedback over and above unity, that is (a) over and above zero preference, or (b) over and above equivalence ($P = N$). As in the Absolute Differencing Method a positive or negative feedback bias is referenced against zero. As in the Ratio Method positive and negative feedback are put into a relationship that overcomes the influence of or emphasis on individual styles of feedback delivery. All individuals are compared according to a ratio percent. Additionally, the percent term is a more commonly understood measure, thus making comparisons and interpretations more affordable.

Thus, the Relative Differencing Method gives a formula where feedback bias is relative to a supervisor's ratio of P and N and not to absolute amounts of P and N . Of course, an absolute method which pursues counts over ratios may have important implications, however, this decision would mean a new set assumptions were in place regarding feedback bias, with subsequent implications regarding the portrayal and interpretation of bias observed.

Appendix F

Cicchetti's Extension of Multiple-Range Tests:

A rapid approximate solution

Cicchetti's Extension of Multiple-Range Tests:

A rapid approximate solution

Cicchetti's (1972) approxiamtion was used to calculate the significance for unconfounded pairwise comparisons. I wished to control for Type I errors, but felt that tests that included comparisons across conditions in interaction (on the diagonal) made the pairwise comparison tests too conservative. Additionally, such tests were not necesssary. Cicchetti's approximation allows a researcher to test fewer comparisons without unduly restricting the tests sensitivty.