Measuring Intellectual Behavior: The Hierarchical Stages of Complex Reasoning in Executive Development

A dissertation submitted

by

RICHARD LEE MCELROY

To

FIELDING GRADUATE UNIVERSITY

in partial fulfillment of
the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

HUMAN AND ORGANIZATIONAL SYSTEMS

This dissertation has been accepted for
the faculty of Fielding Graduate University by

_____

Milton E. Lopes, PhD
Committee Chair

Committee:
Frederick Steier, PhD, Faculty Reader
Placida V. Gallegos, PhD, Faculty Reader
Melanie Guste, PhD, Student Reader
Michael L. Commons, PhD, External Examiner

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Richard Lee McElroy

Abstract

There is an ongoing dialogue regarding the difficulty of effectively measuring executive development and identifying a general basis for this development. The focus of this dissertation was to explore the link between executive development and developed cognitive ability. The context in which this study was conducted was the U.S. energy industry, with a specific consideration of the nuclear power industry. I asked how can an executive's complex reasoning be measured without direct reliance on aspects of domain, context, or culture? I also asked what are the common developmental experiences of its development? This study demonstrates a methodology for and results of performing cognitive development measurement. The chosen research instrument was the Model of Hierarchical Complexity (MHC) which incorporates a technique to discern the hierarchical stages of development. Integral to the use of MHC, my study employed a Rasch analysis and statistical regression techniques. I found this methodology to be well-suited for reduced bias measurement, allowing for a graphical depiction of the revealed hierarchical stages of developed complex reasoning. I believe this methodology will prove significant in providing a cognition-centered framework that informs both executive development program design and the post-development assessment methodology.

KEY WORDS: ADULT DEVELOPMENT, COGNITION, COGNITIVE DEVELOPMENT, COMPLEX REASONING, EXECUTIVE DEVELOPMENT, ORGANIZATIONAL DEVELOPMENT, REASONING

ACKNOWLEDGEMENT

I would like to express my appreciation to the following individuals for their support, guidance, and encouragement, as well as their direct contributions to this project:

The members of my committee: Drs. Milton Lopes, Fred Steier, and Placida Gallegos.

Dr. Michael Lamport Commons. His guidance was invaluable. In addition to serving as the external examiner on my dissertation committee, he took many telephone calls, answered numerous questions, and helped me work through the interrelated complexities of postformal stage development, his model of hierarchical complexity, and Rasch analysis. It was an honor to be able to turn to him for advice.

Dr. John Michael Linacre for his personal help with the WINSTEPS program. I am grateful for the time, attention, and feedback he provided in reviewing my research data.

I especially appreciate the encouragement from my father-in-law, Dr. Bobby Leonard. He said I could do it. He was my inspiration to tackle this daunting task.

My family, Renee and Ashley, made significant contributions to this project. Each sacrificed, in large and small ways, as this work was integrated into our lives. Both reassured me, expressed their pride, and enveloped me in their love. Because of them I always had a warm sanctuary in which to weather the storms inherent in the dissertation quest.

DEDICATION

I am dedicating this body of work to my wonderful wife and daughter, Renee and Ashley. I am constantly buoyed by their love and support. Without them I could not have accomplished my doctoral work.

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CHAPTER ONE: INTRODUCTION

Problem

Worldwide, companies are becoming aware of the link between executive development and developed cognitive ability (see, e.g., Downey, Papageorgiou, & Stough, 2006; Granello & Underfer-Babalis, 2004; Green, 2004; 2002, p. 56-57; Laske & Maynes, 2002; Spitulnik, 2006; Zhang, 2002). This knowledge is critical for the U.S. nuclear power industry where such development is further linked to operational performance and safety (Martin, 2007; Tan & Gallupe, 2006). Additionally, forecasted for near-future resurgence (Weil, 2007), the nuclear industry is projected to enter a period of robust growth at the same time that its workforce is aging (Weil, 1999), resulting in retirements (Harrison, 2007) and the departure of experiential knowledge (DeLong, 2004). Newer, younger executives will have to fill the void (R. Miller, Dean FPL Group University, personal correspondence, June 24, 2008; A. Domijan, Director of Power Center for Utility Explorations, University of South Florida, personal correspondence, October 19, 2008).

The link between executive development and developed cognitive ability is the focal point of the research presented here. First, it is important to clearly delineate a methodology whereby cognitive development can be effectively measured. This study centers on such a measurement methodology. Second, it is equally important to clearly identify the contributing experiences to this development. The study presented here, using statistical regression analysis, seeks to identify the general area of contributing experiences that correspond with higher developed complex reasoning stages.

This will inform the scholarly community relative to design considerations of future development programs. I hope to add voice to replacing current development practices borne of coincidence experiences (educational and work) to that of deliberate and concentrated development protocol.

To add foundation to the subsequent literature review of chapter 2, the remainder of this introduction explores the problem in two parts. First, I briefly explore measurement schemes of executive development. Second, I explore the current concepts relative to contributing developmental experiences. Subsequently, I will state the problem, the purpose of this study, my research question, my hypotheses, assumptions and limitations of the study, and provide the definition of terms used throughout.

Executive Development: Measurement Schemes

The first prominent issue relative to executive development centers on assessment or, more specifically, what to measure. Some suggest that it can be something that is *exhibited*. This can include a set of qualities (Bornstein & Smith, 1996), characteristics (Decrane, 1996), behaviors (Mendonca, 2001), or competencies (McFarland, Senn, & Childress, 1994). Viewed variously, development could be measured as the demonstration of qualities or as an expanded repertoire of competencies.

Similarly, parallel positions taken in this is that measurement centers on what executives *are* (*e.g.*, risk taker (Gardner, 1995; Wolniansky, 1990), change agent (R. E. Quinn, 1996), change leader (Bardwick, 1996; Kotter, 1996), or steward of culture (Schein, 1997)) or by what they *do* (*e.g.*, employ a collection of actions (Bornstein & Smith, 1996), change the larger system (R. E. Quinn, 1996), "tapping the wellsprings of human motivation" (Kouzes & Posner, 1987, p. xvi), or setting direction (McFarland, et al., 1994)).

These measurement schemes employ context and domain-specific constructs. As such, there is a conflict between development and its measurement. Development is the "orderly change" in an individual's complex reasoning (Stevens-Long & Commons, 1992, p. 548). However, traditional post-development measurement schemes rely on intellect-focused education or skill-based performance training (Commons & Pekker, 2005).

The literature suggests that coincident with the organizational change effort that executives would assume new roles (Covey, 1996; Senge, 1990), acquire new skills (Kouzes & Posner, 1987), and be well-prepared to lead the change (Blanchard & Hersey, 1993; Conger, Spreitzer, & Lawler, 1999; Hesselbein, Goldsmith, & Beckhard, 1996; Schein, 1997). It is posited that the executive engages in "reinvention" or "realignment" of self (R. E. Quinn, 1996, p. 139). However, a question remains: How is this realignment measured?

The research proposed here will demonstrate that executive development can effectively be measured as a function of intellectual behavior; further, that it is separate from measurement notions which are linked to domain, context, or culture. For the purpose of this research, executive (senior, middle, or lower) is defined as active policy makers and heads of functional areas through general managers with authority over and responsibility for entire business entities or major divisions or departments of such. While recognizing that leaders may exist throughout the organization (Decrane, 1996), this study focuses on those individuals that hold a position of organizational authority.

Executive Development: Developmental Experiences

The second problematic issue in executive development is the complex array of concepts relative to contributors to development. While development activities include awareness, motivation, and skill-building (Stringer & Cheloha, 2003), there is a debate centered on the mechanism by which these are employed. Rodwell (2005), while examining effective management development, proposed that the academic setting is considered the "key avenue" of development. Some, however, while critical of the generic mass-production in academia (Leavitt, 1989), nevertheless suggest a structured mechanism for the development exercise. Others contend that it cannot be structured, but rather experientially derived (*e.g.*, emerging from the circumstances of life (Gardner, 1995; Handy, 1996), learned by observation or workplace experience (Stringer & Cheloha, 2003) or simply "unstructured, self-discovery" (Eastburn, 1987). However, another question remains: What developmental experiences are employed in the process?

Problem Statement

There is on-going dialogue regarding the problem of effectively measuring executive development and identifying the general contributors for this development. Both aspects hinder the design of effective development programs. At root for both is the emphasis on intellect-based education or skill-based training versus a concentration on the fundamental aspect of development, namely that of cognition.

Study Purpose

The principal objectives of this research were, first, to show that hierarchical stages of executive complex reasoning can be measured within an organizational setting and, second, to identify the common developmental experiences that have contributed to the development. With this research I foremost hope to add to the executive development literature. My basic contention

is that the stage of complex reasoning is a measure of executive development. My presumption is that most measurements of executive development within the corporate environment are based on intelligence and skill development.

Secondarily, it is my hope that this research will adequately introduce a potential means to measure *intellectual behavior* (movement in time), as necessary in the paradigmatic representation of underlying cognitive patterns. It is hoped that by so doing that I can open a dialogue in the discipline of developmental neurocognition that moves dynamic-systems-based cognitive development research from the physical behavior of infants (see, e.g., Kelso, 1995; Thelen & Smith, 1994) to that of the intellectual behavior of adults.

Research Question

How can the hierarchical stages of complex reasoning be measured in an organizational setting without direct reliance on aspects of domain, context, or cultural bias? And what are the common developmental experiences of the development?

Statement of Hypotheses

The organizational executive experiences disparate and various developmental circumstances throughout their careers that results in a sequential movement in the order of hierarchical complex reasoning stages. It follows then that executive development:

1. Positively correlates to a combination of education and experience;
2. Can be ascertained by focused examination within the theorized psychological dimensions of organizational tasks;
3. Correlates with higher stages of complex reasoning;
4. Can be measured by the order of hierarchical complexity of reasoning stages that is divorced from concepts of skill-based performance;
5. Can be measured divorced from concepts of domain and context in which the assessment is conducted.
6. Can be conducted in such a way as to reduce cultural bias.

There are discernable stages of developed intellectual behavior required of and manifest in the executive. Further, there are contributing developmental, experiential, and maturational circumstances for the acquisition of these stages of complex reasoning. Therefore, executive development is orderly change to stages of higher complex reasoning brought about by complementary experiences.

Assumptions and Limitations

Generalizability

A potential limitation of this study is the "*generalizability*" or, more specifically, the "quality of a research finding that justifies the inference that it represents something more that the specific observation on which it was based" (Babbie, 1998, p. G3) of findings derived from a relative small sample size. Sample size is a common theme in discussions of generalization of research results, or as it is also referred "external validity" (see, *e.g.*, Babbie, 1998 p. 244). As examples, James Kalat cautioned that small sample size may yield "uncertain" any generalization claims (1993, p. 56). It is attributed to Auguste Comte (19th Century French

philosopher), providing a similar view, that generalization is dependent upon a "sample of sufficient size" (see, e.g., Easterby-Smith, Thorpe, & Lowe, 1997, p. 23).

The selected instrument for application, the MHC, has been repeatedly demonstrated to be applicable, as Commons contended, in "*any* situation regarding task difficulty and performance" [italics added] (2006, p. 20). Expanding on Piaget's work, Commons, et al. (1984a) approach mimics that of Piaget. Schwarzer's (1999, p. 324) comments of Piaget's work seem to also reflect Commons, "it is characterized first of convergence in that they apply to the change and development of all individuals, in all contexts, and across all contents and second by an emphasis on the strong connection between theory, method, and application." It is, then, considered generalizable by the instrument's author and the repeated demonstration of such by Commons and his colleagues. MHC has been incorporated into such diverse studies as those centered in society (Commons & Rodriguez, 1990, 1993), the workplace (Commons, Krause, Fayer, & Meaney, 1993), and politics (Commons & Sonnert, 1994). It has been incorporated into doctoral dissertation research with, similar to this study, small sample sizes, such as Ross (2006) in her 8-subject analysis of citizen's reasoning complexity or Bowman (1996) in her 10-subject review of organizational work practices. Generalizability, then, is not assumed to be compromised by this study's small sample size. I recognize that research as that reported here can "tolerate imperfect sample" size (Blair & Zinkhan, 2006). However, there are other factors that could impact the claim of research generalizability.

Research generalizability, to be valid, has to allow, as Kalat (1993) contended, that similar results would be achieved with a different population or, said a different way, that the "patterns observed in a sample will also be present in the wider population" (Easterby-Smith et al., 1997 p. 41) or, still differently, in the "real" world (Babbie, 1998 p. 244). Some of these factors are explored next.

Paramount factors that could potentially influence this study were those of testing and instrumentation (for expanded discussion, see, Babbie, 1998 pp. 240-245). Testing and retesting, as well as varying measures could influence research participants' behavior. This phenomenon has been alleviated from this study by the strict adherence to vignette construction (Commons, Goodheart et al., 2005). Modeled after similar complexity scenarios (see, e.g., Commons, Rodriguez, Adams, & Goodheart, 2006), I understand that the vignettes used in this study positively correspond to the guidelines for reduced bias, sequentially more complex vignettes (Dr. Commons, personal correspondence, January 26, 2008).

Other potential influencing factors include those of diffusion (communication between research subjects), compensatory rivalry (compensating for perceived difference between research subjects), and subject compensation. These factors were rendered invalid by the employed Internet-based research instrument. Participants did not know other participating subjects and could not, then, communicate nor compare with them.

Another important potentially influencing factor is that of selection bias. While there could be a naturally emerging bias from those that chose to participate (*e.g.,* similar attitudes), there was no bias on the part of the researcher in the selection process. Participation solicitations were sent, without prescreening or pre-selection, to thousands of U.S. energy industry personnel.

Definition of Terms

Behavior: The way in which a person, organism, or group responds to a specific set of conditions, specifically anything that the organism does involving action and response to stimulation within time. Important to this study is the notion that it includes a recurring or characteristic pattern of observable actions or responses.

Cognition: The mental activity, act, or process of acquiring and processing information as necessary in perceiving or knowing; processes enabling one to imagine, gain knowledge, to reason about knowledge, and to judge its meaning.

Cognitive patterns: Coherent structures of complex reasoning formed by the concept of self-organization from Dynamic Systems Theory.

Competencies: As explained by Hoffmann (1999), two discrete meanings of the term have evolved through common usage, generally expressed as behaviors or standards of performance. This notion is reflected in Baca and Starzmann's (2006) definition, "certain characteristics of individuals which, when exhibited, allow total rewards" and Castillo's (2005) "group of specific abilities defined in observable behaviors that produce a competitive and advantageous result." For this study it is defined as the individual's complex behavioral system comprised of knowledge, skills, and abilities. It differs from developmental stage in that it deals with behaviors rather than cognition.

Complex reasoning: The ability to form or have an awareness of the relationship between or among theoretical, conceptual, or intangible ideas; a foundational concept in definitions of intelligence.

Complexity: Authors speaking of complexity, such as *Complexity: The Emerging Science At the Edge of Order and Chaos* (Waldrop, 1992), admit that complexity is a "subject that's still so new and so wide-ranging that nobody knows quite how to define it" (p. 9) and, as explained in *Harnessing Complexity: Organizational Implications of a Scientific Frontier* (Axelrod & Cohen, 2000), it is generally accepted that a precise definition remains in the future. For this study it is defined as many individual parts with enormous diversity acting in a coordinated fashion to evolve into macro-stage order.

Culture: The social norms (mores, customs) by which one acts and reacts to circumstances for survival, literally or, in the case of organizational life, metaphorically. Within the workplace these are typically "learned" through experience rather than formally communicated to new employees. (Such norms are learned from experience, generally, and not taught). These represent traditions by which employees act within their work environment. Schein contended that culture is a discernable "pattern of shared basic assumptions" (1997, p. 12) that have worked well in group problem solving.

Development: The vertical or, as theorized by Michael Commons and colleagues (Commons, Richards, Ruf, Armstrong-Roche, & Bretzins, 1984), *hierarchical* representation of sequentially more complex cognition. Development is evidenced by "orderly change" (Stevens-Long & Commons, 1992, p. 548) in an individual's complex reasoning in forming relationships between ideas and concepts. It embodies, then, the notions of thinking, "critical thinking," reasoning, "abstract reasoning," complex reasoning, and cognition. Development is, then, not the acquisition of additional, horizontally-oriented knowledge, skills, and abilities that constitute no higher or more complex reasoning stage.

Development stage: The hierarchical representation of sequentially more complex behaviors, popularly linked to early cognitive development research conducted by Piaget and Inhelder (1958) and *neo-Piagetian* theorists (Commons, Richards, & Armon, 1984) such as Kurt

Fishcher (Fischer, Hand, & Russell, 1984), Juan Pascual-Leone (1984), and Michael Commons (Commons, Richards, Ruf, et al., 1984). Adopted in this study, as it is traditionally defined, develop stage is "a new organization, whether psychological, biological, or social, that is 'higher' or more mature than the last" (Stevens-Long & Commons, 1992, p. 22).

Development stage 10–Formal: The last defined Piatian stage, characterized as logical, employing empirical or logical evidence in coordinating "if… then" relationships connecting two abstract variables.

Development stage 11–Systematic: At this postformal developmental stage elements of abstract systems cooperate and, thereby, construct multivariate systems. Relationships are considered in context.

Development stage 12–Metasystematic: At this stage there is collaboration of formal systems and, thereby, construction of supersystem, muti-system or metasystems. Metasystems are formed from a system of relationships.

Domain: Similar to the general definition of domain, "a field of thought or activity," as adopted for this study it is defined as the "generalization of sets of tasks… [that] are abstracted properties of sets of tasks" (Richards & Commons, 1984, p. 94); "A set of tasks that share certain qualities in common. Such tasks are similar in both their actions and the objects acted upon (content)" (Commons, Goodheart, Miller, & Danaher-Gilpin, 2005, p. 22).

Dynamic systems theory: "The qualitative study of differential equations" (Norton, 1995, p. 46) which "describe the way systems change continuously over time" (Gleick, 1987, p. 46).

Dynamical systems: A body of mathematics. It describes a system, the state of which changes as a function of time.

Executive, senior-level: Active policy makers of the firm.

Executive, upper/middle/lower: Heads of functional departments through general managers.

Executive development: The process by which an ordered change in complex reasoning ability in forming relationships between ideas and concepts is brought about, including that of informal experiential learning (*e.g.*, increasing workplace demands such as progression through organizational positions), and formal experiences (*e.g.*, seminars, workshops, courses).

Hierarchical Complexity Scoring System (HCSS): The scoring system developed as a complement to the Model of Hierarchical Complexity (Commons, Goodheart, et al., 2005).

Hierarchical complexity: Commons' (see 2005, pp. 7-8) description is adopted for this study, namely that the hierarchical complexity is a mathematical representation of the complexity of a task, the subtasks of which are carried out in a specific order. Also referred to as vertical complexity, it refers to the number of recursions that the coordinating actions must perform on a set of primary elements in order to successfully complete the task.

Intellectual behavior: A way of acting, reacting, or functioning (reasoning) in a specific and recurring way or characteristic pattern of observable actions reflecting responsive complex reasoning to internal or external motives. It is posited as the operational definition of intelligence (Haken, 2003b) and is linked to cognition relative to behavioral decision theory.

Intelligence: Described by 52 researchers in the field as "a very general capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience" (Deary, Spinath, & Bates, 2006, p. 690), it is the faculty of thought and reason; the ability to learn or understand or to deal with new or trying situations

Model of Hierarchical Complexity (MHC): A method of examining universal patterns of development that are based on a General Model of Stage Theory (Commons & Richards, 1984a, 1984b; Commons, Richards, & Armon, 1984) which, in turn, is based on the hierarchical complexity of mathematical models (Coombs, 1970). The order of stages in accordance with MHC are "hard distinct stages varying only in the degrees of hierarchical complexity" (Commons, Goodheart, et al., 2005).

Neuroplasticity: The ability of neurons to change the way they behave and relate to each other (Cozolino, 2002), make new connections (Cain, 2001; Katz & McAllister, 1999; Katz & Schatz, 1996), and bring about observable cognitive change (Schwartz & Begley, 2002; Schwartz & Beyette, 1996).

Organizational leader: For this study, leader is defined as an executive-level individual who assumes ultimate authority over and responsibility for entire business entities or major divisions of such, including aspects of culture creation or management (see, e.g., Schein, 1997, p. 5), with a definitive set of "followers" (see, e.g., Kouzes & Posner, 1987, pp. 30-31). Recognizing that leaders may exist throughout the organization (Decrane, 1996), this study will include those executives that have advanced through various levels of defined organizational responsibility and are, then, identified by formal executive-level organizational positions (*e.g.*, the organizational chart, job descriptions).

Paradigmatic representation: Proposed by Hermann Haken (1983, 1984), it is the notion that one system can represent another (see Haken, 2003a). It has been mathematically established (Le Van Quyen, 2003, p. 77; citing research by Taken, 1981) that "meaningful references about underlying dynamic structure" that are, themselves, un-measurable can be discerned via an observable variable of an associated system.

Phase shift: The nonlinear, discontinuous transition behavior of a system through state space (defined below).

Postformal development: While some contend that Piaget did not neglect development past his theorized stage of formal operations (see, *e.g.*, Lourenco, 1996), many contemporary development theorist contend that there are developmental stages that progress past that described by Piaget and Inhelder (1958) as an endpoint in development. These are described, therefore, as *postformal* operations (see, e.g., Fischer, et al., 1984; Richards & Commons, 1984; Sternberg, 1984). This study incorporates the notion of such postformal development stages.

Recursion: The process by which the output of the lower-order actions forms the input of the higher-order action.

State space: A mathematical construct of a multi-dimensional plane which, according to Thelen and Smith (1994), constitutes "an abstract construct of a space whose coordinates define the components of a [dynamic] system" (p. 56). It is the collection of all possible values for the variables for the state of a dynamic system (see introduction in Norton, 1995).

System: A bounded set or structure that has organized, interacting components exhibiting order, patterns, or purpose that, according to von Bertalannfy (1969), satisfies three conditions: a) the behavior of each element has a behavioral effect on the whole, b) the behavior of the elements have a consequential, interdependent, and relational effect on the whole, and c) while subgroups of elements have an effect on the whole, none has an independent effect (see expanded description in Skyttner, 1996).

CHAPTER TWO: LITERATURE REVIEW

Literature Review Organization

Our general hypothesis is that as the organizational executive experiences disparate and various developmental circumstances throughout their careers there results a sequential movement in the order of hierarchical complex reasoning stages. This notion forms the framework upon which I structured the literature review.

I sought to systematically segregate out from the scholarly discourse the integral hypotheses that constitute this general idea. As well, I sought in the literature review to more fully understand the opinions and ideas relative to the questions "Can such development be measured?" and "What are the contributing experiences to the development?" To explore this, the literature review is organized in two parts: Part I, intended to be foundational, informs the reader of the general discourse in the area of executive development. Part II is a study-specific review of literature relevant to cognitive development, both the measures of and contributing experiences of development.

Part I is organized in three sub-parts. First, sub-part one is an exploration of the general concepts of development and the notion that executive development is evolving into greater importance. Various foundational rationales are explored upon which this sub-part is constructed. Second, sub-part two is that the effective assessment of this development is equally important. Third, sub-part three explores the psychological dimensions in which development is made manifest in the organizational setting. The research instrument vignettes incorporate this notion.

Part II is organized in three sub-parts. First, sub-part four is a conceptualization of stage-like cognitive development. Second, sub-part five is an exploration of the current state of cognitive stage measurement. Discussed within this section are various methodological issues such as employed terminology, use of performance-focused assessments, and environmental aspects of the measurement processes. Finally, sub-part six is the concluding argument.

Lastly, the presumption of the hypothesis and the research question is that the current state of executive development measurement is inadequate. Underlying aspects of this sub-part are explored, including the oft-switched terms of "development" and "training" and the consequential impact to development program design, delivery, and employed assessment methodologies. The conclusion is the notion that there is a need for improved executive development measurement that is a) linked to cognition, b) is separate from performance measures, c) that reduces biases borne of performance-based ties to domain, context, and culture, and d) forms an absolute scale. This forms the framework upon which is constructed the research hypothesis and research question.

Part I: Foundational, Executive Development

Sub-part 1: Importance of Executive Development

General Conceptualization of Development

As Lockman (2001) contended relative to earlier cognitive development concepts, they were meant to "serve as a window onto the origins of symbolic thinking, means-ends problem solving, spatial knowledge, self-environment differentiation and so forth – in short, cognitive capacities." Stevens-Long and Commons (1992) spoke to this "orderly change" in an individual's complex reasoning ability in forming relationships between ideas and concepts. General concepts of development are constructed on foundational concepts of cognition (*i.e.*, thinking, reasoning).

Executive development is similarly about cognition. Jackson, Farndale, et al. (2003) found in their exploration of executive development that it results in "high levels of cognitive skill" or, as McClelland (1993) explained, it must lead to "a visionary who must think in more abstract terms." Reflective of this, Galagan (1990) reported that a survey by the Board of Governors of the American Society for Training and Development (ASTD) found that development practitioners believe that executives must change mindsets (a person's frame of reference that is fixed) or, as defined by Mroczkowski, Linowes, et al. (2002) in their study of changing mindsets, their "mental associations."

The notion of changing cognitive ability coincident with development is what Garavan, Barnicle, et al. (1999) spoke to relative to developmental trends which point to the need for the executive leader to *think* in terms of a multicultural and transnational perspective. Part of this development is suggested to include changed *thought process* toward a systems orientation (Limerick & Cunnington, 1989) which is also the theme Senge (1990) spoke to relative to the "learning organizations" when he suggested the need for managers to "start *thinking* in terms of the systems archetypes"(p. 95) [italics added]. A review of the scholarly literature suggests that the notion of development is inextricably linked to that of improved cognitive ability and that it is of increasing importance.

Beyond the expected aspects of education, the literature suggests that experience plays a critical role in development, including that of support (Bernthal, Cook, & Smith, 2001), coaching (Cramm & May, 1998), mentoring (Walsh, Borkowski, & Reuben, 1999), or a friend's feedback (Guinn, 1999). Each of these experiential aspects is theorized to aid in deriving meaning from the experiences.

Research suggests that development results from the "seamless" integration of multiple factors that includes education and experience (Bernthal, et al., 2001). Ballou and colleagues (1999), in their study of 53 advanced professionals, found that development is most powerfully accomplished with the "action-learning" combination of experiences and education. Vicere, Taylor, et al.'s (1994) and Vinere (1998) research has shown that executive development will continue to rely on action learning which incorporates experience-based methodologies, or as others refer to as (Seibert, Hall, & Kram, 1995) "experience-based" learning.

Importance

Rausch, Sherman, et al. (2002) contended that there is widespread criticism of executive development. Within the scholarly literature there is a call for improvement (see, e.g., Limerick & Cunnington, 1989; Temporal, 1990), including expanded employee participation and enhanced program content (Saslow, 2005). Cairns (1998) identified six trends in her interviews conducted in 200 companies:

1. Processes to align executive development to the business objectives,
2. The parallel development of individuals and learning organizations,
3. The development of critical individual competencies,
4. The creation of a select but comprehensive menu of development options,
5. The development of global partnerships, networks and alliances,
6. The creation of competitive advantage through learning.

The scholarly discourse suggests two principal reasons to call for improved development: organizational (survival) and individual (expanding organizational demands). Temporal (1990)

links executive development with the viability of the organizations in which the development takes place where, as Leitch and colleagues (1996) suggest, "learning is central to the survival and growth of all organizations." Shen (2005), expanding this notion, contended that this is increasingly an international phenomenon. Therefore, executive development is seen as a critical precursor to the future of the organization.

Also, some contend that organizational restructuring in past decades, and the consequential reduction in the number of managers, has fostered a greater demand for effective development for the remaining staff (see, *e.g.*, Bickerstaffe, 1985). There are fewer individuals with greater and more diverse challenges. Therefore, development is also tied to the individual's ability to survive in a changing workplace. No studies reviewed for this research indicated anything other than an emerging increased need for development. Coincident with the need for improved development, as suggested by Tulloch (1989), there is a parallel need to improve development measures.

Hypothesis 1:
Executive development leading to the acquisition of higher stages of complex reasoning positively correlates with a combination of education and experience.

Sub-part 2: Importance of Developmental Measures

Most reviewed accounts regarding executive development make reference to an associated need to assess the effectiveness of the development activity. Bedinham (1998) spoke to the "holy grail" of development measurement in that such measurement has always been important in development activities and, further, that there has always been a quest to determine a means to effectively execute it. However, the literature suggests some confusion with the appropriate methodology.

Brown (2003) contended that there has "been little development of conceptual frameworks to inform a more rigorous understanding and evaluation" of development. The scholarly discourse related to development measures seems to bear this out. Most of the referenced assessment methodology falls within the distinctly different categories of quantity of development activities, individual performance measures, organizational performance measures, or, as explored earlier, that of personal qualities and characteristics. As an example, Bernthal, Cook, et al. (2001) spoke to the dominate development measurement area as that of the "how many, how much" approach whereby post-development assessment is linked to the quantity of development activities to which the executive is exposed. Presumably, more activity ensures development. So, input is used as a correlate to outcome. This may be an attempt to link development activity, as Mayo (2000) suggests, to the "intangible assets" of the organization: developed employees.

Similarly, development assessment is frequently linked with individual outcome measures. This is illustrated by Burke and Collins' (2005) research where they found a transfer of skills via executive development, which is indicative of an employee-level skills assessment strategy. Rausch, et al. (2002) concluded in their research that "effective management programs, [require] a widely accepted definition of management competencies, specific enough to allow meaningful outcome assessment." Again, development is linked with skill enhancement.

However, others who link development measures with individual performance argue against a skills-based methodology. Lee (1999) contended that there has been insufficient emphasis on the psychological dimension of contemporary work environments. She citeed as

one element of development assessment the "confusion and lack of psychological knowledge" in understanding "development as psychological development." In her scheme, then, assessment would move from one of skill-based to one of psychology-based.

Finally, executive development assessment has been linked to organizational outcome performance such as profit (Landale, 2003), business strategy (Cannon, 1995), and motivation and self-efficacy (Bernthal, et al., 2001). However, a study of 179 European firms across six countries (Mabey & Ramirez, 2005) found there is little empirical evidence that executive development correlates to organizational performance. Organizational performance measures are, then, a failed assessment methodology for executive development.

Therefore, the importance of adequate assessment of executive development is revealed by the repeated references in the scholarly discourse.

Sub-part 3: Psychological Dimensions of Measurement

Adequate post-development assessment will be framed by the psychological dimension in which the developed complex reasoning ability will be made manifest. Therefore, a review was conducted of the theorized dimensions of organizational tasks, the environment in which the executive develops. Considered in this review was the notion that the executive is often referred to as an organizational leader (Barner, 2000; Kathman, 1989; Myrsiades, 2001; Olshfski & Jun, 1989; Stumpf & Mullen, 1991). Also, the psychological dimensions–as shall be explained in the remainder of this section – include those of *aware, accept, attune, act,* and *align*. While the focus of this study is on the executive, these psychological dimensions are theorized to be reflective of all organizational levels.

As mentioned previously, the topic of *leadership* often falls narrowly into topical areas of qualities, characteristics, personality, or behaviors examining, as Gardner (1995) explains, the specific context of power, politics, policies, and practices. Decrane (1996) contended that such qualities constitute a "*de facto* set of core leadership competencies" that remain constant throughout time and across domains. Mendonca (2001) suggested that leadership is, by definition, a set of role behaviors. It is interesting and important for this exploration of development measures to note, however, that Bonnstetter posited (2000) that experts cannot agree on what an executive leadership competency is, and further that to suggest that there is such a thing as a defined set of competencies is heresy. In that a definitive set of competencies cannot be established, he suggests that any post-development methodology based on them will be flawed.

Clarity into the topic of the psychological dimensions of organizational tasks may be afforded through the perspective of systems theory (see, *e.g.*, von Bertalanffy, 1969). Specifically, that many elements must be in interrelationship and mutually influence one another to result in the phenomenon called *leadership* or, more generally, as proposed here, executive complex reasoning. For proper analysis, then, each constituent element has to be examined. However, it is the dynamic of their interrelationship and the resultant patterns that is of specific interest in this study; it will be exploited in the methodological approach to this research (*i.e.*, utilized in the design of sequentially more complex vignettes). Each element is explored next in order to inform the reader into the foundational logic incorporated in the design of the research instrument vignettes.

Hypothesis 2:
Executive development can be examined by focused examination within the theorized psychological dimensions of organizational tasks.

Aware

Gardner (1995) argued that the seed of leadership is planted in need, in great challenges, opportunities, and causes; Boulais (2002) explains that it is the stuff of legend. Whether causes of "perceived-inequity" or "search-for-excellence" (Work, 1996, p. 74), Gardner (1995) contended that the leaders profiled in his study were aware of the circumstances in which they found themselves. His account of Eleanor Roosevelt serves as an apt model for this, consciously embracing many causes (p. 197) as does Martin Luther King, alert to the fact that he was "propelled" into a position of influence in the civil rights movement of his day (p. 223). Quinn (1996, p. xiiii) suggested, however, that leaders may evolve an awareness that they are "surrounded by circumstances that seem to demand more than… [they can] deliver."

Handy (1996) posited that leaders are borne of such demanding causes; "Perhaps none of us knows our true strength until challenged to bring it forth" (Kouzes & Posner, 1987, p. 322). Leaders as "pioneers" (Ulrich, 1996), engaged in "path finding" (Covey, 1996) are alert for opportunities to lead. Bardwick (1996) suggested that the leader may understand the issues better than anyone else. Supportive of this notion, Kouzes and Posner (1987) suggest that leaders "must use their 'outsight' staying sensitive to external realities"(p. 45). However, such evidence awareness is not isolated to the executive level, but rather as posited by self-actualization assumptions serves as a motivator, permeating all levels in the organization (see Schein, 1980, pp. 70-72).

Accept

As explicit in religious studies, leader acceptance of the leadership positions can be difficult. Moses was adamant that he was not suitable for leadership, even questioning God's rationale (Bible, 1984 Exodus 3:11 - 4:17). Aslan (2005, p. 37) extended this phenomenon to Mohammad, promoting that as prophets before him he wanted nothing to do with God's calling. Aslan explained that he was so despondent about God's command for him that his first thought was to kill himself. Fortunately for two of the world's great religions, these leaders ultimately accepted leadership with great conviction.

Acceptance is critical. Gardner (1995) illustrated this in many leaders, especially Eleanor Roosevelt who's effectiveness is attributable, in part, to her conviction and acceptance of her role. The leader's acceptance seems to energize them, adding energy to the system. The key condition by which this is accomplished is in the process of energy flow. Thelen and Smith (1994) explain, as Bertalanffy (1969) argued in the 1960s, that biological systems defy the second law of thermodynamics. Referencing Prigogine and Stengers (1984), they explained that dissipative structures maintain equilibrium by drawing energy from a high-energy potential, using it to do work, and then dissipating some of the energy back into the environment. Systems, as Kelso explained (1995, p. 4), that are in a state of thermodynamic equilibrium are "as dead as anything can be." These "living" complex systems meet two criteria:

1. System components can interact in nonlinear and nonhomogeneous fashion;
2. In accordance with dissipative dynamics these systems exists far from thermodynamic equilibrium.

External conditions with sufficient energy drive a system from equilibrium. The resultant end state is, then, a drastically altered macroscopic state of the system. As Kelso defined, self-organization is "the spontaneous formation of pattern or pattern change that arise due to nonlinear interactions among the components of a system" (1995, p. 260). The self-organized end state is a function of the collective action of the individual elements until their behavior dominates and governs further behavior. This is supported by Kelso's research (1995). He explained that the coordination of the constituent parts of a system will, in turn, feed back and influence the behavior of the parts. Kelso refers to this as "circular causality" (1995, p. 10).

Attune

The leaders presented in Gardner's (1995) study prepared themselves and their constituency for the task at hand. This was a critical consideration in the design of my research instrument vignettes; I specifically used language suggesting "vision" in the wording of the vignettes. Maxwell Maltz (1960) taught that both imagined and lived experiences are treated equally as true by the brain; it reacts automatically to provided information. The leader, perhaps unknowingly, uses this concept as they "reinvent" themselves and prepares the followers through a shared vision, both explored next.

Reinvent Self

Executive leaders attune themselves for the presented organizational challenge through development. Some suggest that leadership is learned by doing or watching (Stringer & Cheloha, 2003). There is great importance on the leader changing self in order to change the greater system. Quinn (1996) suggested that self-change is necessary before leading change in the organization (p. 156), the culture (p. 103), or the world (p. 9). Executives are frequently referenced relative to how they "reinvent" themselves in preparation for leadership (R. E. Quinn, 1996, p. 11, 66) (see e.g., Gardner, 1995, p. 185 relative to Eleanor Roosevelt and Martin Luther King). Such reinvention comes about in the process of resolving life's issues (Gardner, 1995, p. 15), what Quinn called the "hero's journey" (1996, pp. 41-49). Exhibiting courage to leave the comfort of known roles, behaviors, "life scripts," and "reinvent" one's self, the executive leader repeats "core stories" that are central to their emerging identity (R. E. Quinn, 1996, p. 67).

Vision

Leaders "reflecting upon our past may enhance our ability to be forward-looking" (Kouzes & Posner, 1987, p. 107) illustrating Gardner's (1995) concept of "stories" and the need to address the concerns of "past and future" (p. 50). Leaders, perhaps subconsciously, construct a visionary story by which they lead (see, e.g., Kotter, 1997, pp. 197-209). As Kouzes and Posner contended, "past is prologue" (1987, p. 106) in that one's ability to envision the future is, in part, a reflection of past experience. This vision of what is possible centers the follower on "what we're here for, what our priorities are, and where exactly we're headed" (see also Kotter, 1996; McFarland, et al., 1994, p. 111). Through their vision the executive leader helps their followers "dream new dreams" (R. E. Quinn, 1996, p. xii), to see what is possible, orient themselves accordingly, and to "struggle for the shared vision" (Kouzes & Posner, 1987, p. 30). The leader's vision paints a clear picture of things doable, powerful, and believable (Kotter, 1996).

Act

There are two principal ways in which the executive leader may act: empowering others and taking personal and professional risk. Both are explored next.

Empowerment

The very concept of "system" suggests that the leader cannot act alone. The executive is but one element in a dynamic, interrelated system. Others must be involved in the enterprise. This concept takes on many titles in executive and leadership literature. Some refer to it as "participatory management" (dialogue with Reuben Mark in McFarland, et al., 1994, pp. 68-69) or "decentralized leadership" (dialogue with James E. Burke in McFarland, et al., 1994, pp. 77-78). Quinn (1996, pp. 221-228) spoke to "empowering' others, Kouzes and Posner (1987, pp. 151-178) to "enabling" others, and Conger, et al. (1999, p. 358) as "shared ownership" with others. All, however, give voice to the same underlying concept: The executive leader brings followers into action in order to achieve change (see "empowerment" discussion in Kotter, 1996). This notion is specifically incorporated in the research instrument vignettes.

This shift from "position power" to "people power" is founded on the idea that the followers are closest to the situation and know how to handle it (see, e.g., McFarland, et al., 1994, pp. 63-92). It, then, recognizes the expertise that exists within the constituent elements of the system. It also reflects General Systems Theory (von Bertalanffy, 1969) and the foundational principle that the system's end state is a function of the collective action of the individual elements until their behavior dominates and governs further behavior. One can expect that while "position power" may elicit response, the system behavior will not be as sustainable when the followers have a respected position within the system (*i.e.*, system's self-organization). This is a notion supported by Kouzes and Posner (1987) when they suggested that followers be given ownership of and responsibility for their work (p. 181).

There are two fundamental issues relative to employee empowerment that must be successfully addressed: The executive's ability to affect such a shift in "ownership" and the competencies of the followers brought in to "share" leadership. McFarland et al. suggest that leaders, to engaged in empowerment, only need to "realize" the need (1994, p. 84). However, realization alone will not promote development and its associated improved cognitive ability; fundamentally, realization alone cannot shift cognitive patterns as necessary to effect the necessary belief change and, therefore, behavior. If such realization were enough psychotherapy would be a much easier task (see, *e.g.*, Cozolino, 2002). Significant research suggests that these cognitive patterns may be altered (see, e.g., Kelso & Zanone, 2002; Thelen & Smith, 1994). Some contend that such shift may be self-initiated by the conscious act of the individual (see, e.g., Schwartz & Begley, 2002; Stapp, 1993). No research reviewed for this paper suggests that "realization" *per se* is enough to provide a psychological state that would reasonably be expected of an individual to shift a long-held behavior (*e.g.*, that of not empowering followers). There has to be effective development in order to change long-held beliefs relative to roles and responsibilities.

The second fundamental issue relative to empowerment is the requisite capabilities of the followers. As McFarland et al. (1994) contended, while empowerment may be "triggered" by the leader-provided vision (p. 100), realization of empowerment is a function of educated people (p. 67). Gardner (1995) supported this notion when he stated that viable members must themselves attain a level of expertise within the domain (p. 30).

Risk

Gardner (1995) recognized that basic behaviors exhibited by leaders is taking risk and challenging authority (p. 75) (see, also Pollard, 1996, p. 241). History suggests that leaders do not accept the status quo, but rather, as Quinn recognized of executives, they "take some significant risk" (1996, p. 5). This is repeatedly revealed in Gardner's (1995) examination of great leaders. There, as an example, he chronicled how Martin Luther King accepted the ultimate risk, death, in order to continue leading the civil rights movement of the 1960s (pp. 218-219). Challenging authority, some suggest as a "marker of leadership" (Gardner, 1995, p. 25), reflects that "waiting for permission is not a characteristic of people who get extraordinary things done" (Kouzes & Posner, 1987, p. 251). Quinn (1996) suggested that the leader's ability to take risk is linked to their self-confidence. This seems to be the foundational leadership trait involved when authors speak relative to risk taking that the leader has to do so "willing" (Gardner, 1995, p. 74) and be "not afraid" to do so (dialogue with Rieva Lesonsky in McFarland, et al., 1994, pp. 187-188).

Align

Ultimately, leadership is a relationship (Kouzes & Posner, 1987), bonded by the common needs of the executive and his/her followers (Gardner, 1995). To influence the behavioral patterns of a leadership system, executives will need to align followers to the envisioned end-state. This is realized in communication and role modeling, both explored below.

Communication

An executive's communication with followers is central to the notion of effective leadership (Kotter, 1996). Gardner (1995) explored this in-depth in *Leading Minds*, framing such communication as "stories." Others hold the same view. Experts recognize that leadership is maintained through the creative (Gardner, 1995) and ritualized (R. E. Quinn, 1996) telling of core stories. Kouzes and Posner contended that doing so must be accomplished with "vivid language and an expressive style" (1987, p. 11). Quinn, Mintzberg et al. (1988) expanded this notion holding that "symbolic communication" creates vivid mental images for the executive's follower(p. 125). Such emotion-laden language most probably touches the heart of the "self-identity" issue that Gardner speaks to relative to the leader's stories and as Kouzes and Posner (1987) suggested, "our need to survive" (p. 39). Through communication, leaders flame the fire of emotion not solely walk the icy logic of the intellect.

Model

Gardner (1995) suggestd that "telling" a core story is important; however, "embodying" it is critical. This notion is supported by all reviewed executive and leadership authors. Relative to this, Quinn, Mintzberg et al. spoke to what leaders are–"role models" (1988) and Kouzes and Posner to what effective executive leaders do–"model the way" (1987, p. 13). The old adage "walk the talk" captures this notion. Quinn, Mintzberg et al. (1988) contended that it is the leader's actions, not words, that ultimately sends the follower a message. Kouzes and Posner suggested that there is power in the leader's example (1987, p. 220) echoing Stephen Covey's assertion that leaders live their best value system "so they are very powerful models and mentors" (McFarland, et al., 1994, p. 194).

There has been significant research into aspects of executive development. Most, as reviewed in Part I, center on improved skill, abilities, qualities, or characteristics. However, few

studies center on improved cognitive ability and, therefore, few measure cognition. They rely instead heavily on demonstrated performance that is assumed a correlate of developed underlying cognitive abilities.

Up to this point I have explored the foundational literature relative to executive development. Specifically, explored in sub-part one was the notion that executive development is growing in importance. Outlined in sub-part two is the notion that the measurement of executive development is similarly increasing in importance. Lastly, in sub-part three, the multiple psychological dimensions of organizational tasks were explored relative to their importance in the executive's complex reasoning and their use in the design of my research instrument. They form the framework upon which my vignette-based research instrument is constructed. Next, in part two of the literature review, is an exploration of cognitive stage development and multiple aspects of its measurement.

Part II: Study-Specific, Cognitive Development Stages

Sub-part 4: General Conception of Cognitive Development

Macroscopic behavior (individual, group, organization, and social) is a function of microscopic system dynamics (neural networks, brain activity, cognitive patterns, belief systems, and consciousness). Relative to this study, it follows that intellectual behavior such as complex reasoning is a function of development in accordance with the neurological basis for learning (see, e.g., Changeux & Konishi, 1987). This line of research in developmental neurocognition or dynamical cognitive science rests upon the foundational research of Donald O. Hebb (1952), father of cognitive psychobiology (see, *e.g.*, Kolb, 2003; Milner, 2003).

Neural Network

Hebb's primary interest was that of understanding the mechanism by which the brain perceives the world (Kolb, 2003). Emerging from this early work is the recognition that all learning entails physiological changes to the brain, most significantly that of the synaptic structure (see, e.g., Kolb, 1995; Kolb & Whishaw, 1996), even that associated with psychotherapy (Cozolino, 2002). An important note relative to executive development is that this was a contradictory notion from that previously held, namely that such synaptic changes could occur only during early development (Gould, Reeves, Graziano, & Gross, 1999). Hebb postulated a means by which synaptic assemblies could be changed, what is contemporarily referred to as neuroplasticity (e.g., Cain, 2001; Shaw & McEachern, 2001a). His postulate, variously called *Hebb Rule* or *Hebb Synapse* (Milner, 2003), made a significant impact in research on the underlying neural mechanism of learning (see, e.g., Carew, Hawkins, Abrams, & Kandel, 1984; Changeux & Konishi, 1987). While the exact mechanisms for and nature of neuroplasticity remains an on-going discussion (see, e.g., Shaw & McEachern, 2001b), the general notion that the brain physiologically changes with learning is not (see, e.g., Changeux & Konishi, 1987; Cozolino, 2002; Kolb, 1995; Schwartz & Begley, 2002). Therefore, executive development is positively correlated to neurological change.

Cognitive Patterns

Gerald Edelman (1988, 1989, 1992) expanded Hebb's earlier work with his introduction of the *Theory of Neural Group Selection* (TNGS) (see expanded discussion, Edelman, 1989, pp. 239-252). Most notably Edelman (1989) credited Hebb with providing researchers with a neurophysiological perspective of psychology that, in his insightful words, "could have remained

unrelated to brain structure [if not for Hebb]" (p. 38). Cognition emerges from coordinated activity of multiple neurological assemblies, a concept of *embodied cognition* (see origins for in Thelen & Smith, 1994, pp. 321-327). It is theorized that cognitive development and neural-network growth are "two aspects of the same fundamental development process" (Fischer & Rose, 1999, p. 208). This is the concept of how the resultant *brain maps* or cognitive patterns coordinate by way of *reentrant signaling*, whereby repeated synaptic firing reinforces and strengthens these neuronal connections. In Edelman's (1992) words, the neuroanatomical "primary repertoire" is a function of dynamic development processes that are unique to a species, while a "secondary repertoire" of neural connections is a function of experience (see section "Neural Darwinism" in Edelman, 1992, pp. 81-98). This is the elemental premise of all executive development. Therefore, neurological change positively correlates with cognitive patterns.

Intellectual Behavior

TNGS, variously referred to as "neural synchronization" (Velde & Kamps, 2002) or "complementaries" (Lewis, 2002) facilitates strengthening the coupling of active neuronal groups and allowing to atrophy those of competing, less active neural structures. This forms the basis for cognitive patterns and the characteristic physical and intellectual behavior. As Thelen and Smith (1994) explained, TNGS "fits my basic requirement for a plausible account of ontogeny: that there be no homunculus in the brain or in the genes directing the process [of ontogeny of cognition and action]."(p. xxi) Development, then, is the experientially-driven self-organization of multiple neuronal assemblies giving rise to intellectual behavior (Lewis, 2002). Therefore, cognitive patterns are positively correlated to intellectual behavior. Further research is needed in this area to further inform research into executive development.

Development of Intellectual Behavior

Brain organization will adapt to and be changed by personal experience and environmental stimulus (Kolb & Whishaw, 1996). Such "input" has been proven to change neuronal network connections and bring about psychological change (e.g., obsessive-compulsive disorder discussed in Schwartz & Begley, 2002), physical coordination (Bressler & Kelso, 2001; Hock, Kelso, & Schoner, 1993), social coordination (see Kelso, 1995, pp. 93-94) and in stress-retarded activity-dependent foundational neuroplasticity of behavioral change in those suffering with post-traumatic stress disorder (PTSD) (on-going research, see Department of Defense, 2003). Therefore, it is posited that manifest intellectual behavior (*e.g.*, complex reasoning) is a function of neurobiology and the emergent properties of a complex cognitive system (Gerrans, 2004). Most of this research, facilitated by measurement of physical behavior, has been explored relative to and been found reflective of underlying dynamic cognitive patterns with manifest phase transition in state-space (see expanded discussion in Kelso, 1995; Thelen & Smith, 1994). Thelen (see 2003, p. 40) contended that stage development is one perspective of what she refers to as lifespan continuity of "dynamic grounding of cognition." The notion of stage, then, does not negate that of continuous development suggestive of dynamic systems theory, nor, conversely, do the properties of dynamics negate stage-like development. It is, rather, that each focuses on a level of abstraction that substantiates the given theory. An objective parallel review suggests that they are at least complementary if not two views of a single phenomenon. Therefore, the phase transition of cognitive patterns in conceptual state-space is that reflected in

transition between the theorized developmental stages of complex reasoning, such as that of executive development.

Hypothesis 3

Executive development correlates with higher stages of complex reasoning.

Sub-part 5: Limitations with Current Stage Measurement

Measurement Distinctions

A principal objective of the research proposed here is to demonstrate that executive development can be measured as a function of the intellectual behavior that is exhibited in task complexity. Further, that it can be measured without direct reliance on notions linked to domain, context, and culture. And, further still, that the measurement can be conducted in such a way as to incorporate the theorized dimensions of the workplace tasks. Identification of an adequate methodological concept was facilitated by a literature review, mapping the scholarly discourse in cognitive development (executive, leader, manager, employee, worker, and adult) to the methodological procedures employed in the research. As explored earlier, the scholarly discourse related to development suggests that there are three types of difficulties associated with typical measures, namely that they are: domain-, context-, and culturally-biased. The commonly applied methodological approach for development assessment, then, has one or more inherent deficiencies. Therefore these measurements are not suitable for this study.

Other executive development measurements are similarly not suitable. These center on such development aspects as personality using instruments like Myers-Briggs personality index (see, e.g., Davey, Schell, & Morrison, 1993), and intelligence using such instruments as Daniel Goleman's (1995) emotional intelligence (EI), the EI competency assessment (see, *e.g.*, Kunnanatt, 2004), and IQ tests (Harari, 1997; J. B. Quinn, Anderson, & Finkelstein, 1996). This notion was examined earlier, illustrative in the workplace analysis of leadership. Stated there, research typically centered on qualities, characteristics, personality, or behaviors (Gardner, 1995). Therefore, these approaches do not address the fundamental concept of cognition as required of this study. They were not considered further as potentially applicable.

Also, much of the cognition-related research (*e.g.*, complex reasoning, critical thinking, or cognitive development) that was identified in the literature review for this study was found to be based in infant or child development, for example birth weight and childhood cognitive development (Tong, Baghurst, & McMichael, 2006), the effects of perinatal HIV infection on cognitive development (R. Smith, Malee, Leighty, & Brouwers, 2006), and breast-feeding influence on cognitive development (Daniels & Adair, 2005). Therefore, similarly, it is not suited for this study, one centered on executive (adult) development.

As further examples, of 76 studies identified in a multiple research database review, where the search was conducted by document title incorporating the terms "abstract reasoning" OR "critical thinking" OR "cognitive development," none were associated with the workplace (*e.g.*, business, company, employee, manager, or executive). Three (3) of the 76 were identified as associated with the term "adult." However, these were studies centered on adulthood consequences of childhood period development, such as Feinstein and Bynner's (2004) exploration of middle childhood development and adult socioeconomic status, mental health, and problem behavior and Rauscher's (Rauscher, 1997) review of the future importance of preschool music.

Measurement Method Critique

Therefore, exploration continued for instruments that afford an adequate measurement methodology in three aspects: a) facilitates a view of executive (adult) development, b) allows for incorporation of the multiple psychological dimensions of work, c) structured in such a way as to mitigate or eliminate the inherent biases in domain-specific, context-specific, or culturally-influenced instruments. This review included those which Dawson (2004) posited have exhibited "empirical evidence of correspondence between levels," specifically Colby and Kohlberg's (1987) Standard Issue Scoring System (SISS), Armon's (1984) Good Life Scoring System (GLSS), Dawson's (2004) Lexical Abstraction Assessment System (LAAS), and Commons, Ross et al. (2005) Hierarchical Complexity Scoring System (HCSS). This review was greatly facilitated by Dawson's (2002; 2003; 2004; Dawson, Xie, & Wilson, 2003) in-depth critique of each of these.

A principal criticism that Dawson has of both the SISS and GLSS is their dependence on domain. Commons & Richards (1984a), similarly, caution against such dependence. Armon (1984) vividly explained this dependence when she stated her "circular bootstrapping" methodology whereby she iteratively compared theoretical and empirical aspects within the dual disciplines of developmental psychology and formal ethics to development of the domain-specific GLSS. Her measurement system is embedded, then, within the constraints of a specific context. Such "circularity of domain-based developmental assessment systems," is what Dawson-Tunik, Wilson et al. (2005) cautioned against when attempting to assess an individual's stage of development. It constitutes a significant source of assessment problems. Prominent problems which arise from a domain-specific approach are twofold: performance measurement necessitates a "matching" link to predetermined, domain-specific scoring guide (limiting its use outside of the domain), and domain-specific scoring complicates cross-domain research (for expanded discussion of domain-specific problems, see Dawson, 2002, pp. 149-151).

Dawson, utilizing the generalized Rasch model of Random Coefficient Multinomial Logit (Adams & Wilson, 1996) which she explained "tests the extent to which different instruments measure the same latent dimension," found a great deal of correlation between the HCSS and that of SISS and GLSS. All of these methods adequately measure the order of hierarchically complex reasoning. Using data from 440 interviews (220 respondents with the following interview profile: 138 moral judgment, 147 good life, and 155 good education), identifying in each the "scorable statements," she calculated a HCSS correlation of .90 with SISS and .92 with GLSS. She interestingly noted that "there is less difference between these instruments than is often found between two administrations of the same instrument in other areas of psychological measurement" (Dawson, 2002, p. 162). However, she provided a narrowing note by her comment "HCSS is a more consistent method of assessing stage."

While LAAS is based on Fischer et al.'s Skill Theory (1984) and Commons' Model of Hierarchical Complexity, Dr. Commons (personal communication, December 1, 2006) contended that it lacks an underlying theory. LAAS has to be standardized for each content area, as well. Therefore, it similarly is not well-suited to this study. Therefore, further applicability review was narrowed to the Model of Hierarchical Complexity (Commons & Pekker, 2005) and its associated measurement instrument the Hierarchical Complexity Scoring System (Commons et al., 2005).

MHC and Stages of Hierarchical Complexity

The Model of Hierarchical Complexity (MHC) was developed by Dr. Michael Lamport Commons based upon the foundational work of Piaget. It is important to note in this regards that there is an active debate relative to Piaget's stage-like development (Lourenco, 1996). While some suggest heresy to do so (Cohen, 1983), there is a call for greater assimilation of Piaget's concepts into contemporary developmental psychology (see, *e.g.,* Chapman, 1992). This is the notion exploited by Dr. Commons. However, some contend that while Piaget did not exclude development after adolescence, that there is a final structure to it (see, *e.g.,* Lourenco, 1996). In this light, Lourenco explained that while the *content* of the stage continues to develop, it is the stage *structure* that is final; thus, continued development is characterized by the operative manner of the formal stage. Critical of postformal concepts, Lourenco seems to misinterpret and discounts the position of Neo-Piagetian postformal theorists, such as Dr. Commons.

It is the contention of these theorists that the reasoning process reflective of intellectual behavior that is employed after the stage of formal operation is distinctly different from that described by formal operations (see, e.g., Commons & Richards, 1984b; Jaques & Cason, 1994; Sternberg, 1984), and that it is distinguishable in discreet hierarchical stages (see parallel argument in Jaques, 1976, pp. 139-160). Koplowitz (1984) explained that "system thinkers" (MHC Stage 11, see e.g., Commons, Richards, Ruf, et al., 1984, pp. 136-137) comprehend the principles of the lower formal operational stage (theorized as MHC Stage 10); however, those at a "formal-operation" stage of development do not comprehend a systems reasoning stage that is characterized at a higher developmental stage. Therefore, higher stage development does not preclude reasoning that incorporates lower stage ability; however, lower developmental stages cannot construct the logic structure necessary to reason at higher developmental stages. So, whether a demonstrated ability (Sternberg, 1984), employed process (Luria, 1962), or evolved knowledge form (Piaget, 1950), all accounts of intelligent behavior have as central notion that of the ability to develop progressively more sophisticated constructs of complex thinking (M.L. Commons, personal communication, July 10, 2006).

Dawson (2003) has reported on significant work that supports the notion of levels beyond Piaget's formal operational, namely as explained by Fischer et al. (1984) that the successive developmental levels are reflective of one's increased ability to coordinate abstractions in progressively more complex relations. It is the complex reasoning, mathematically articulated, that Commons speaks to when he explains the mathematical theory upon which the Model of Hierarchical Complexity is constructed (Commons & Pekker, 2005) and which expands the concepts first articulated by Piaget. Further elaboration of the Model of Hierarchical Complexity, my research instrument of choice, is provided in chapter 3: Methodology.

Measuring executive development is inadequate and remains difficult (A. Smith, 1993). Dawson (2004) posited that many development measures are not practical, reliable, nor objective. This is reflected by the fact that Smith identified a principal factor in post-development measurement difficulty in selecting and integrating an adequate measurement methodology. As Dawson suggested, there are few. Evans (1999) illustrated paradoxically that even academia has difficulty constructing tests that adequately assess cognitive development. She explained that "educators still struggle with creating accurate tests for evaluation [of creative thinking]" (p. 616). There are attempts to provide guidance. However, much of the difficulty in doing so may be borne of the methodological issue of using incorrect terminology (language), giving rise to three types of difficulty: performance-based measures, domain-specific measures, and culturally-biased measures.

Methodological Issue: Terminology

While *development* is about cognition, conversely, Vassallo (2005) suggested that *training* is linked with performance. This is the same notion promoted by Endres and Kleiner (1990) when they suggested that training is simply a "*subset* of management development" [italics added]. Vassallo contended that "training concentrates on performance," which the American Society for Training & Development (2005) supports with their definition of training as the "planned experiences that are focused upon individuals learning specific skills that will normally be applied within a short period of time or almost immediately." The U.S. Government's Code of Federal Regulations (see, *e.g.,* Jacobs-Simmons, 2000) continues this theme with the definition of training as that activity necessary "to impart technical skills and information required to perform a specific job or group of jobs," again, linking training to performance. Confusing in the scholarly literature is the notion that while development is associated with cognition post-development assessment is typically linked to skill-based performance.

Some of the confusing disparity between developed cognitive ability and the acquisition of additional skills may arise by the inappropriate interchange of the term *development* for that of *training* and the subsequent action and practice relative to development program design, delivery, and assessment. Vloeberghs (1998) in his exploration of management development via a case-study of two large Belgian companies provided illustration of this phenomenon. He found that the companies were confusing development and training, using development as a synonym for training. Some practitioners, such as Efran (1986), similarly used this incorrect use of the terms when they speak to "integrated" development with a prescriptive focus on combining skills training with improved attitude and self-confidence (which are behavioral responses to a psychological object). Again, this conspicuously omits reference to cognition.

As well, research continues in this vein, as evidenced in the doctoral work of Phyllis W. Parrish (1986) at George Washington University in her management development research. Her academia-based research centered in *development* focused on the practical application of *skill* areas (*e.g.,* technical, human, and conceptual). Shen (2005) pointed to the "considerable gap between academic theories… and practices." This incorrect, synonymously switching of terms creates additional issues in the area of post-developmental measurement.

Difficulty: Performance-Based Measures

As mentioned previously, theoretical aspects of development are inextricably linked to thinking, to cognition. However, the practice of development tends to center on the performance-based acquisition of skills (suggestive of a training exercise) (see, *e.g.,* Holstead, 1988; McHale, 1995). Digman (1978) highlighted this notion in his in-depth study of 10 management development programs. He found that most narrowly define development as that "concerned with a person's job related skills." Similarly, Posner, Kouzes, and Manley (1988) found two principal considerations for development program design, both performance-based: relevant content and appropriate process. When end-users were queried, they discovered that subjects believed that the most significant issues that should be addressed in a development program are: "getting things done," "getting things done well," and "making things happen." Again, all are skill-based performance.

Many development measurement schemes rely on the aspect of changed competencies (see, e.g., Rodwell, 2005; Tovey, 1993) reflecting the misapplied training aspect of the endeavor and the resultant performance. Caird (1992), referencing McClelland (1973), went so far as to

argue that competency testing is a more valid development assessment than is any measure of intelligence. She further elaborated on an effective methodology by which these development-resulting competencies can be assessed: a) critical incident technique, b) job function analysis, c) behaviorally anchored rating scales, and d) action research approach. As the names imply, these tests are centered on manifest performance. Hrynkiw (1994), continuing a performance-based foundation for development assessment, further suggested that measurement should fall with the dimensions of skills, knowledge, and behaviors and Endres and Kleiner (1990) proposed the dimensions of emotional reaction, achievement of learning objectives, behavioral changes, and organizational impact. Conway (1994) continued this theme by suggesting that development assessment should center in seven key competencies (*e.g.*, managing for results, knowing the market, managing people, applying judgment, solving problems, planning for the long term, and being effective on an individual basis). However, these schemes conspicuously omit measurements of changed cognition (thinking), as the basic definition of development prescribes.

This notion permeates many development explorations. A recent online search of multiple research databases (including those dedicated to developmental psychology, cognitive development, and education) of the combined position-specific development subject terms (*e.g.*, management development) revealed that the associated subject search term of "skills" or separately that of "behavior" produced more "hits" than that of the five combined search terms of "thinking," "critical thinking," "reasoning," "abstract reasoning," and "cognition" (see Table 1).

Table 1
Subject-Based Literature Review

	Subject Search Terms	**Developmental Psychology**	**Cognitive Development**	**Education**
	"Management Development" OR "Executive Development" OR "Employee Development" OR "Worker Development"			
AND	"Skills"	142	105	162
AND	"Behavior"	146	127	90
AND	"Thinking" OR "Critical Thinking" OR "Reasoning" OR "Abstract Reasoning" OR "Cognition"	5	3	5

This is a vivid illustration of the popular view of development as skill-based competency enhancement and, consequentially, assessment centered on performance. While there is no agreement of what executive leader competencies are (Bonnstetter, 2000), nevertheless, executive development concentrates on them as the objective of the development process. There is, then, a variance between development (*e.g.*, ordered change in one's cognitive ability) and the measures of such (*e.g.*, substituting an assessment of demonstrated performance-reflecting skills and abilities). Even calls for improved development assessment (Tulloch, 1989) confuse the objective and the assessment (*e.g.*, "improved creative thinking" while measuring "units of demonstrated competence"). This leads to the following hypothesis:

Hypothesis 4

Executive development can be measured by the order of hierarchically more complex reasoning that is divorced from concepts of skill-based performance.

Difficulty: Domain-Specific Measures

Performance measures are necessarily linked to specific domains and contexts. Such a reliance necessarily leads to inherent bias in that, as Dawson-Tunik, Wilson et al. (2005) explained, there is "circularity" of development levels being defined in terms of the context in which they exists. As examples, Tovey (1993) suggested that the resultant development "must reflect the critical success factors of the company." Temporal (1990) argued that individual development must be linked to the organization's development and Hall (1995) to the organization's strategic functioning. Boodoo (1998) further argued that post-development measures must incorporate cultural context to be valid.

Therefore, beyond the disparity between developing cognitive function yet measuring manifest performance, questioned has been the adequacy of using domain- or context-specific measures (as that required of performance-based schemes) (Commons & Pekker, 2006). Commons and Pekker contended that such measures "lead to an essential inability to compare [cognitive ability] with any great reliability and validity" (2005, p. 2). The primary reason, as explained by Dawson (2002), is the reliance on the required methodology of "matching" domain-specific performance against a predetermined domain-specific scoring manual. As she concludes, this makes "cross-domain research difficult." This leads to the following hypothesis:

Hypothesis 5

Measures of executive development can be performed separate from concepts of domain and context in which the assessment is conducted.

Difficulty: Culturally-Biased Measures

An additional domain- and context-related concern of current executive development measures is the potential for cultural bias. Rotundo and Sackett (1999) found a lack of differential prediction in post-development assessments due to "an artifact of the predominant use of performance ratings provided by supervisors who are members of the majority group; a criterion that is potentially against members of the minority group." This is the same theme explored by DeShon, Smith, Chan, and Schmitt (1998), where they found development assessment failing due to a lack of incorporation of minority-specific cultural phenomenon into the assessment methodology. Dawson (2003) explained that such cultural biases have negatively impacted the use of the Standard Issue Scoring System (SISS) (Colby & Kohlberg, 1987); it is seldom used today. Colby and Kohlberg in the development of the SISS had used an analysis only of Chicago school boys (see Dawson, 2002), excluding women and individuals of other cultures. It is imperative, then, from the perspective of effective post-development assessment in a rapidly diversifying workforce (American Meteorological Society, 2002; Jamieson & O'Mara, 1991; Kossek, Markel, & HcHugh, 2003; Trompenaars & Hampden-Turner, 1998) that these tests move toward a domain-, context-, and culturally-neutral position.

I understand that culture is a set of social norms (mores, customs) by which one acts and reacts to circumstances for survival, literally or, in the case of organizational life, metaphorically. Within the workplace these are typically "learned" through experience rather than formally communicated to new employees. (Such norms are learned from experience, generally, and not

taught). These represent traditions by which employees act within their work environment. Reflective of a family's culture, if children learn that whining works on the parents, they whine. If fighting works, they fight. If silence is the norm of the family, they fall silent (hiding feelings). Similarly, in organizations, employees learn quickly "what works" (to survive). If finger pointing is the norm, they point fingers at other functional areas, disciplines. If hiding from problems is the norm, they do not highlight problems. If yelling works, they yell. These are all negative examples, positive examples are as valid. If expected through tradition to reveal problems and move aggressively into problem solving, the employee will highlight discovered problems. If coordination, collaboration, and cooperation are held traditions within the organization, the employee will engage in teamwork. For my work here I did not want to introduce culture. Rather, to the greatest extent possible, I sought to focus on a situation that emphasized the ordering of information (orders of hierarchical complexity).

Of course culture must influence cognitive development. In my theoretical framework encompassing synaptic genesis, neural network alignment, and the consequential cognitive patterns, early family culture *must* influence cognitive development. Elementarily, it would defy logic and biology to suggest that even embryonic development awash in stress hormones within a troubled mother would not be impacted. Early stage development, then, continuing in a stressful environment would respond to "synaptic pruning" reflective of these circumstances. As an example, if escape repeatedly proves prudent, the child will continue to strengthen neural networks that support "flight." Subsequent behavior, then, will not be that founded on intellect alone, but rather includes the nameless fears that are "hard wired" into the brain of the emerging adolescent.

While I fully recognize the cultural influence on development, I sought to conduct post-development assessment in a reduced culturally biased fashion. Most systems of developmental stage theory rely on the notion of utilization of sequential orders of hierarchical complexity of knowledge structures (Dawson, 2003). The internal principles employed in the MHC are mathematical representation of the participants ordering of information in complex reasoning. Therefore, it is not reliant upon, as Dawson contended there are weaknesses in other developmental stage assessments, "matching arguments with exemplars selected from the performance of small sample of predominantly White, middle-class respondents" (Dawson, 2003, p. 337). Employing a methodology that has to match performance to set "standards" by definition has to introduce bias, for example culturally biased by matching against a single group (say, all male or all White responses), or domain biased by matching against a specific body of literature (say, accounting), or environmentally biased by matching against those of one domain (say, only utility engineers). That said the application of the model, to a great extent, is neutral relative to these dimensions (culture, etc) in that the singular assessment interest is the underlying organization of information employed in the task. Therefore, relative to "divorced" from these, Commons went on to assert that "We propose that the notion of hierarchical complexity can be applied to any task domain and within any context with any kinds of subjects, human or animal" (Commons & Pekker, 2006, p. 6), *i.e.*, they don't matter, they are neutral to the assessment.

However, I recognize that "an actual task action's difficulty includes its hierarchical complexity but also includes other sources of difficulty such as the domain of the task and other non-hierarchical complexity properties of the task" (Commons & Pekker, 2006, p. 33) or, said a different way, "difficulty depends on the domain and other non-stage properties of the task, complexity does not" (Commons & Pekker, 2006, p. 37).

I am planning research that will explore the physiological changes to the brain that are coincident with higher stages of cognitive ability (as with complex reasoning, *intellectual behavior*). This future research was the driving force for identifying an assessment tool that moved toward a reduced biased (focusing, rather, on pure cognition) and a mathematically sound methodology. So, my attempt to understand the "pure" underlying abilities was not meant to imply a negative valance on cultural influences, but rather that they are not directly important to my intended use in measuring intellectual behavior, specifically exploring the link between developed cognitive ability and physiological changes to the brain (see, e.g., Cozolino, 2002; Kelso, 1995; Schwartz & Begley, 2002). This leads to the following hypothesis:

Hypothesis 6

Measures of executive development can be conducted free of cultural bias.

This section explored the study-specific literature relative to executive development, namely aspects of stage-like development and its measurement. Specifically, explored in sub-part four was a discussion of the general conception of the developed stages of cognitive development. Outlined in sub-part five were the limitations with current stage measurement schemes.

Sub-part 6: Conclusion, Improved Stage Model Assessment

Therefore, there must be improvement in executive development assessment methodology to adequately discern the developed ability for greater complex reasoning within the theorized dimensions of workplace tasks. This leads to the hypothesis for this research.

CHAPTER THREE: METHODOLOGY

Introduction

The principal objectives of the research proposed here are, first, to show that hierarchical stages of complex reasoning can be measured and, second, to identify the common developmental experiences that have contributed to the development. Toward this end, first, it is assumed that executive development can effectively be measured as a function of the intellectual behavior that is exhibited in task complexity—that is divorced from measurement notions linked to domain, context, and culture. Secondly, it is assumed that measurement can be reflected in the theorized psychological dimensions of organizational tasks. Lastly, this research will explore the circumstances that are theorized to have contributed to the progressive transition in stages of complex reasoning, including education and experience.

I have organized this chapter into two parts. First I will further elaborate on my research instrument of choice, the Model of Hierarchical Complexity. Within this section I will explore the instruments foundational axioms, the requirements of the theory, MHC application in measuring developmental stages, and the beneficial difference of the MHC.

Second I will review the research procedure. Within this section I will elaborate on the questionnaire protocol (including procedure and design), my selection of study participants, the study procedure and data collection, and data analysis (including complex reasoning stage and statistical analysis of developmental circumstances).

Model of Hierarchical Complexity

The Model of Hierarchical Complexity (MHC) is a mathematical theory, with a sound "mathematical and logically developed basis" (E. H. Brown, 2004; referenced in Commons & Pekker, 2005, p. 1), providing, as Fischer and Rose (1999) suggested, a "life and power" to stage-based research. Commons and Pekker (2005) explained that this instrument provides for a definition of developmental stage in terms of the hierarchical complexity of the successfully accomplished task in accordance with the following axioms (derived from Commons & Pekker, 2005, p. 8):

Foundational Axioms

1. There is a starting point for hierarchical complexity such that there exists a simple action, where h = the hierarchical stage, and A = action,

   Equation 1. Axiom one

   $$h(A) = 0$$

2. Every non-simple action is either a chain of at least two previously defined actions of arbitrary orders of hierarchical complexity or a coordination of at least two previously defined actions all of which have the same order of hierarchical complexity with a relationship defined by a rule "R," where A = action, and R = rule.

   Equation 2. Axiom two

   $$A = ([A_1,\ldots],R)$$

3. For a non-simple action $A = ([A_1,\ldots],R)$

   Equation 3. Axiom three (chain)

   $h(A_1)$ if A is a chain

   Equation 4. Axiom three (coordination)

   $h(A) + 1$ if A is a coordination

Theory Requirements

A task is more complex, in accordance with this theory, if the following three requirements are met (example equations adapted from Commons, 2006):

1. Higher stages are defined in terms of lower ones. Also described as the formation of actions from prerequisites.

   Equation 5. Principle one: lower order defining role

   $$E_h = [E_{one}, E_{two}\ldots];$$

   where E_{one}, E_{two} are tasks, and "h" refers to an order of hierarchical complexity.

2. Higher order stages organize lower ones, *i.e.*, relational composition (Commons & Miller, 2001), what some describe as "modulation and control" of lower cognitive skills (see, e.g., McCarthy & Warrington, 1990, p. 343) or in the terms of Synergetics, "slaving" (White, Bock, Storb, & Blaser, 2003).

   Equation 6. Principle two: higher order organizing role

   $$E_h = R(E_{one}, E_{two}\ldots),$$

   where E_{one}, E_{two} are tasks, "h" refers to an order of hierarchical complexity, and "R" is an ordering relation on two or more tasks.

3. Coordination is non-arbitrary. There is an order of definition (Commons & Miller, 2001). This is reflective of the dynamic systems theory notion of self-organization (Keijzer, 2003; Kriz, 2000; Lemke, 1996; Tschacher, Dauwalder, & Haken, 2003) and, as that described relative to neuropsychology, "the right skill harnessed at the right time" (McCarthy & Warrington, 1990, p. 343).

   Equation 7. Principle three: non-arbitrary order

   $$E_h = -(i)R_i(E_{one}, E_{two}\ldots),$$

   where "i" is the index indicating which order is defined by ordering relation R_i, "-(i)" means that it is not the case that for every "I" or every ordering that task execution occurs.

MHC and Measuring Stages

Rose and Fischer (1998) contended that human development theories such as Piaget's have been difficult to test. While there is contemporary defense for Piaget's work (Cohen, 1983; Lourenco, 1996; Vidal, 1997), many consider the sequential behavioral changes explained by his theories as too *ad hoc* (Commons & Pekker, 2005) and, therefore, of marginal benefit in the continuing exploration of human development. Therefore, there has arisen a call for researchers to construct effective rulers for measuring "important characteristics of cognition" (Fischer & Rose, 1999, p. 204) or, as described by Port and van Gelder in *Mind as Motion* (1995b) the "behaviors of interest" such as "perceiving, remembering, conversing" (p. 11). Other authors add to this list of cognitive behaviors that of assessing, performing abstractions, understanding, problem solving, and, as Commons and Richards (1984b) contended relative to hierarchical complexity, that of complex reasoning. With the repeated calls for extended research into effective cognitive development rulers, various models have been developed to compensate Piaget's limitations (see, e.g., Fischer & Kennedy, 1997), including that of the Model of Hierarchical Complexity (MHC) (Commons & Pekker, 2005; Commons, Richards, Ruf, et al., 1984).

MHC Difference

MHC compensates for other measures of intelligence and intellectual development which are domain and context based (Commons & Pekker, 2005), that infer a mental structure reflective of mentalistic theories (Commons, Goodheart, et al., 2005; Commons & Miller, 2001); it bases such measurement, rather, on the logic structure that is domain and context neutral. Commons and Pekker (2006) countered potential claims of arbitrariness of this concept of absolute scale of stage by emphasizing its foundation in the "hierarchical complexity criteria of mathematical models and information science" (p. 4). It is a "mathematical theory of the ideal" (Commons & Pekker, 2005).

MHC and its corresponding Hierarchical Complexity Scoring System (HCSS) (Commons, Goodheart, et al., 2005) fundamentally differ from other measures of intelligence (including, as used in this research, the notion of intellectual behavior) in that it is centered on task-based versus performance-based schemes. Such performance schemes have a long history. From Broaa's 19th Century notions of relative correlation to brain size to the 20th Century assessment procedures pioneered by Binet in 1904, Yerkes' *National Intelligence Test for Children* (see Hothersall, 1990, pp. 329-337) and today's frequently used *Wechsler Adult Intelligence Scale* (WAIS) (for definition see Stevens-Long & Commons, 1992, p. 325; for description see Sweetland & Keyser, 1991, pp. 63-66) measures of intelligence have focused on demonstrated performance. As Alfred Binet stated of these advancements in assessment, "[they] cease to be a matter of tact and intuition, but rather becomes something objective and tangible" (Binet, 1904; referenced in Hothersall, 1990, p. 337).

MHC, conversely, measures developmental stage based on task complexity inherent in complex reasoning (Commons, Goodheart, et al., 2005). Fundamentally, the measure of the hierarchical complexity is "the minimum number of simple actions, N, needed to accomplish the action" (Commons & Pekker, 2005, p. 7), each action, in turn, comprised of two lower stage actions and an organizing rule (what Jaques & Cason, 1994, p. 30 allude to in the notion of "mental processing types"), such that any non-simple action, A, is represented by $A = ([A_1,\ldots.], R)$. The order of hierarchical complexity is determined by the stage of the most complex task that is successfully completed. The stated goal of MHC is to a) measure action complexity and b) to do so in such a manner as to allow it to relate to complexity of other actions.

An illustrative example that Commons and colleagues use in the description of MHC is that of the distributive law in mathematics, where the same product results from multiplication that is performed on a set of numbers as when the multiplication is performed on the individual numbers of the set:

Equation 8. MHC illustration

$$a \times (b + c) = (a \times b) + (a \times c)$$

This example depicts how the output of two lower-order actions, x and +, when combined or "nested" in a specific order as input, lead to a the higher order action of distributivity (for expanded description see Commons, Goodheart, et al., 2005, pp. 5-6; Commons & Pekker, 2006, pp. 4-11; Commons, Richards, Ruf, et al., 1984, pp. 120-140). As Dawson (2003) explained this system employs two systems of hierarchical complexity. First, there is a hierarchical complexity of *abstraction* (levels of lexical generality) and second, the *logic structure* of the argument, with the evidenced structure of logic revealing the underlying employed thinking (see, e.g., Cooper &

Patton, 2004, pp. 53-86). This scheme is represented in Table 2 (mathematical representation, see footnote #1).

Table 2
Mathematical Representation of Stage

Stage	Mathematical Example
10: Formal	The general left hand distribution relationship: $x \times (y + z) = (x \times y) + (x \times z)$
11: Systematic	The right hand distribution law is not true for numbers but is true for proportions and sets: $x + (y \times z) \neq (x \times y) + (x \times z)$ numbers $x \cup (y \cap z) = (x \cap y) \cup (x \cap z)$ proportions and sets
12: Metasystematic	The system of propositional logic and elementary set theory are isomorphic: $x \,\&\, (y \; or \; z) = (x \,\&\, y) \; or \; (x \,\&\, z)$ Logic $\Leftrightarrow x \cap (y \cup z) = (x \cap y) \cup (x \cap z)$ Sets $T(False) \Leftrightarrow \Phi$ Empty set $T(True) \Leftrightarrow \Omega$ Universal set

(Adapted from information contained in Commons, Goodheart, et al., 2005 Table 1; Commons & Miller, 2001 Table 3)

Research Procedure

Questionnaire Protocol

Questionnaire Procedure

The research instrument used was a questionnaire (total time to complete was less than 15 minutes, with additional time determined by the length of response rationale, estimated to be between 5-30 minutes). After providing the participant an introductory letter (see Appendix 4: Participant Letter) and the requisite informed consent form (see Appendix 5: Informed Consent Form), I asked the participant to complete a brief development inventory, including items of age, gender, formal education (*e.g.*, degrees), professional training (*e.g.*, seminars), and work experience (Appendix 6: Executive Development Inventory (EDI)). Second, after providing the participant guidelines for completing the questionnaire (see

Appendix 7: Survey Guidelines), I requested that the participant describe an ideal interaction (six open-ended questions, see Appendix 8: Assignment Preparation – Ideal Interaction), and then prepare for the exercise (

Appendix 9: Assignment Preparation).

The employed vignette format centers on a theorized assignment preparation interaction between executives and their subordinates (see Appendix 10: Interaction Methods #1, Appendix 11: Interaction Methods #2). Finally, I asked the research participant to review and assess differing interaction scenarios (each interaction with embedded, sequentially higher levels of complexity), followed by five assessment-based questions (Appendix 12: Interaction Questions) and a three-question opinion poll (Appendix 13: Opinion Poll), each employing a 6-point Likert scale. Through the assessment responses I expected to learn the relative stage of complex reasoning that is used (see Appendix 14: Anticipated Responses). I hoped to answer the questions, How can the hierarchical stages of complex reasoning be measured in an organizational setting without reliance on domain, context, or cultural bias? And what are the common developmental experiences of the development? This is not a test of their ability as an individual (it is so stated in the questionnaire). Rather, I wished to know how executives, in general, reason about the presented issues.

Questionnaire Design

Embedded within each interaction, in addition to the complex reasoning structure of sequentially higher stages of development, are the theorized psychological dimensions of aware, accept, attune, align, and act (see Sub-part 3: Psychological Dimensions of Measurement). Extended elaboration is sought by a request to explain the chosen assessment. This is used to elicit underlying reasoning (Bowman, 1996; Colby & Kohlberg, 1987) and is an acceptable format for testing developmental stages (see Commons & Pekker, 2006, p. 23). It has been used in such studies as workplace atmosphere and moral development (Commons, et al., 1993), organizational work practices (Bowman, 1996), citizen's reasoning relative to political development (Ross, 2006).

The design and development of the questionnaire included, first, an emphasis on providing sequentially more complex scenarios in the vignettes. It is important to note here that the complexity represented in the vignettes reflects the foundational MHC axioms (equations 1-4), theory requirements (equations 5-7), and incorporates the mathematical representation of the model (see Table 2

Mathematical Representation of Stage). It was modeled on similar hierarchical complexity studies (see, e.g., Commons, et al., 2006).

Second, the questionnaire vignettes were designed to include the three developmental stages (see Table 3

Research Stage Profile) that are anticipated to be represented in this research; they are those deemed most appropriate for research of executive development (Commons, Goodheart, et al., 2005). They are considered the most common stages of adult development (see, e.g., Stevens-Long & Commons, 1992, p. 121) and are theorized to adequately assess the cognitive development for the technician, manager, and executive (see Commons, Goodheart, et al., 2005, p. 75, Table 9). Table 3

Research Stage Profile, shows for each of the developmental stages, first, the anticipated organizational positions. As an example, I anticipated that managers tested in this study would predominately be at a developmental stage 11, Systematic. Second, the table lists the anticipated arguments that the research participants would use in organizing information (see Appendix 14: Anticipated Responses).

As stated earlier, I recognized that development results from the "seamless" integration of multiple factors that include education and experience (Bernthal, et al., 2001; Seibert, et al., 1995; Albert A. Vicere, 1998; Albert A Vicere, et al., 1994). This was a principal consideration in my design of the inventory of possible developmental contributors (see resulting list in Appendix 6: Executive Development Inventory (EDI)). Constructed upon previous research in contributing factors to executive development (see, *e.g.*, Close, 1981), I included non-career related factors such as participant gender and age. I incorporated various aspects of education such as attained academic degree and specialized education (*e.g.*, supervisory training, leadership development). Relative to experience I included in the inventory those factors related to the career path of the participant, such as organizational positions that they have held and functional areas in which they have worked. Additionally, relative to experience, I recognize that support plays a critical role in development (Bernthal, et al., 2001), including that of coaching (Cramm & May, 1998), mentoring (Walsh, et al., 1999), or a friend's feedback (Guinn, 1999). Each of these aspects of support is theorized to aid in deriving meaning from the experiences, so have been included in the development inventory.

Table 3
Research Stage Profile

Stage	***Position***	***Characteristics***
10: Formal	Technicians, Line Staff	• Argue using empirical or logical evidence
11: Systematic	Managers, Professionals	• Determining possible causes and outcomes that may be determined by many causes • Building of matrix representations of information in the form of tables and matrices coordinating more than one variable • Multidimensional ordering of possibilities • Events and ideas situated in larger context
12: Metasystematic	Executives	• Analyze, compare, contrast, transform, and synthesize systems • Integrate systems to construct multi-systems • Coordinate at least two multivariate systems

(Adapted from information contained in Commons & Bresette, 2006; Commons, Goodheart, et al., 2005; Commons & Pekker, 2006)

Participant Selection

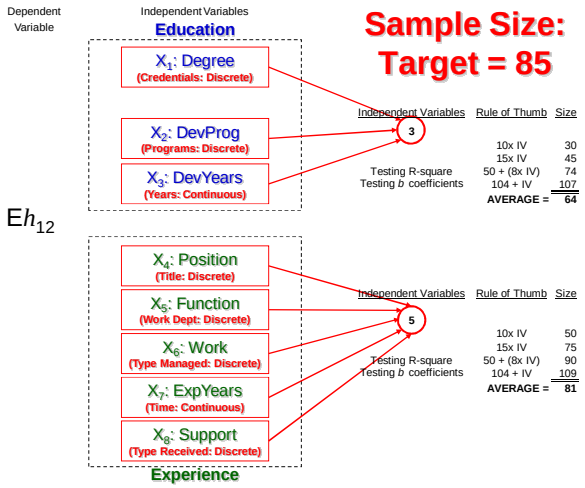


Figure 1. Sample size

Targeting 85 participants (see *Figure 1*. Sample size) I solicited in the 14+ month period between August, 2007 and September, 2008 the participation of managers and executives of the U.S. energy industry, with a specific consideration of those in the nuclear power industry.

This is due to two principal reasons. First, is the researcher's energy industry background (U.S. Navy Nuclear Program/Submarine Service, Nuclear Regulatory Commission (NRC) licensed reactor operator, and staff and consultant to the nuclear power industry). Second, there is a well-documented concern regarding the energy industry workforce given the dual challenges of, first, a projected increase in construction of these facilities and, thus, in operational demand and, second, the aging workforce both domestically (APPA, 2005; DOE, 2006; Ebert, 2006; NERC, 2007) and internationally (CEA, 2006; Ray, 2007).

Table 4
Solicited Energy Organizations

1. American Nuclear Society (ANS)
2. American Public Power Association (APPA)
3. ANS Decommissioning Division
4. ANS Education and Training Division
5. ANS Human Factor Division
6. ANS Math Division
7. ANS Nuclear Installations Safety Division
8. ANS Operations and Power Division
9. Center for Energy Workforce Development (CEWD)
10. Configuration Management Benchmarking Group (CMBG)
11. Department of Energy (DOE)
12. DOE Human Performance Center (HPC)
13. DOE National Training Center (NTC)
14. DOE Nuclear Energy Research Advisory Committee (NERAC)
15. Edison Electric Institute (EEI)
16. Energy Facility Contractors Group (EFCOG)
17. Energy Power Research Institute (EPRI)
18. Federal Regulation and Oversight of Energy (FERC)
19. Institute Of Electrical And Electronics Engineers (IEEE)
20. Institute of Nuclear Power Operations (INPO)
21. International Atomic Energy Association (IAEA)
22. National Association of Regulatory and Utility Commissioners
23. NRC Human Resource Development
24. NRC Training
25. Nuclear Energy Institute (NEI)
26. Nuclear Industry Association (NIA)
27. Nuclear Regulatory Commission (NRC)
28. Professional Reactor Operator Society (PROS)
29. World Association of Nuclear Operators (WANO)
30. World Nuclear Association (WNA)
31. World Nuclear University (WNU)

Specific energy industry solicitation was made to 31 organizations (see

Table 4

Solicited Energy Organizations), and the 30 top U.S. electric utilities (see Appendix 1: Top U.S. Electric Utilities), employing a dual public domain email address approach: general utility employees found via an Internet search and the utility's executive staff (identified on the company's web site). This was followed with a phone call to the senior executives. The only organizations to agree to participate were the Energy Facility Contractors Group (EFCOG) and no utility responded to the request. It is interesting to note that the Professional Reactor Operator Society (PROS) declined to participate, stating as their reason that the study was "too academic."

Focused solicitation was made to six utilities due to their size, the close proximity with or familiarity to me, and the probability of their active engagement in the nuclear power industry expansion: American Electric Power (AEP), Duke Energy, Entergy, FPL Group, Progress Energy, and Tennessee Valley Authority (TVA). This was accomplished by, first, a letter of introduction followed, second, by a phone call to the head of the Human Resources Department. All declined.

Also, letter and email solicitations were made to energy industry associated companies Framatome/AREVA and General Electric (GE), including GE Corporate, the GE Executive Development program, and GE-Hitachi Nuclear Energy. They declined to participate, as well.

Table 5
Solicited Organizations

1. Academy of Management (AOM)
2. American Management Association (AMA)
3. American Society for Training and Development (ASTD)
4. Senior Executive Association (SEA)
5. Service Corp of Retired Executives (SCORE)
6. Small Business Association (SBA)
7. Society for Human Resource Management (SHRM)

Given the anemic response of the energy industry, general solicitation was made to the seven organizations listed in

Table 5

Solicited Organizations. All declined to participate with the exception of the Senior Executive Association (SEA). I also contacted were six Academy of Management (AOM) ListServs with some 6,407 subscribers (Managerial and Organizational Cognition, Management Education, Organizational Behavior, Network of Leadership Scholars, Organization and Management Theory, and Organizational Culture), two professional ListServs Professional and Organizational Development Network in Higher Education (POD), and Society for Research in Adult Development (SRAD), and the 115,231 members of 36 general development Listservs (see

Appendix 3: ListServ Research Participation). Unfortunately, access was universally denied to these general development ListServs because research solicitation was not a stated purpose for these groups.

Study Procedure and Data Collection

I used SurveyMonkey (http://surveymonkey.com). It is an online survey tool which allows design flexibility using various scoring means (*e.g.,* multiple choice, rating scales, and open-ended text) and the ease to send to multiple target audiences, while ensuring the greatest participant ease and confidentiality. Downloaded in MSExcel format, the data can be further imported directly into SPSS (for statistical analysis), and, from there, into WINSTEPS (for Rasch analysis).

Data Analysis

Stage of Complex Reasoning

I conducted in Assessment 1 a Rasch analysis to determine the developmental stages (see footnote #2 for excerpt from Commons & Pekker, 2006, pp. 20-21). The Rasch model is a member of the family of item-response latent-trait models. The analysis, where the total score summarizes a person's standing on a variable, emerges from the fundamental requirement that the comparison of two people is independent of which items may be used within the set of items assessing the same variable. It requires a set of carefully selected survey questions, as I employed in this study (Appendix 12: Interaction Questions), producing an interval scale that determines both item difficulties and person measures. The analysis is a method for obtaining objective, fundamental, linear measures (qualified by standard errors and quality-control fit statistics) from stochastic observations of ordered category responses. The Rasch model is the only item response theory model in which the total score across items characterizes a person totally (Bond & Fox, 2007). As stated previously, the MHC has shown that hierarchical complexity is a function of coordinated, organized actions and their sub-actions. Such an analysis, then, will produce an ordinal scale reflecting stage of development.

Statistical Analysis: Circumstances to Reasoning Level

The second phase of data analysis was a statistical analysis in two parts, both of which use data relative to each participant's development circumstances (see Appendix 6: Executive Development Inventory).

The first step for this phase, Assessment 2, was a statistical analysis of the differences between two subsets, those that exhibit a complex reasoning stage theorized as appropriate for the organizational level (stage 12) and those that exhibit a retained, lower stage of complex reasoning (*e.g.,* 11, 10, 9, 8). The second step in this phase, Assessment 3, was intended to provide a statistical view of the significant developmental contributors to the single subset of executives that exhibit a theorized stage of development (*i.e.,* stage 12).

A complex multivariate analysis as selected for this study limits the scope of appropriate methods to bivariate correlation and regression, ANOVA, and *t* tests (see expanded discussion in Newton & Rudestam, 1999, pp. 137-140). For purposes of this study the most appropriate methods are multinomial logistic regression analysis for Assessment 2 and logistics regression for Assessment 3. They were conducted with associated techniques for significance, importance, and strength. Unfortunately, explained later, the small and similar research population necessitated the adoption of a statistical binary logistic regression analysis.

CHAPTER FOUR: RESULTS

Research Participation

Participant Response

In the 14+ months (August, 2007 – September, 2008) of soliciting participation for this research I found the response to be anemic. Some 69 organizations were invited to make their employees and members aware of this research, asking them to distribute the survey internally. These include the 31 energy industry organizations listed in

Table 4

Solicited Energy Organizations, shown on page 35. In addition, via public domain email addresses, individual invitations were sent to 4,362 energy industry individuals, including an initial invitation and at least two follow-up solicitations for more than 13,000 email correspondence ("most efficient methodology," see Babbie, 1998, p. 261). Hundreds of letters were sent and scores of phone calls made.

It is important to note that that the survey is the “best method” for a widely dispersed, large population as that targeted for this study (Babbie, 1998). In accordance with Babbie’s advice for mailed surveys, I hoped for a 50% “adequate” rate of response (1998, p. 262), which corresponds with general advice relative to survey size (Edwards, Thomas, Rosenfeld, & Booth-Kewley, 1996). I understood that the online survey response rate would be lower, targeted at 30% (Anonymous, 2008a). While the actual rate was anticipated to be less, I expected greater than 5% response (n>250). However, only 90 individuals fully completed the survey, providing viable data, representing only 26% of the 340 that entered the online site, accessing and starting the survey (see

Table 6

Participation Statistics). Given the number of employees and members of the solicited organizations, the ListServ subscribers (see, Participant Selection), and the initial and follow-up email invitations, this response rate is less than 0.05%. Subtracting the failed listserv attempt, and conservatively estimating the survey population at only 30,000, the response rate was still very low at 0.3%.

Penn State University has studied this phenomenon: the growing problem of survey non-response. While they find an increasing problem they could not identify any underlying causation (Johnson, 2005). They state that web-based surveys to a student population may garner a response rate as low as 30%. One can imagine that a targeted population of executives via an online survey would be less. How much less, even Penn State "finds it hard to answer." This is a prevalent problem in research, as evidenced by the volume of related articles on the topic (see, Appendix 19: Nonresponse in Survey Research: A Selected Bibliography).

Table 6
Participation Statistics

Survey Step	*No.*	*%*
Estimated total research invitations	35k	
Entered survey and provided self-coding	340	
Self-coding + demographic info	252	74.1%
Self-coding + demographic data + survey ratings	95	27.9%
Viable data	90	26.2%

Many in the energy industry voiced to this researcher their recognition of and concern with this lack of responsiveness. It has hampered other studies (W. Reder, VP, S&C Electric Company, personal correspondence, May, 2008). Many reasons have been posited, from "the people complain about 'outside surveys'–going so far as to complain about the company's ethics hotline," "HR is very protective of the executives [they won't allow outside contact]," "they are too busy," to a general statement of "it is our policy to not take surveys."

Some energy industry Human Resources professionals have asked that should this study reveal why it is so difficult to engage the energy industry executive and manager they would like prescriptive feedback. This study is not one investigating the prevalent culture of the energy industry. However, if continued research is to be conducted relative to development within the energy industry the phenomenon of non-responsiveness will have to be effectively addressed. Therefore, further research will have to be conducted along these lines. I call for such here.

Participant Description

As explained in the section Participant Response, I provided research invitations to more than 4,362 energy industry individuals via public domain sources (*i.e.*, email addresses), and well over 30,000 via coordination with host organizations and associations. Given the low response, in order to obtain a statistically valid sample size, I had to limit the research to the core elements of the instrument (those most answered by participants). Therefore, I isolated the analysis to only the five ranking questions (that most completed) of the two sets of scenarios and eliminated the three follow-up 'polling' questions (relative to executive liability) of each. Of the 340 that visited the Internet-based research instrument, 95 completed the survey through the five ranking questions (see

Table 6

Participation Statistics). However, 5 participants provided responses that were not suited for this study, as an example ranking all questions and all vignette executives as "1". Therefore, they were eliminated from further analysis. The analysis was conducted on the 90 remaining responses, of which only 16.6% *(n* = 15) came from the energy, nuclear power, or utilities industries and, of this group, only 13.3% *(n* = 2) came from an operational function. The others came from functional areas such as Human Resources, Marketing, Information Technology (IT), and Finance. I next describe the demographic profile of this group.

The gender distribution of the participants was weighted to male, 58.8% male *(n* = 53). The age of the 90 participants spanned from 25 to 74 years. However, while the average age was 50.1 and the median 51.0 years, the most represented age group was that between 45 and 55 years, with 50% *(n* = 45) of the participants from this 10-year range. There was a difference by gender. The average age of the males was 52.2 years and of the 41.1% female *(n* = 37) the average age was 47.1 years. This gender difference was represented, as well, in the educational descriptive statistics, described next.

The most represented degree level of the participants was a master's degree, with 51.1% *(n* = 46) of the participants holding the degree, and the next, PhD, held by 27.8% *(n* = 25) of the participants. However, again, there was a difference by gender. While there were similar master's degree representation in both gender groups (males = 54.8%, *n* = 29; and females = 45.9%, *n* = 17), there were more PhD's represented in the female population (43.2%, *n* = 16) than the male (17.0%, *n* = 9). This is a result of the gender representation by industry. While females represented 41.1% *(n* = 37) of the general participant population, nearly half were from education (48.3%, *n* = 14) and representing only 13.3% *(n* = 2) of those from the energy, nuclear power, and utilities industries.

By position title the span of participants was constricted toward the low end of the range, with 84.3% *(n* = 70) of the participants at the VP level or below, 12% *(n* = 10) president to CEO, and no board members. Therefore, while striving for a wide-cross section from managers and senior managers to junior and senior executives in order to produce a well-dispersed range of developmental stages my sample was heavily loaded to more junior organizational positions.

Data Analysis and Hypothesis Testing

The Rasch model was utilized in this analysis to test the model of hierarchical complexity, upon which the vignettes were constructed (see justification Commons & Pekker, 2005, pp. 23-25). As Commons and Pekker explained, the vignettes embody varying levels of task difficulty, each order more highly complex should be more difficult to perform than a lower order task. The more complex task, then, should generally be performed less successfully (see 2005, p. 21). The probability of selecting a specific complexity level depends on the ability of the individual and the difficulty of the item (as determined by the embedded complexity) (see explanation in Bond & Fox, 2007, pp. 10-11). The Rasch model illustrates the relationship between the participants' responses (selections) and the items in a logarithmic, interval scale. Further, it specifies the form of the relationship between persons and the items that define a single trait; here the targeted ability is that of complex reasoning. The equality of intervals in the Rasch scaling is achieved through log transformations of the raw data (see Bond & Fox, 2007, pp. 15-27). However, the Rasch analysis is not without potential for misrepresentation of the data.

Commons and Pekker cautioned that other variables can inherently affect the task difficulty, "These include horizontal complexity [the acquisition of additional, horizontally-oriented knowledge, skills and abilities], familiarity with the language and symbols, where the information is placed in a given array, etc." (2005, p. 22). This is especially important in this study where, first, the research participants are from a highly concentrated group of participants (narrow range of developmental stages) and, second, the diverse theories and practices relative to leadership (in the shadow of which the executive-subordinate discussion are assumed to occur, for example participatory management, shared leadership, authoritative, autocratic, or dictatorial approaches). In the first, in that the Rasch analysis is a mathematical procedure for determining the logarithmic scale of the odds or probabilities of specific levels, the high concentration of participants in the study skewed the odds. In the second, as an example, an executive with highly developed complex reasoning ability may have adopted a leadership style precluding intimate involvement of subordinates in the decision making process. The Rasch maps, then, were not expected to exactly mimic the MHC complexity stages that would occur in a wider range of research participants; a Rasch analysis assumes a wide range of responses (Bond & Fox, 2007).

Data were downloaded from the Internet-based survey instrument (SurveyMonkey.com) in MS Excel spreadsheet format. In that a Rasch analysis "expects the data to represent ascending qualitative levels of the latent trait" (J.M. Linacre, personal communication, August 18, 2008. See also Linacre, 2006), I arranged the data, first, horizontally across the spreadsheet columns in the order of hierarchical complexity (*e.g.,* 8-12) and, secondly, vertically by the demonstrated ability of the individual respondent (*e.g.,* those assigning on the Likert scale a rate of '6' to the level-12 executive scenarios). My data conform to this scheme (J.M. Linacre, personal communication, August 18, 2008). Subsequently, it was imported into SPSS, first, to facilitate further analysis and, second, modified in order to support a Rasch analysis using WINSTEPS, a Rasch analysis software program created by John Michael Linacre, PhD[7] (Linacre, 2006; Trudeau & Adams, 2005). Toward this end, the SPSS data was saved in fixed ASCII format, the necessary format for the Rasch analysis.

Stages of Complex Reasoning

This section summarizes the results of participant responses. It is organized in six subsections: model reliability and fit, WINSTEPS maps, scattergram depiction of results, ANOVA and regression analysis, stage measures, and the hypothesis testing. It should be noted that the necessary preparatory steps for the Rasch analysis was the organization of respondents' raw 6-point Likert scores in a linear scale fashion, highest to lowest: The respondents were ordered in accordance with their complex reasoning ability as reflected by their rating of the hierarchical complexity ordered vignette models. A Rasch analysis determines the relationship, the pattern, between the matrix cells in the spreadsheet of results (see, e.g., "Important Principles of Measurement Made Explicit" in Bond & Fox, 2007, pp. 15-27). The subsequent Rasch analysis transformed this raw score ordinal scale to an interval log odds scale.[3] Finally, a regression analysis was conducted on the Rasch scores versus the order of hierarchical complexity to understand the relationship between the two.

Reliability

WINSTEPS provides both a person and item reliability index, necessary to determine if enough test items spread along the continuum (Bond & Fox, 2007). Linacre (2006) explained

that “person reliability” is equivalent to the traditional "test" reliability while "item reliability" has no traditional equivalent. In the first, low values indicate a too narrow range of person measures, or a small number of items. In the second, low values indicate a too narrow range of item measures, or a small sample. The generally accepted lower level is 0.70 (Hair, Anderson, Tatham, & Black, 2005). The data collected for this study resulted in a person reliability level of 0.79 and an item reliability of 0.98, both representing a strong acceptable level.

Fit

In an analysis such as the one presented here, the typically reported information is “Rank” (variable name, such as “08-Bb”), “Measure” (the identified Rasch score), and the significance test of “Infit MnSq” and “Outfit MnSq” (Trudeau & Adams, 2005), see Table 7

Rank: Measure. Originally Rasch used the chi-square (χ^2) significance test, “one of the most widely used tests in social statistics” (Rowntree, 1981, p. 150), to determine how well empirical data met the requirements of the Rasch model (see, e.g., Bond & Fox, 2007, pp. 238-239). Basically, it is the product of the row and column totals in the matrix of collected data divided by the total sample size (Agresti & Finlay, 1986).

Table 7

Rank: Measure

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	DISPLACE	RANK
6	193	86	1.02	.10	1.09	.6	1.16	1.0	.45	29.1	35.8	.00	08-Bb
28	99	43	.92	.14	1.12	.6	1.12	.6	.43	30.2	34.6	.00	10-Ya
48	95	41	.89	.15	.96	-.1	.98	.0	.54	19.5	34.5	.00	10-Ye
33	102	43	.86	.14	1.30	1.4	1.27	1.2	.44	23.3	33.4	.00	10-Yb
38	102	43	.86	.14	.89	-.5	.91	-.3	.47	32.6	33.4	.00	10-Yc
21	205	83	.82	.10	.99	.0	.94	-.4	.50	42.2	32.6	.00	08-Be
32	105	43	.81	.14	.99	.0	1.01	.1	.40	23.3	32.8	.00	09-Ab
16	213	85	.79	.10	.86	-1.0	.85	-1.0	.56	42.4	32.4	.00	08-Bd
11	218	85	.74	.10	.94	-.4	.91	-.6	.57	31.8	31.9	.00	08-Bc
43	107	42	.72	.14	1.05	.3	1.05	.3	.49	28.6	32.1	.00	10-Yd
1	239	90	.68	.09	1.08	.6	1.11	.8	.30	26.7	30.7	.00	08-Ba
37	112	43	.68	.13	.68	-1.7	.71	-1.5	.47	41.9	31.1	.00	09-Ac
31	113	43	.66	.13	.94	-.2	.94	-.2	.34	23.3	30.9	.00	08-Jb
8	235	86	.62	.09	1.28	2.0	1.27	1.8	.37	31.4	30.3	.00	10-Fb
47	110	41	.60	.14	.81	-1.0	.82	-.9	.39	34.1	30.7	.00	09-Ae
13	239	85	.56	.09	1.09	.7	1.06	.5	.44	27.1	29.6	.00	10-Fc
3	256	90	.54	.09	1.22	1.6	1.23	1.7	.21	22.2	29.4	.00	10-Fa
42	117	42	.54	.13	.81	-1.0	.84	-.8	.48	35.7	29.8	.00	09-Ad
46	115	41	.51	.13	.75	-1.3	.74	-1.3	.51	22.0	30.0	.00	08-Je
26	122	43	.50	.13	1.04	.3	1.04	.3	.24	20.9	29.9	.00	08-Ja
27	124	43	.47	.13	.79	-1.1	.79	-1.1	.32	41.9	29.9	.00	09-Aa
36	125	43	.45	.13	.82	-.9	.80	-1.0	.44	27.9	29.9	.00	08-Jc
18	252	85	.45	.09	1.01	.1	.99	-.1	.48	29.4	29.5	.00	10-Fd
23	243	81	.42	.09	1.01	.1	1.01	.1	.42	33.3	29.5	.00	10-Fe
41	125	42	.40	.13	.92	-.4	.92	-.4	.45	19.0	29.8	.00	08-Jd
7	274	86	.30	.09	.78	-1.8	.77	-1.8	.45	24.4	28.7	.00	09-Sb
2	290	90	.28	.09	.90	-.7	.89	-.9	.39	26.7	28.7	.00	09-Sa
12	278	85	.24	.09	.71	-2.5	.70	-2.5	.63	29.4	28.9	.00	09-Sc
22	273	82	.20	.09	.87	-1.0	.86	-1.0	.47	30.5	28.9	.00	09-Se
17	283	85	.20	.09	.76	-2.0	.74	-2.1	.58	28.2	28.8	.00	09-Sd
34	173	43	-.30	.13	.97	-.1	1.01	.1	.25	25.6	29.8	.00	11-Gb
15	359	85	-.42	.09	.96	-.2	.98	-.1	.39	27.1	31.3	.00	12-Wc
39	183	43	-.48	.13	.78	-1.1	.75	-1.2	.36	51.2	31.6	.00	11-Gc
49	174	41	-.48	.14	.87	-.6	.83	-.8	.36	39.0	31.5	.00	11-Ge
44	180	42	-.50	.14	.90	-.4	.88	-.5	.35	40.5	31.9	.00	11-Gd
20	370	85	-.52	.10	1.03	.2	1.08	.6	.34	35.3	32.6	.00	12-Wd
10	377	86	-.54	.10	.95	-.3	1.04	.3	.21	29.1	33.0	.00	12-Wb
25	343	78	-.56	.10	.95	-.3	.98	-.1	.46	37.2	32.9	.00	12-We
29	189	43	-.58	.14	.88	-.6	.99	.0	.19	34.9	32.9	.00	11-Ga
5	408	90	-.66	.10	1.23	1.5	1.29	1.8	.26	34.4	35.0	.00	12-Wa
45	204	42	-1.01	.16	1.28	1.2	1.32	1.3	.32	33.3	39.3	.00	12-Md
50	174	36	-1.03	.17	1.19	.8	1.14	.6	.48	41.7	39.4	.00	12-Me
40	216	43	-1.19	.17	1.21	.9	1.28	1.1	.27	34.9	39.5	.00	12-Mc
24	410	81	-1.21	.12	1.32	1.7	1.47	2.3	.21	33.3	40.7	.00	11-Ee
14	432	85	-1.23	.12	1.24	1.3	1.38	1.9	.19	42.4	40.6	.00	11-Ec
30	218	43	-1.25	.17	1.15	.7	1.14	.6	.37	37.2	40.2	.00	12-Ma
4	460	90	-1.26	.12	1.85	4.0	1.95	4.3	.24	25.6	40.4	.00	11-Ea
35	220	43	-1.31	.17	1.09	.4	1.13	.6	.29	44.2	40.9	.00	12-Mb
19	448	85	-1.49	.14	1.00	.1	1.04	.3	.32	40.0	42.7	.00	11-Ed
9	466	86	-1.74	.15	1.04	.3	1.08	.5	.27	45.3	48.1	.01	11-Eb
MEAN	227.4	63.8	.00	.12	1.01	.0	1.02	.1		32.2	33.3		
S.D.	107.4	21.7	.79	.03	.20	1.1	.22	1.2		7.5	4.4		

Statistically, the Rasch mean-squares are χ^2 statistics divided by their degrees of freedom. They show the size of the randomness, *i.e.*, the amount of distortion of the measurement system, with 1.0 the expected value. Values less than 1.0 indicate observations are too predictable and those greater than 1.0 indicate unpredictability; mean-squares are always positive (Anonymous, 2008b). Dawson-Tunik et al. (2005) considered acceptable person fit statistics between -2 and +2. Linacre stated that values of 0.5 – 1.5 are "productive of measurement" (2006, p. 223), but Linacre contends that up to 2.0 is acceptable (Trudeau & Adams, 2005) . It can be seen in the table that all items fit. Therefore, the data are deemed acceptable for this study.

WINSTEPS Maps

The WINSTEPS maps graphically represent how the items of consideration and the participants' responses relate, or are distributed (as seen in *Figure 2.* Rasch map: participants). Depicted on the right side of the graphs are the items with their order of hierarchical complexity indicated by the number (*e.g.*, "08" for the Concrete stage). The left side of the graph shows the relative distribution of each participant, in *Figure 2.* Rasch map: participants the letter reflects the first element of the participants self-code and in *Figure 3.* Rasch variable map each "#" represents 2 participants.

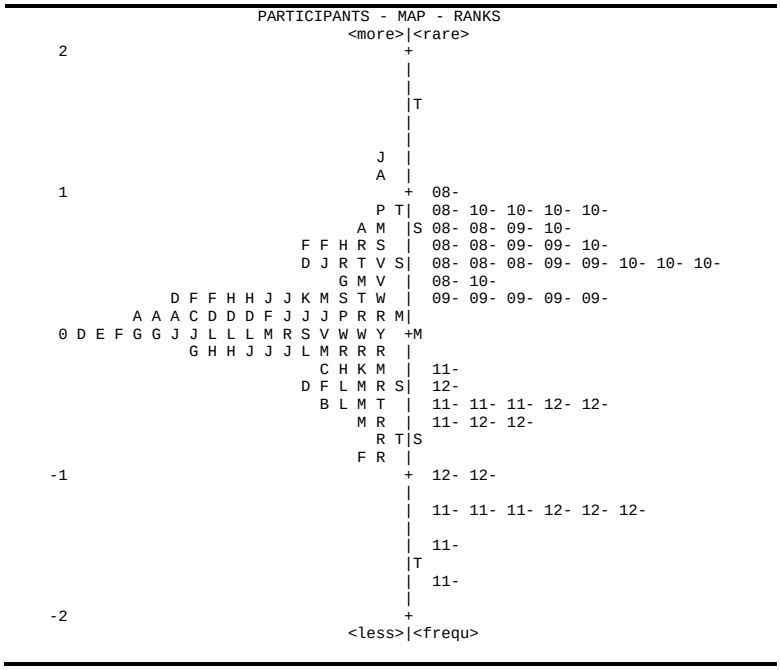
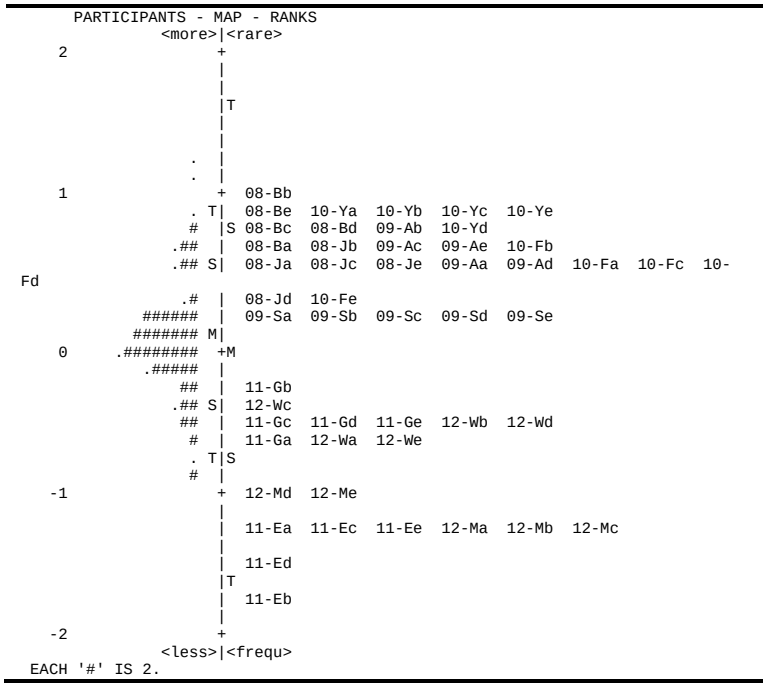


Figure 2. Rasch map: participants

It should be noted that the "M" in the graphical display is the location of the mean, the "S" represent one standard deviation from the mean, and the "T" two standard deviations from the sample mean. Also, the range of the log scale is a function of the range of difficulty represented by the vignettes (in this case, -2 to +2), with each unit representing an equal increase in difficulty.



The variables are laid out vertically with those demonstrating higher stage reasoning and the more difficult (higher order) scenarios at the bottom of the graph. The stage coding system for the right side of the graph is: 8 = Concrete, 9 = Abstract, 10 = Formal, 11 = Systematic, and 12 = Metasystematic.

Figure 3. Rasch variable map

While there is a strong fit of the items to the model, exhibited in the strong grouping around the mean and distribution both high and low indicating varying levels of development, *Figure 3*. Rasch variable map clearly shows that 82% of the participants were within one standard deviation. As stated previously, the participants for this study came from a constricted organizational level and developmental stages. A wider distribution of development stages would have resulted in concrete and abstract items to have mapped between one and two standard deviations below the mean, with those of systematic and metasystematic to have mapped between one and two standard deviations above the mean. As explained previously (in section "Participant Response") the low response resulted in not having low enough stage performing participants.

ANOVA and Regression Analysis

A regression analysis was conducted in order to better understand the relationship between the Rasch score and the order of HC. Explained by Newton and Rudestam, "the multiple correlation coefficient and its square, the multiple coefficient of determination (R and R^2, respectfully), assess the 'fit' of the data to the Rasch model's specifications. When the fit is perfect, both R and R^2 are 1.00" (1999, p. 249). This ensures the invariant measurement within the model's unidimensional framework, or that my assessment focuses on one attribute at a time (see human science measurement comparison to physical measurement in Bond & Fox, 2007, pp. 32-34). It is important to note that R^2, as Agresti and Finlay explained, provides a measure of total variation as a function of the predictive power of the independent variables (for expanded discussion, see 1986, pp. 326-327). As can be seen in Table 8

Regression Analysis, Model Summary these values are well in range, at 0.759 and 0.577, respectively.

Table 8

Regression Analysis, Model Summary

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	.759	.577	.568	.51525

Analysis of variance (ANOVA) assesses the significance of the relationship between the independent variables and a single continuous dependent variable. The test statistic for analysis of variance is called *F*, where a ratio is calculated between the variability differences of the "between group" and "within group." The value is large enough to indicate that the findings are statistically significant.

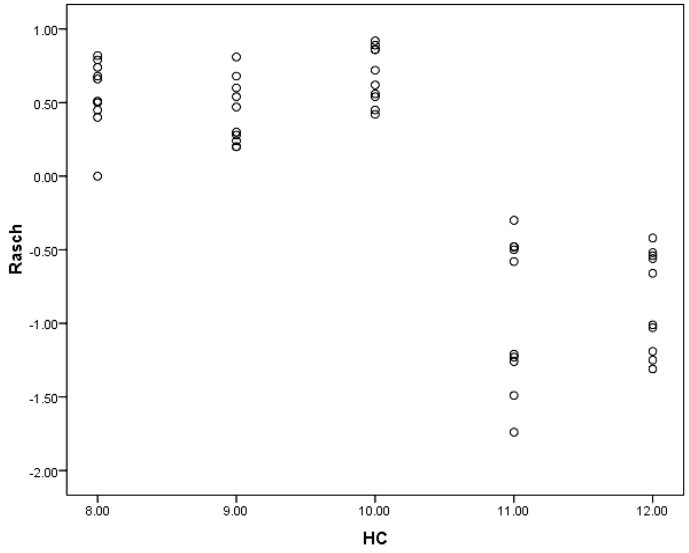
Table 9
ANOVA Summary Table

Model	Sum of Squares (SS)	Df (Deg. of Freedom)	Mean Square (SS/df)	*F* *(between/ within)*	Sig.
Regression	17.364	1	17.364	65.405	<.001
Residual	12.743	48	.265		
Total	30.107	49			

Scattergram

The scattergram depicts the regression analysis of grouped item order of hierarchical complexity versus the Rasch scores, see *Figure 4.* Scattergram: item Rasch score versus order of hierarchical complexity. Ideally, the groupings would match the calculated Rasch score and the stage of complexity. For example, lower stages of complexity (*e.g.,* 8) would be grouped higher on the Rasch scale axis (*e.g.,* 2.00). As can be seen, this is not the case. While the lower complexity stages 8-10 are relatively high in the scattergram, they are all near-equal in distribution. Similarly, the higher stages 11 and 12 are both appropriately depicted low on the Rasch scale (below 0.00 to -2.00); they are, similarly, near equal. As previously stated, this is attributable to a constricted sample relative to complex reasoning development.

Figure 4. Scattergram: item Rasch score versus order of hierarchical complexity



Stage Measures

Determining the participants' complex reasoning stage was achieved through a calculation in accordance with the below equation:

Equation 9. Stage calculation

$$\text{Stage of Person} = \frac{\text{PersonRaschScore} - \text{StageMean}_1}{\text{StageMean}_2 - \text{StageMean}_1} + \text{ItemHC}$$

First, to conduct this calculation I calculated the item average Rasch score (*e.g.,* StageMean = the average of all raw Rasch scores for same order of HC questions, such as "Systematics" stage 11 listed in column "Rank"), see Appendix 20: Calculating Stage Scores: HC Stages. This was facilitated by the WINSTEPS scores shown in the appendix (column "Measures"). As an example, all Concrete stage 8 questions resulted in an average measure of 0.657. These values, ordered by the HC stage, are shown in

Table 10

HC Stages-Ordered by Rank.

Table 10
HC Stages-Ordered by Rank

Average of HC Stage *Ordered by Rank*		
8	0.657	Concrete
9	0.432	Abstract
10	0.684	Formal
11	-0.927	Systematic
12	-0.849	Metasystematic

As can be seen, the calculated average values for each HC stage does not linearly change from HC stage 8 to HC stage 12. Rather, these values "jump" (moving out of sequence).

Table 11
HC Stages-Ordered by Measure

Average of HC Stage *Ordered by Measure*		
10	0.684	Formal
8	0.657	Concrete
9	0.432	Abstract
12	-0.849	Metasystematic
11	-0.927	Systematic

As shown in

Table 11
HC Stages-Ordered by Measure, when the table is sorted on the measure value, as necessitated by the calculation (

Equation 9. Stage calculation), the orders of HC of the items are out of sequence.

Our stage calculation requires a linear transition in measurement values. The results, as can be seen in the table, reordering of HC stages, places them out of the sequence that was anticipated by the complexity structure of the questions (determined by the model of hierarchical complexity). As stated previously, I attribute this to the constrained population of research participants (from a narrow range of developmental levels).

Table 12
HC Collapsed Stages

Average of HC Stage *In order of HC Rank & Measure*		
8, 9, 10	0.591	Concrete-Abstract-Formal
11, 12	-0.888	Systematic-Metasystematic

This necessitated a corresponding narrowing of stages–collapsing of stages–into fewer than originally designed (from five: 8, 9, 10, 11, 12 to only two: high and not-high stages), see Table 12

HC Collapsed Stages and Appendix 21: Calculating Stage Scores: Participants' Stage. This is necessitated by the minimum number of observations for the statistical regression analysis where individual participant HC stages must be calculated.

Second, my next step in determining participant HC stage was to retrieve from my analysis (WINSTEPS table) each participant's score. In accordance with the calculation methodology, each participant score must fit between two stage scores. I found seven (7) below the minimum HC stage 8 score (*i.e.*, higher than 0.657 as shown in

Table 10

HC Stages-Ordered by Rank), so were eliminated from further analysis. This reduced the population for future statistical analysis to 83. The results of this HC stage analysis are shown in Appendix 21: Calculating Stage Scores: Participants' Stage where each participants HC stage has been determined, as by calculation

Equation 9. Stage calculation.

Results of Stage of Complex Reasoning Hypothesis Testing

The hypotheses that were tested in this phase of the research analysis are those listed below (2, 4-6). The theme of these hypotheses is that of ability to measure development within general psychological dimensions of workplace activity that are themselves divorced from domain-specific skills, abilities, and competencies and, further, can be conducted with reduced cultural bias.

Hypothesis 2:
Can be ascertained by focused examination within the theorized psychological dimensions of organizational tasks.

Hypothesis 4:
Can be measured by the order of hierarchically complexity of reasoning stages that is divorced from concepts of skill-based performance.

Hypothesis 5:
Measures of executive development can be performed separate from concepts of domain and context in which the assessment is conducted.

Hypothesis 6:
Measures of executive development can be conducted with reduced cultural bias.

The design of the research instrument was based on vignettes of sequentially increasing complexity. This was to guard against the environmental influences which may be introduced through domain, context, or culturally specific circumstances. Research respondents were anticipated to have an affinity for scenarios reflecting their individual stage of complex reasoning (Commons & Pekker, 2005), or as Commons et al. (2005) suggested, stage of complexity which the individual "utilizes to organize information" or "perceive the world."

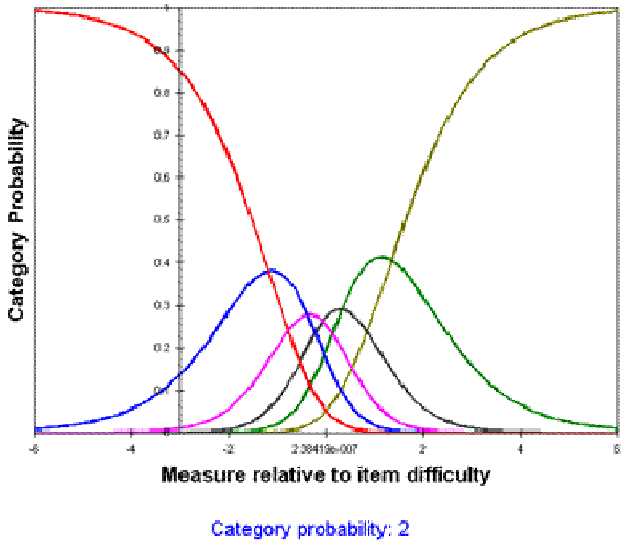


Figure 5. Category probability curves

A first review of the success of this scheme is a review of the participant selection of response categories (Likert scale 1-6). In accordance with the design of the research instrument, respondents were anticipated to selected higher order complexity scenarios reflecting their development stage (rather than familiarity with domain, context, or cultural influences). Therefore, expected was a pattern of higher category selection (*e.g.,* "6") as the item complexity increased (*e.g.,* across the x axis from "concrete" stage 8 to "metasystematic" stage 12) depicted in the graph as Rasch log scale measures. Shown in *Figure 5.* Category probability curves shows this distribution. The relative item difficulty is on the x axis and the probability of selection scaled on the y axis. The graph reveals that as the item difficulty increased, moving across the x axis, that the selection probability shifted from category "1" (first curve), to category "2" (second curve), through categories "3," "4," and "5" to the most complex scenario and correspondingly the most developed individual with probability depicted in the sixth curve ("6").

Table 13
Category Frequencies

CAT LABEL	OBSERVED COUNT	%	OBSVD AVRGE	SAMPLE EXPECT	INFIT MNSQ	OUTFIT MNSQ	CATEGORY MEASURE	
1	360	8	-.77	-.77	1.02	1.07	-2.56	1
2	605	13	-.53	-.56	1.09	1.22	-1.13	2
3	584	13	-.29	-.27	1.09	1.18	- .34	3
4	582	13	.10	.15	.99	1.00	.29	4
5	636	14	.70	.67	.85	.84	1.13	5
6	423	9	1.16	1.16	1.00	1.01	2.66	6

Similarly, a second review of the success of this scheme was to assess the rating category functioning. Bond and Fox suggested that the simplest way to do this is to review the use statistics (2007, pp. 222-223), see Table 13 *Category Frequencies*. They suggest that "eyeballing" the category average measures reflect the average respondent ability on a log scale. The average measures should increase as the variable difficulty increases. The WINSTEPS statistics reveal

this pattern. As the response categories increased from "1" to "6" the average measure increased from -2.56, through -1.13 and +1.13 to +2.66.

The ability to assess complex reasoning development free of domain, context, and cultural influences is clearly shown in the data-to-model reliability and fit (see Table 7 *Rank: Measure*), the response distribution depicted in *Figure 2.* Rasch map: participants and *Figure 3.* Rasch variable map, the regression statistics (see Table 8 *Regression Analysis, Model Summary* and Table 9

Model	Sum of Squares (SS)	Df (Deg. of Freedom)	Mean Square (SS/df)	*F (between/ within)*	Sig.
Regression	17.364	1	17.364	65.405	<.001
Residual	12.743	48	.265		
Total	30.107	49			

ANOVA Summary Table), the scattergram depiction of development stage responses (*Figure 4.* Scattergram: item Rasch score versus order of hierarchical complexity), and the category function assessment shown in *Figure 5.* Category probability curves and Table 13

Category Frequencies.

Statistical Analysis: Contributors to Complex Reasoning Stage

This section summarizes the results of the comparative analysis of the participants' exhibited complex reasoning stage and the underlying, contributing developmental circumstances. It is organized in two subsections: first, a basic correlation review and, second, a binary logistic regression analysis of the two collapsed HC stages.

Basic Correlation Review

I first attempted to identify any obvious bivariate correlations between the HC stage dependent variable and one of the seven independent variables (IV) listed below, see Table 14

Bivariate HC Correlation. I executed this examination first to identify the existence of and understand the strength of any variable relationships before executing a regression analysis to explore the nature of such relationships. I compared HC stage to the participants':

1. Degree (*e.g.*, BS, MS, PhD)
2. DEVprog, development programs (*e.g.*, seminars, courses)
3. DEVyrs, development years (time dedicated to development programs)
4. CARwork, type of engaged career work. (*e.g.*, routine, organizational change)
5. CARfunc, functions in which work was performed (*e.g.*, administration, engineering, human resources)
6. CARsupport, type of received support (*e.g.*, collegial, role model, mentor)
7. CARyrs, years of experience throughout the career

Table 14
Bivariate HC Correlation

Correlation

		HC
Spearman's rho	Degree — Correlation Coefficient	-.108
	Degree — Sig. (2-tailed)	.333
	Degree — N	83
	DEVpro — Correlation Coefficient	.004
	DEVpro — Sig. (2-tailed)	.970
	DEVpro — N	83
	DEVyrs — Correlation Coefficient	.150
	DEVyrs — Sig. (2-tailed)	.175
	DEVyrs — N	83
	CARwork — Correlation Coefficient	-.003
	CARwork — Sig. (2-tailed)	.978
	CARwork — N	83
	CARfunc — Correlation Coefficient	-.065
	CARfunc — Sig. (2-tailed)	.560
	CARfunc — N	83
	CARspt — Correlation Coefficient	-.071
	CARspt — Sig. (2-tailed)	.524
	CARspt — N	83
	CARyrs — Correlation Coefficient	.037
	CARyrs — Sig. (2-tailed)	.743
	CARyrs — N	83

I found no correlation between the individual's HC stage and the seven circumstances of interest when examining the Spearman's ρ correlation, the most appropriate non-parametric measure of correlation for this analysis (R. Mooring, PhD, Statistics Professor, Clayton State University, personal correspondence, September 15, 2008). As can be seen in Table 14

Bivariate HC Correlation all correlation values fell below the +.20 weak positive correlation and above a -.20 weak negative correlation (see Table 10.11 in Newton & Rudestam, 1999, p 264). As explained in an earlier section (WINSTEPS Maps), I attribute this to the constricted development levels and the exhibited stage of complex reasoning among the participants; all participants were narrowly defined in these dimensions. This inability to clearly indentify relationships between the dependent and any independent variables foreshadowed difficulty in running a meaningful regression analysis where relational character would be explored. I explain this difficulty in the next section.

However, I identified some obvious moderate to strong positive correlations such as an individual's age and the years of experience (Spearman's ρ = .656). One would expect that as years of experience increases that the participant ages. As a further example, I explored the correlation between participants' development programs and the development years dedicated to these programs, where I expected to find a significant relationship. I found a positive correlation, Spearman's ρ = .553 (a complete correlation review is provided in Appendix 22: Complete Bivariate Correlation Review).

I sought, as well, to explore other basic correlations between the expanded variables from the participants' survey-based development inventory (*e.g.*, age, gender). I identified interesting correlations between the work in which the research participants have engaged (CARwork, *e.g.*, organizational change) and the functions within which they have worked (CARfunc, *e.g.*, Engineering, with a Spearman's ρ = .294) and with the amount of support received throughout their careers (CARspt, *e.g.*, role model, mentor, with a Spearman's ρ = .264). While not part of this research study, these findings call for further research into type and amount of support provided individuals and the influence on work in which they are engaged.

Binary Logistic Regression Analysis

In that research participation necessitated the collapsing of HC levels, I conducted a binary logistic regression analysis to determine significant contributing factors to higher stages of developed complex reasoning. Binary logistic regression requires that the dependent variable be dichotomous (or ordinal in the case of HC stages) and the independent variables be metric or dichotomous.

First it was necessary to determine if I had obtained an adequate sample size for this analysis. To determine this I ran a baseline logistic regression in order to obtain basic information, such as outliers that lay outside of two (2) standard deviations. My data contained no outliers. In addition, the 83 valid cases met the requirement of at least 10 to 1 cases to independent variables (considering seven independent variables, the ratio of 11.9 to 1). Second, I determined the validity of interpreting the relationship between the HC stage dependent variable and the selected independent variables (*e.g.*, degree, years of experience) by conducting a test of accuracy rate on my model (in SPSS). As shown in Table 15 *Model Accuracy Rate Test*, the accuracy rate of my regression model is 77.1%; therefore, it is valid to use the model to interpret the relationship between the HC stages and independent variables of interest.

Table 15
Model Accuracy Rate Test

Model Accuracy Rate Test

Classification Table[a,b]

			Predicted HC		
		Observed	**0**	**1**	**% Correct**
Step 0	HC	0	64	0	100.0
		1	19	0	.0
		Overall %			**77.1**

a. Constant is included in the model.

b. The cut value is .500

Third, I checked for multicollinearity (high correlations between independent variables, see, e.g., Newton & Rudestam, 1999, p. 264) and numerical problems with the model. I did this by examining the standard errors (S.E.), or the "standard deviation of a hypothetical distribution of correlation coefficients among samples sizes of a given size drawn from the same population" (Rowntree, 1981, p. 166), for the *b* coefficients. An S.E. larger than 2.0 indicates a numerical problem (such as multicollinearity). As shown in Table 16 *Multicollinearity and Numerical Problems*, no independent variable has an S.E. larger than 2.0; therefore, I identified no problems that would preclude using the model.

Table 16
Multicollinearity and Numerical Problems

Variables in the Equation

		B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Step 1	**Degree**	-.142	**.227**	.390	1	.532	.868
	DEVpro	-.009	**.047**	.035	1	.851	.991
	DEVyrs	.036	**.081**	.197	1	.657	1.037
	CARwork	-.015	**.031**	.227	1	.633	.985
	CARspt	-.023	**.051**	.193	1	.661	.978
	CARyrs	.018	**.025**	.526	1	.468	1.018
	Constant	-.778	**1.098**	.502	1	.479	.460

Fourth, I examined the overall seven-IV model relationship, based on the statistical significance of the model's chi-square (χ^2) value. I sought to understand the significance of the difference between the

HC stages within the dimensions specified in the seven independent variables or, in other words to determine whether the observed frequencies clearly differ from the frequencies that could be expected by chance.

Table 17
Model Overall Relationship

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	1.639	6	.950
	Block	1.639	6	.950
	Model	1.639	6	.950

The assumed null hypothesis in this test is that both high and not-high development stage groups have equal educational and experiential circumstances. The resultant $\chi^2 = 1.639$ is non-significant. The null hypothesis is true, which was explained earlier in the constricted participant group with narrowly defined developmental dimensions.

Fifth, I next examined the individual relationships to determine if there is a relationship between each independent variable and the dependent variable (HC). To do this I examined the significance of the Wald χ^2 test of the β coefficient and the interpretation of the odds ratio, Table 18

Individual IV Relationships. It is used to test the statistical significance of each coefficient (β) in the model.

Table 18
Individual IV Relationships

Variables in the Equation

		β	S.E.	Wald	df	Sig.	Exp(β)
Step 1	**Degree**	-.142	.227	.390	1	.532	.868
	DEVpro	-.009	.047	.035	1	.851	.991
	DEVyrs	.036	.081	.197	1	.657	1.037
	CARwork	-.015	.031	.227	1	.633	.985
	CARspt	-.023	.051	.193	1	.661	.978
	CARyrs	.018	.025	.526	1	.468	1.018
	Constant	-.778	1.098	.502	1	.479	.460

Shown in Table 18 *Individual IV Relationships* is that no IV has a probability of the Wald χ^2 statistic that is less than or equal to $\rho = 0.05$, as required for significance. Even if the significance has been acceptable no Wald χ^2 was significant. As an example, the significance of the number and type of development programs taken by the research participants (DEVpro) is 0.851. In other words, they are near chance level. Again, this is attributed to the constricted participation group with similar developmental circumstances and complex reasoning stages.

Similarly, in Table 18 *Individual IV Relationships*, the Exp(β) factor indicates the decreased odds ratio (decrease in odds = [Exp(β) – 1]) are insignificant. In the case of the number and type of development programs taken by the research participants (DEVpro), there is a 0.9% (.009) chance that higher developmental stage participants chose lower stage choices.

Results of Contributors to Reasoning Stage Hypothesis Testing

The hypotheses that were tested in this phase of the research analysis are those listed below (1, 3). The theme of these hypotheses is that the inherent aspects of education and

experience of executive development will be manifest in and measurable by higher complex reasoning stages.

Hypothesis 1:
Executive development leading to the acquisition of higher levels of complex reasoning positively correlates with a combination of education and experience.

Hypothesis 3:
Executive development correlates with higher levels of complex reasoning.

I found in this study no strong correlations between stages of complex reasoning and examined developmental circumstances. However, I recognize the general acceptance of this phenomenon, that development is a result of "a variety of forces that may interact in quite complex ways" (Stevens-Long & Commons, 1992, p. 55). All world view incorporates this, albeit in different ways (see, *e.g.,* Goldhaber, 2000). As an example, a "mechanistic" worldview accounts for connected parts of a greater whole where development emerges from responses to life experiences (Super & Harkness, 2003). The "organistic" worldview allows for the notion meaning borne of a maturing pattern of psychological constructs as espoused by Frued (see reference in Hothersall, 1990), Erickson (2002) and Piaget (1950). And the "contextualist" worldview (Thomas, 1996) where contextual circumstances shift from a setting in which developmental "unfolds" to one in which the individual "self-constructs" or engages in *autopoiesis* (Greek: self-production), which is considered more "pragmatic" (Morris, 1997). So, while there is a robust debate among these lines of developmental theory (Super & Harkness, 2003), all incorporate a view that development is associated with and a function of life circumstances, occurring "across the lifespan" (Coleman & Watson, 2000).

I attribute the inability in this study to isolate specific circumstances to two principal reasons. First, as stated earlier the sample size was small and constricted to a narrow range of participants (organization position, degree, etc.). This resulted in the inability to, one, acquire participants with a wide range of development stages necessitating collapsing the sought-after five-stage response (Stage 8-12) into two groups (high and not-high). I started, then, not with five-stage wide-ranging cases, but rather two. Second, this was combined with the similar developmental circumstances of the participants (*e.g.,* 80% possessing graduate level degrees, and nearly half from the departments of Administration and Human Resources: respectfully, n = 24 or 27.6% and n = 13 or 14.9%).

These results suggest the need for additional research into the influences of developmental circumstances to the acquired ability for higher stages of complex reasoning.

Summary of Data Analysis and Results

Human research idiosyncratic circumstances can result in unexpected test results (Bond & Fox, 2007). In the case presented here, for example, an individual with a highly developed stage of complex reasoning may score lower due to, in part, the environmental circumstances at the time of participation. One could well imagine the influences to ability if taking the survey in the evening "over a glass of wine" versus one taking the survey in the office as an emergency occurs or one setting time aside to complete the survey in the quiet of a home office. This calls for future research to offer suggested environment circumstances in which to take the survey. However, I recognize that the complete elimination of this phenomenon is not likely in human

research. As Fox and Bond suggested, “human behavior rarely shows rigid step-like patterns of progression” (2007, p. 23).

The results of this study are mixed. First, I found that the Model of Hierarchical Complexity to be well-suited for reduced bias measurement of development within an organizational setting. Beyond measuring relative stages of development, utilizing the Rasch model, this approach allows for an understanding of the relative “distances” between levels. This is facilitated by the Rasch calculation of a logarithmic, interval scale on which to map the results.

However, there are important aspects of utilizing this methodology, including sample size and the distribution of the research participants’ development stages. As was evidenced in this study, a relatively small sample size that is concentrated within a narrow trait range can produce confusing results. As an example, I found the HC stages to be out of order, as can be clearly seen in *Figure 2*. Rasch map: participants. It can be seen that, as expected, the “concrete” stage responses (stage 8) are depicted high on the scale (indicating a low stage of reasoning development). However, the next emerging development stage in this test is the “formal” stage (stage 10) which becomes intermixed with the next emerging stage, “abstract” (stage 9). Therefore, to adequately apply this methodology to the measure of development, the sample size has to be, first, large and, second, well-dispersed across all development stages of interest.

Second, I was not able to identify from this small, similarly developed group significant contributors to their development. Again, this is attributable to the research participation. When several explanatory variables are introduced into the analysis, as in the case of contributing factors to the development of higher stages of complex reasoning, a regression analysis is the best suited statistical methodology (Cook, et al., 2000). However, it as well requires an adequate sample size with well-dispersed variables.

CHAPTER FIVE: DISCUSSION

Objectives, Approach, and Questions

The principal objectives of this research were, first, to show that hierarchical stages of executive complex reasoning can be measured within an organizational setting and, second, to identify the common developmental experiences that have contributed to the development. In my approach to explore these I employed different statistical assessment methodologies for each objective. First, to assess developmental levels I used a Rasch analysis (Bond & Fox, 2007; Bradley, 2005). This sophisticated statistical methodology is used in human science studies to discern and graphically illustrate the relationship between study participants' responses and the survey questions (*i.e.*, items of interest). This underlying statistical formula determines "patterns of relationships," transforming the raw data into an interval log odds scale. I used a statistical program designed for this type of analysis: WINSTEPS (Linacre, 2006; Trudeau & Adams, 2005). It is, then, possible to measure and compare various individuals within a single trait (in this study that of complex reasoning) using a standard measurement ruler. Second to determine the contributing experience to the development I employed statistical regression analysis. My intent in this analysis was to identify the experiences (academic and work) that strongly correlate to higher stages of complex reasoning. I explore the findings of my research of these objectives in the next two sections.

A subordinate objective was to better understand the capacity of the Model of Hierarchical Complexity (MHC) to assess stages of developed executive complex reasoning within the theorized dimensions of work (see Sub-part 3: Psychological Dimensions of Measurement). While MHC has been used in various applications (see, e.g., Armon & Dawson, 1997; Commons & Bresette, 2006; Commons & Rodriguez, 1990; Commons, et al., 2006; Commons & Sonnert, 1994; Oliver, 2004) including organizational (Commons, et al., 1993), the prior applications of the instrument have not included executive development studies that incorporate hierarchically complex executive-subordinate scenarios that occur within the theorized dimensions of organizational tasks.

Research Question 1

The first principal question I sought to answer in this study was how can the hierarchical stages of complex reasoning in the organizational executive be effectively measured without reliance on domain, context, or cultural bias? This question was borne of an exploration of the active dialogue in the scholarly community relative to, first, *what* to measure in executive development (often confused between conflicting notions including those of intelligence and performance) and, second, *how* to make the measurement? It was my hope to show an effective, reduced-biased, and cognitive-based means to do so.

Research Question 2

The second principal question this study sought to answer was what are the common developmental experiences of the development? I employed a statistical regression analysis for this aspect of the study.

Findings

Objective 1, Developed Stage of Complex Reasoning

The first principal objective of the research was to show that hierarchical stages of complex reasoning can be measured for the executive within an organizational setting. This was

clearly shown. Based on the utilization of a Rasch analysis (see, e.g., Bond & Fox, 2007), the measured stages were determined from a sophisticated mathematical foundation, resulting in a logarithmic interval scale.

Objective 2, Contributing Developmental Factors

A second principal objective of this study was to better understand the experiential contributors to the development of higher stages of complex reasoning. I was disappointed to have a "negative finding," one that does not support my hypothesis. However, there is significant value in this.

Subordinate Objective, MHC

This study established the capacity to assess stages of developed executive complex reasoning ability within the theorized dimensions of work. In a reduced bias fashion, each vignette was designed with, first, these work dimensions and, second, with sequentially higher levels of complexity in accordance with the application practice for MHC (Commons, Goodheart, et al., 2005). With the utilization of a Rasch analysis, it also provides a graphic display of the stage results (see Figure 2. Rasch map: participants and Figure 3. Rasch variable map).

Findings Relative to Research Question 1

Some researchers contend that there has been little progress toward more effective development measurement (P. Brown, 2003). This area remains confused, employing a wide-range of approaches for development measurement, from the individual executive's characteristics (Bernthal, et al., 2001), personal performance outcomes (Burke & Collins, 2005), psychological dimensions (Lee, 1999), or the organizational performance in which he or she works (Landale, 2003). All of these approaches introduce different biasing aspects which precludes effective cognitive development assessment (Tulloch, 1989).

My study used a different measurement to eliminate the biases introduced through the aforementioned concepts. I used the Model of Hierarchical Complexity (Commons & Pekker, 2005, 2006) to measure executive development within the organizational setting. Employing a reduced-biased, mathematically-sound, logic structure in the design of sequentially more complex single-trait (reasoning) vignettes, the participants were free to employ their complex reasoning stage in the vignette assessment. From the observed maps of relative complex reasoning stages of the participants (*Figure 2.* Rasch map: participants and *Figure 3.* Rasch variable map), I conclude that the methodology was effective. It is important to note that the intellect- and domain-neutral language of the employed vignettes, centered on the single trait of complex reasoning, allowed the participants to apply their reasoning stage to the underlying logic structure of the hierarchically more complex arguments. This eliminated the adulterating aspects of intellect (what they know) and performance (what they can do), as is commonly employed in such measurements. This allows me a methodology to measure executive development on an absolute scale and, further, to compare these stage measurements of complex reasoning between disparate populations (*e.g.*, occupations, industries, and experience levels). From my investigation of other development assessment methodologies, I conclude that the MHC, as here applied in an organizational setting to be a superb one for executive development measurement.

In addition, I conclude from my research post-mortem that there are other positive features of the methodology that are worthy of consideration in the scholarly discourse.

Principal among these are: the employed Rasch analysis, resultant interval scale, identification of stage transition, and application in studies of dynamic cognition.

First, I conducted a rigorous examination of the data through the lens of a Rasch analysis (Bond & Fox, 2007) which produces an interval log-odds scale from raw Likert categories. While this analysis is fundamental in the human sciences, it seems, paradoxically, to be little recognized and used in the human sciences. As an example, in conversation with two psychology professors at the University of North Carolina, this researcher found that neither was familiar with it (I invite the reader to review footnote 6). Those under the tutelage of Dr. Commons, including me, not surprisingly, all use a Rasch analysis in their studies. In that the Rasch identifies statistical patterns in matrix data and, from that, develops a log odds scale (see footnote 3) it provides an interval scale based on the empirical difficulty of the vignette from the ordered Likert scale data. As an illustration, the distance between the single stage move from the formal stage 10 to the systematic stage 11 may be different from that of systematic stage 11 to the metasystematic stage 12. Therefore, I conclude that the Rasch analysis is excellent tool in the human science researchers' repertoires.

Second, I concluded in my investigation of the MHC, its design, application, and potential application to be well-suited to investigating stage transition (Commons, 2006). This is important in two dimensions. First, is the clear depiction of stage movement indicating the degree of movement to the next higher stage and, as well, the probable degree of difficulty executing the remaining movement and, consequently, the degree of development effort necessary to influence this movement. This could prove exceptionally beneficial in the design and application of executive development programs, from "generic" to that customized to the circumstances in which the executive resides. As an example, executive development could be designed with strong consideration of the currently developed cognitive stage of the executive and their movement to the next higher stage. Second, this is particularly important to this research in its implication for future research in developmental neurocognition. In this application, the MHC could measure the change in behavior (intellectual) in time, as necessary to conduct dynamic systems research. As an example, while Kelso (1995) conducted development research in accordance with dynamic systems theory, he did so reflected by physical movement. Specifically, he researched the undergirding cognitive patterns that are made manifest in infant physical behavior (*e.g.*, leg movement). However, he contended that other systems are as adequate for this "paradigmatic representational" systems research, such as that introduced here in my study of intellectual behavior. I conclude that with continued development, including aspects of three-dimensional state space and time, that MHC can be adapted for dynamic cognition research.

The MHC, as a mathematically-sound instrument, has implication for future dynamic cognition studies. Dynamic cognition researchers well-recognize the importance of modeling cognitive patterns within three-dimensional state space (see, e.g., Port & van Gelder, 1995b; Tschacher & Dauwalder, 2003). As a matter of fact, Kelso (1995) contended that the first step in the design of a development program is the ability to map the existing cognitive patterns, necessary in the design of interventions to disrupt these initial patterns. This would prove problematic without an ability to discern, as theorized for the MHC, the cognitive movement in time as necessary to map patterns. I conclude, then, that with future refinement and modification that the MHC will be applicable to adequately measure intellectual behavior (cognitive pattern movement in time) which is necessary in cognitive systems research. This, as stated earlier, was an objective of this study–to introduce the MHC for such use.

However, I did not find the application of the MHC without difficulty.

Findings Relative to Research Question 2

The second principal question this study sought to answer, what are the common developmental experiences of the development? I employed statistical regression analysis for this aspect of the study. However, I found the results somewhat weak in that, given the narrowly defined population of participants, the regression analysis was ineffective. However, first, I conclude from earlier investigations in this area that a regression analysis is well-suited for this application. Second, again based on previous research, I believe that there are definable contributing experiences to cognitive development made manifest in hierarchical stages of complex reasoning. However, I ultimately conclude, that one has to be fiercely respectful of the underlying statistical principles in application. Most noteworthy and fundamentally here is the principle that a regression analysis requires an adequate number of subjects (see, e.g., Newton & Rudestam, 1999).

Conclusion

Contribution to the Body of Knowledge

There is an on-going debate within the scholarly community that has direct impact on the development practitioner. Executive development centers on cognitive development (Jackson, et al., 2003). This foundationally rests upon the notion that learning involves neurological change (Changeux & Konishi, 1987). However, there is a gap between theories of cognitive development and developmental practices (Shen, 2005). Rather than cognition-based development, many executive development programs concentrate on intellect-focused education and skill-based training (see, *e.g.*, Digman, 1978; Holstead, 1988; McHale, 1995; Rodwell, 2005). This study makes a significant contribution to the scholarly discourse in two dimensions.

First, I have successfully demonstrated that executives' development can be measured in an absolute scale of hierarchical stages of complex reasoning. This supports my hypothesis that there is such correlation between development and higher stages of complex reasoning (hypothesis 3). Additionally, in that the employed vignettes were constructed within the theorized psychological dimensions of organizational tasks and neutral relative to domain, context, and culture, these findings support my hypotheses 2, 4, 5, and 6. Therefore, executive development can be measured in terms of cognition (complex reasoning) in a reduced-bias fashion.

Second, while hindered by sample size, I demonstrated a methodology whereby subsequent research can discern principal contributing experiences for higher stages of complex reasoning. Hopefully, this will contribute to the scholarly discourse relative to moving executive development into the realm of cognition and away from simply acquiring more knowledge or skills. I was, then, unable to support my hypothesis that executive development positively correlates to a combination of education and experience.

I am confident that, rather than what the finding here suggests, that there *are* environmental influences to development, including education and experiences. Future research into this area will have to account for the research circumstances encountered with this study in order to avoid similar results (*e.g.*, small and too similar research population). Future research will benefit from securing the support of one or more sponsoring organization that may act as advocate, or at least facilitator, in the process of inviting individuals to participate in the research. As evidenced in the study, without such "up-front" support, the participation

solicitation process is, first, complex and time consuming, and second, can result in anemic response (*e.g.*, the 90 responses from over 30,000 invitations).

However, I am confident in the regression analysis as the appropriate technique to identify the circumstantial variables within a wider representation of research participants (J. Osborne, Ph.D., Professor, North Carolina State University, Statistics Department, personal correspondence, September 2008). There are various procedures for a regression analysis, distinguishable "in terms of both how variability is partitioned among the variables and who controls the process of entering variables into the regression equation" (Newton & Rudestam, 1999, p. 252). The procedure advocated by me is that of a "stepwise regression" where, in the "step-up stepwise" version, the order of variable entry into the procedure is determined by the program (*e.g.*, SPSS) in accordance with their contribution to prediction (see, e.g., Howell, 1987, pp. 494-500). This should identify and order the various contributors in terms of importance.

In addition to the perspectives of this study provided in the previous section and the foreshadowed research outlined in the next, this study has contributed to the body of knowledge by informing the dialogue in executive development to a reduced bias measurement. As discussed earlier in this study, much of the discussion relative to development is locked in reviews of qualifications, attributes, performance, characteristics, and traits (specifically, relative to leaders). As many have found, such assessments have been left wanting. Peter Senge (1990), when he called for "systems thinking," is calling for a higher stage of developed complex reasoning, which was the focus of this research. Measuring traits and characteristics does not measure such thinking. This research opens the door to a mathematically sound means to more accurately assess executives' developed stage of complex reasoning. Therefore, I hope that this research provides a cognition-centered framework that informs both executive development program design and the post-development assessment methodology. I hope, as well, that this research informs human resource practitioners as they consider the findings of this research for potential applicability in non-development areas, for example application to hiring, advancement, and development plans.

This is of significant importance to the development community. I recognize that there has been little development in conceptual framework of development (Bedinham, 1998). This impacts both development program design and the subsequent, post-development assessment. As stated earlier, executive development programs are significantly linked to intellect-focused education and skill-based training. Respectfully, the assessments center on acquired knowledge or demonstrated performance. I hope that this research provides a cognition-centered framework that informs both executive development program design and the post-development assessment methodology.

This research has potential applicability in non-development areas, as well. As an example, it could include its application to hiring, advancement, and development plans. One could assess the current complex reasoning stage, the degree to which the participant has transitioned to the next higher stage and, thereby, indicating the degree of effort necessary for the move to the next. The employed hierarchical complexity methodology compensates for other measures of intelligence and intellectual development which are domain and context based (Commons & Pekker, 2005), that infer a mental structure reflective of mentalistic theories (Commons, Goodheart, Miller, & Danaher-Gilpin, 2005; Commons & Miller, 2001); it bases such measurement, rather, on an absolute scale of hierarchical complexity development.

Importantly, this depiction of the stages provides me, and hopefully in the future practitioners, an informed view on the necessary "movement" from one development stage to the

next. With further research (see following "Recommendation for Future Research" section, "Dynamic Systems and Cognitive Development"), this understanding could include the necessary developmental actions that are necessary to result in a stage movement. As an example, in accordance with principles of a dynamic systems approach to cognitive development (see, e.g., Kelso, 1995; Port & van Gelder, 1995b; Savelsbergh, van der Maas, & van Geert, 1999; Thelen & Smith, 1994; Tschacher & Dauwalder, 2003) and reflective of the Model of Hierarchical Complexity, such customized actions may include calculated and purposeful interaction with the environment (education, experience), purposeful deconstruction of previous stages (*i.e.*, the necessary destabilization of the attractor and stable state), and the systematic construction of a new stage (*i.e.*, phase shift to a new pattern) (M.L. Commons, personal correspondence, November, 2005). Foundational work in understanding this pattern of transition has been accomplished (Dawson-Tunik, et al., 2005).

As I stated earlier, the application of the MHC is not without difficulty in this regard. They are explored next.

Narrowing Stage View

I found that this study would have been strengthened by narrowing the range of stages of the study to those considered most appropriate for the participant group of interest (M.L. Commons, personal correspondence, December 16, 2008). Here, as an example, with the focus on the organizational executive, the appropriate stages should have been stages 10, 11 and 12 (formal, systematic, and metasystematic), see Table 3

Research Stage Profile. My decision to include lower stages in the assessment instrument contributed to the confused WINSTEPS mapping; the lower stages were not adequately represented in my research population. They were, then, superfluous to this study.

Minimum Number of Participants per Stage

Rasch researchers recognize that each investigated stage must have a minimum of 7 participants (Dr. Michael Lamport Commons, personal correspondence, December 16, 2008). As clearly depicted in the "maps" in this study (*Figure 2.* Rasch map: participants and *Figure 3.* Rasch variable map) I did not have this level of participation. This is due to two principal causes. First, as stated previously, I expanded the range of stage investigation well beyond the anticipated stage of the research participants (from the required 10-12 to the wider range of 8-12). Second, I experienced significant participant non-responsiveness, as explained earlier. While the lack of research participation is a general problem (Johnson, 2005), it proved to be a significant obstacle in this research. As an example, with only 90 participants covering a five-stage range (8-12), and further with most participants narrowly constrained within a few stages, many stages were left under- or non-represented. I conclude, then, two noteworthy aspects on conducting similar research. First, it is important for the research to narrowly define the exact range of stages that are important to the study and construct the research instrument within this range. Second, it may prove beneficial to secure the backing and sponsorship from an organization in which many potential research participants are affiliated. In this way one would increase the probability of securing an adequate sample size and, as well, increase the probability that all stages of interest are represented in the participant population.

Recommendation for Future Research

Dynamic Systems and Cognitive Development

It is hoped that this research will contribute to an expanded inquiry into the dynamic patterns of cognitive development. As stated earlier in this study (sub-part 4), it is currently constrained within the realm of the paradigmatic representation based on physical behavior (see, e.g., Kelso, 1995; Thelen & Smith, 1994); *physical* behavior is relatively easy to measure (Fischer & Rose, 1999). This study, in part, was designed to introduce a method of measuring *intellectual* behavior that incorporates in the procedure for doing so a sound mathematical foundation. Of course, on the way to application in dynamic systems research, the MHC will have to, first, strengthen in the application of measuring developmental *stage transition* and, second, reconcile a technique that allows for *measurement over time* (as required by the dynamic systems view) (see, e.g., Port & van Gelder, 1995a). In this regard, Port and van Gelder emphasized in *Mind As Motion* that "cognitive processes always take place at many time scales … emergence of sophisticated capacities can take months and years" (Port & van Gelder, 1995b, p. 25).

In light of this, it is important to note also that the paradigmatic notion of one system (*e.g.*, physical or intellectual behavior) representing another (*e.g.*, cognitive processes) is that proposed by Hermann Haken (1983) (see reference in Tschacher & Dauwalder, 2003, p. vii), father of Synergetics[4]. It is extensive applied in current research (see, e.g., Barr, Beek, & Calinoiu, 1999; Carrier, 1992; Hock, et al., 1993; Jirsa, Fuchs, & Kelso, 1998; Kay, Kelso, & Saltzman, 1991; Kelso & Jeka, 1992; Tuller, Case, Ding, & Kelso, 1994).

Leadership System

The psychological dimensions incorporated into the vignettes of this study, were first recognized in an examination of leadership, a dynamic leadership system (McElroy, 2005). Given the probable interplay of the leader's ability within such a complex dynamic system and their individual cognitive development, further research should be conducted in this area.

Support and Work Influence

Found in this study was a correlation between the work in which the research participants have engaged (*e.g.*, organizational change) and the functions within which they have worked (*e.g.*, Engineering) and the amount of support received throughout their careers (*e.g.*, role model, mentor). These findings call for further research into type and amount of support provided individuals and the influence on work in which they are engaged.

Lack of Responsiveness for Research Participation

As stated earlier, some energy industry Human Resources professionals have asked that should this study reveal why it so difficult to engage the energy industry executive and manager they would like prescriptive feedback. This study did not explore the energy industry culture. However, if continued research is to be conducted relative to development within the industry the phenomenon of non-responsiveness will have to be effectively addressed. Therefore, further research will have to be conducted along these lines.

Movement and Link to Human Capital Management

This study and, more broadly, the ability to discern the stage of development in complex reasoning and to understand the stage transitions could better inform human capital management

processes. As an example, it could aid in hiring, advancement, and development plans. One could assess the current complex reasoning level, the degree to which the participant has transitioned to the next higher stage and, thereby, indicating the degree of effort necessary for the move to the next. As detailed earlier in this study, the MHC compensates for other measures of intelligence and intellectual development which are domain and context based (Commons & Pekker, 2005), that infer a mental structure reflective of mentalistic theories (Commons, Goodheart, et al., 2005; Commons & Miller, 2001); it bases such measurement, rather, on the logic structure that is domain and context neutral. Further research into such application should be conducted.

Cognitive Complexity: A Comparative Study of the Theories of Elliott Jaques and Michael Lamport Commons

There are similarities between the development theories of Jaques, as espoused in *Human Capability* (Jaques & Cason, 1994) and *A General Theory of Bureaucracy* (Jaques & Cason, 1994) and Commons, well-established in *Beyond Formal Operations* (Commons, Richards, & Armon, 1984) and, more specifically, incorporated into the Model of Hierarchical Complexity (Commons & Pekker, 2005). Of course, there are distinct differences. A worthy research project would be that of a comparative study that, perhaps, combines the strengths of both to inform an extension of the current thinking relative to developed cognitive complexity encompassed by these theories. Most notable in the similarities of these theories are:

- Both delineate stages (Commons & Pekker, 2005 14 stages, p. 11; Jaques & Cason, 1994 up to 15, p. 103)
- Which are developed over a lifetime
- That are discontinuous (Commons & Pekker, 2005, p. 13; Jaques & Cason, 1994, p. 97).
- Both pay homage to Piaget (Commons & Richards, 1984b; Commons, Richards, Ruf, et al., 1984; Jaques & Cason, 1994, pp. 97-101).
- As Harvard's Kurt Fisher suggested, both describe development beyond Piaget's formal operations as a move into abstract thinking (Fischer, et al., 1984).
- And what Jaques called "mental processing types" (Jaques & Cason, 1994, p. 30) may be Common's "rules" (logic structure) by which actions are coordinated.

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APPENDIXES

Appendix 1: Top U.S. Electric Utilities

Energy Information Administration
Official Energy Statistics from the U.S. Government

http://www.eia.doe.gov/

	Customers		Retail Sales		Revenue
20	**Alabama Power Co**	9	**Alabama Power Co**	13	**Alabama Power Co**
4	**Commonwealth Edison Co**	23	Appalachian Power Co	8	**Commonwealth Edison Co**
5	**Consolidated Edison Co-NY Inc**	6	**Commonwealth Edison Co**	19	Connecticut Light & Power Co
13	**Consumers Energy Company**	24	**Consolidated Edison Co-NY Inc**	5	**Consolidated Edison Co-NY Inc**
9	**Detroit Edison Co**	20	**Consumers Energy Company**	22	**Consumers Energy Company**
8	**Duke Energy Corporation**	12	**Detroit Edison Co**	15	**Detroit Edison Co**
3	**Florida Power & Light Company**	4	**Duke Energy Corporation**	10	**Duke Energy Corporation**
10	**Georgia Power Co**	21	Entergy Gulf States Inc	21	Entergy Gulf States Inc
19	Los Angeles City of	1	**Florida Power & Light Company**	25	Entergy Louisiana Inc
17	Niagara Mohawk Power Corp	2	**Georgia Power Co**	3	**Florida Power & Light Company**
16	**Northern States Power Co**	14	**Northern States Power Co**	6	**Georgia Power Co**
1	**Pacific Gas & Electric Co**	7	**Pacific Gas & Electric Co**	16	Long Island Power Authority
18	**PECO Energy Co**	11	PacifiCorp	24	Los Angeles City of
22	**PPL Electric Utilities Corp**	18	**PECO Energy Co**	23	Niagara Mohawk Power Corp
21	**Progress Energy Carolinas Inc**	16	**PPL Electric Utilities Corp**	20	**Northern States Power Co**
15	**Progress Energy Florida Inc**	17	**Progress Energy Carolinas Inc**	2	**Pacific Gas & Electric Co**
24	**Public Service Co of Colorado**	13	**Progress Energy Florida Inc**	11	**PECO Energy Co**
11	Public Service Elec & Gas Co	19	**Public Service Elec & Gas Co**	18	**PPL Electric Utilities Corp**
12	**Reliant Energy Retail Services**	10	**Reliant Energy Retail Services**	17	**Progress Energy Carolinas Inc**
23	San Diego Gas & Electric Co	5	**Southern California Edison Co**	14	**Progress Energy Florida Inc**
2	**Southern California Edison Co**	22	Tennessee Valley Authority	12	**Public Service Elec & Gas Co**
7	TXU Energy Retail Co LP	8	TXU Energy Retail Co LP	7	**Reliant Energy Retail Services**
25	Union Electric Co	15	Union Electric Co	1	**Southern California Edison Co**
6	**Virginia Electric & Power Co**	3	**Virginia Electric & Power Co**	4	TXU Energy Retail Co LP
14	Wisconsin Electric Power Co	25	Wisconsin Electric Power Co	9	**Virginia Electric & Power Co**

	Top Utilities
2	Alabama Power Co
3	Appalachian Power Co
4	Commonwealth Edison Co
5	Connecticut Light & Power Co
6	Consolidated Edison Co-NY Inc
7	Consumers Energy Company
8	Detroit Edison Co
9	Duke Energy Corporation
10	Entergy Gulf States Inc
11	Entergy Louisiana Inc
12	Florida Power & Light Company
13	Georgia Power Co
15	Niagara Mohawk Power Corp
16	Northern States Power Co
17	Pacific Gas & Electric Co
18	PacifiCorp
19	PECO Energy Co
20	PPL Electric Utilities Corp
21	Progress Energy Carolinas Inc
22	Progress Energy Florida Inc
23	Public Service Co of Colorado
24	Public Service Elec & Gas Co
25	San Diego Gas & Electric Co
26	Southern California Edison Co
27	Tennessee Valley Authority
28	Union Electric Co
29	Virginia Electric & Power Co
30	Wisconsin Electric Power Co

Appendix 2: HSRI Cognition Reading List

(see http://www.donhcs.com/hsr/proceedings/articles_topic.htm)

Cognitive Performance

Mental Readiness for Soldiering

- Bartone, P.T. (2006). Resilience under military operational stress: Can leaders influence hardiness? Military psychology, 18 (s), 131-148.
- Freedberg, S.J. (2006). The ultimate smart weapon. National Journal, April 22, 2006, pp 32-38.
- Gifford, R.K. (2006). Psychological aspects of combat. Chapter 2, pp 15-30. In: Britt, T.W., Adler, A.B. and Castro, C.A. (Eds). (2006). Military life: The psychology of serving in peace and combat. Vol. 4, Military culture. Westport, CT: Praeger Security International; Greenwood Publishing Group, Inc.
- Krulak, C.C. (1999). The strategic corporal: Leadership in the three block war. Marines Magazine, January 1999. Available at: www.au.af.mil/au/awc/awcgate/usmc/strategic_corporal.htm
- Scales, R. (2006). Clausewitz and World War IV. Armed Forces Journal, July 2006.
- Thompson, M.M. and McCreary, D.R. (2006). Enhancing mental readiness in military personnel. Chapter 4, pp 54-79. In: Adler, A.B., Castro, C.A. and Britt, T.W. (Eds.) (2006). Military life: The psychology of serving in peace and combat. Vol. 2, Operational Stress. Westport, CT: Praeger Security International; Greenwood Publishing Group, Inc.
- Wesensten, N.J., Belenky, G. and Balkin, T.J. (20050. Cognitive readiness in network-centric operations. Parameters, Spring 2005, 94-105.

Cognitive Neuroscience and Combat Decision-Making

- Driskell, J.E., Salas, E. and Johnson, J.H. (2006). Decision making and performance under stress. Chapter 7, pp 128-154. In: Britt, T.W., Castro, C.A. and Adler, A.B. (Eds). (2006). Military life: The psychology of serving in peace and combat. Vol. 1, Military culture. Westport, CT: Praeger Security International; Greenwood Publishing Group, Inc.
- Muth, E.R., Kruse, A.A., Hoover, A., and Schmorrow, D. (2006). Augmented cognition: Aiding the soldier in high and low workload environments through closed-loop human-machine interactions. Chapter 6, pp 108-127. In: Britt, T.W., Castro, C.A. and Adler, A.B. (eds.) (2006). Military life: The psychology of serving in peace and combat. Vol. 1, Military performance. Westport, CT: Praeger Security International; Greenwood Publishing Group, Inc.
- Russo, M.B., Stetz, M.C. and Thomas, M.L. (2005). Monitoring and predicting cognitive state and performance via physiological correlates of neuronal signals. Aviation, Space and Environmental Medicine, 76, 7, section II supplement, July 2005.
- Salas, E., Priest, H.A., Wilson, K.A. and Burke. C.S. (2006). Scenario-based training: Improving military mission performance and adaptability. Chapter 3, pp32-53. In: Adler, A.B., Castro, C.A. and Britt, T.W. (Eds.) (2006). Military life: The psychology of serving in peace and combat. Vol. 2, Operational Stress. Westport, CT:
- Operational Applications of Cognitive Performance Enhancement Technologies
- Three introductory articles to Special Supplement Section of Aviation, Space and Environmental Medicine, Volume 78, No. 5, May 2007, pp. 1-11.
- Kollmorgen, L.S. (2007). A Case for operational approach in advanced research projects - the Augmented Cognition story. Pp. B-1-3.
- Schoomaker, E.B. (2007). Military medical research on cognitive performance: The warfighters' competitive edge. Pp. B-4-6.
- Schmorrow, D.D. and Reeves, L.M. (2007). 21st century human –system computing: Augmented Cognition for improved human performance. Pp. B-7-11.

Cognitive Neuroscience

Cognitive Foundations of Human Information Processing

- McBride, D.K. (2007). Mitigation of three types of stress on cognitive performance (Preface). Aviation, Space and Environmental Medicine, Volume 78, No. 5, Section II, Supplement, May 2007, pp. B-12-14.
- Krueger, G.P. and Banderet, L.E. (2007). Implications for studying team cognition and team performance in network-centric warfare paradigms (Preface to Team Cognition and Team Performance). Aviation, Space and Environmental Medicine, Volume 78, No. 5, Section II, Supplement, May 2007, pp. B-58-62.
- Hancock, P.A. and Warm, J.S. (1989). A dynamic model of stress and sustained attention. Human Factors, 1989, 31(5), pp. 519-537.
- Operational Neuroscience, Neurophysiologic Measures and Augmented Cognition
- Kruse, A. (2007). Operational neuroscience: Neurophysiological measures in applied environments (Preface). Aviation, Space and Environmental Medicine, Volume 78, No. 5, Section II, Supplement, May 2007, pp. B-191-194.
- Thomas, M.L. and Russo, M.B. (2007). Neurocognitive monitors: Toward the prevention of cognitive performance decrements and catastrophic failures in the operational environment (Preface). Aviation, Space and Environmental Medicine, Volume 78, No. 5, Section II, Supplement, May 2007, pp. B-144-152.
- Corona, B.M. and Fiedler, E.R. (2007). Potential paradigm for assessments of biomedical technologies in the operational environment (Preface to Operational Processes and Cognitive Mapping). Aviation, Space and Environmental Medicine, Volume 78, No. 5, Section II, Supplement, May 2007, pp. B-245-251.
- Stetz, M.C., Thomas, M.L., Russo, M.B. et al. (2007). Stress, mental health, and cognition: A brief review of relationships and countermeasures. Aviation, Space and Environmental Medicine, Volume 78, No. 5, Section II, Supplement, May 2007, pp. B-252-260.

Appendix 3: ListServ Research Participation

ListServ Solicitation

Category	Name	Address	Subscribers
Career Development	Department of Career Development Adult Education Directors	DCD-ADULTED@LISTSERV.MICHIGAN.GOV	300
Career Development	National Career Development Association List	NCDA-L@LISTS.ASU.EDU	160
Cognition	Cognitive Development Discussion	COGDEVEL@LISTSERV.UNCC.EDU	171
Cognition	Cognitive Science Discussions	COGSCI-HOUSTON@LISTSERV.UH.EDU	102
Cognition	Cognitive Science Discussions - List	COGSCI@NIC.SURFNET.NL	402
Cognition	Cognitive Science in the Humanities Discussions	COGSCI-HUM@LISTSER.UH.EDU	224
Cognition	Israel Cognitive Psychology	COGPSY-IL@TECHUNIX.TECHNION.AC.IL	190
Cognition	Research Discussions in Cognitive Science	COGPSY-D@LISTSERV.TAMU.EDU	58
Cognition	Researchers in Cognitive Science	COGPSY@LISTSERV.TAMU.EDU	349
Development	Adult & Organizational Development	AOD-L@LISTSERV.TEMPLE.EDU	96
Development	American Society for Training and Development Brazos Valley	BVASTD@LISTSERV.TAMU.EDU	27
Executive	Academy of International Business	AIB-L@LIST.MSU.EDU	3,211
Executive	Advocacy Research	ADVOCACYRESEARCH@NEWGANGES.SBA.GOV	13,339
Executive	Break List	BREAK@NEWGANGES.SBA.GOV	3,021
Executive	Business Extension List	BUSEXT-L@LISTSERV.OKSTATE.EDU	4,628
Executive	CED Institute for Learning in Retirement	ILR@LISTSERV.MUOHIO.EDU	205
Executive	College of Business	BUSINESSINFO@LISTSERV.KENT.EDU	3,736
Executive	CUNY Alumni	ZSB-EXECUTIVE-ALUMNI-L@BARUCH.LISTSERV.CUNY.EDU	919
Executive	GPO Business Publications	GPO-BUSPUBS-L@LISTSERV.ACCESS.GPO.GOV	6,745
Executive	IFE Newsletter from Associated Business Publications	FRANCHISEZ@LISTSERV.ABPI.NET	9,732
Executive	Lender List	LENDER@NEWGANGES.SBA.GOV	16,796
Executive	MBA-Membership	MBA-MEMBERSHIP@LISTS.PRINCETON.EDU	685
Executive	News to Alumni from UH Bauer College of Business	UH-CBAALUMNI@LISTSERV.UH.EDU	5,451
Executive	PSU Alumni	L-SMEALZINE@LISTS.ASET.PSU.EDU	24,546
Executive	TAU Business Administration Alumni List	BOGRIM-1230@LISTSERV.TAU.AC.IL	5,750
Executive	U.S. Office of Personnel Management	EXECUTIVERESOURCESPOLICY@LISTSERV.OPM.GOV	1,022
Executive Development	Management and Executive Development Discussions	MGTDEV-L@LISTSERV.MUOHIO.EDU	126
Executive Education	Coizueta Executive Education	COIZUETA-EXECED@LISTSERV.EMORY.EDU	675
Human Development	HEV Human Development and Family Studies	HEVHDFS@LISTSERV.CMICH.EDU	492
Human Development	Institute on Disability and Human Development	IDHD_UCEDD@LISTSERV.UIC.EDU	409
Human Development	Monthly Ezine for Education and Human Development	TRANSFORMINGLIVES@LISTSERV.TAMU.EDU	1,098
Human Development	Undergrads in the College of Education and Human Development	06-07UNDERGRADS@LISTSERV.TAMU.EDU	3,783
Leadership Development	Leadership Development Office	LEADERSHIPDEVELOPMENT@LISTSERV.VT.EDU	420
Leadership Development	Professional Development and Appraisal System	PDAS-ILD@LIST.TETN.NET	938
Leadership Training	Leadership Training Course Candidates Spring 2008	LTC-PROSPECTS-SP08-L@LISTSERV.OKSTATE.EDU	5,345
Management Development	Central Asia Management Development	CAMAN-I@LISTS.MAINE.EDU	80
			115,231

Appendix 4: Participant Letter

Executive-Subordinate Assignment Prep

1. PARTICIPANT LETTER

1333 Four Winds Drive
Raleigh, NC 27615

Dear Research Participant,

Thank you for agreeing to participate in my doctoral dissertation research. I appreciate your interest. I understand your professional desires to have your experiences considered in this study and, hopefully, to strengthen your concepts of development. You may develop greater personal awareness of stage-like executive development as a result of your participation in this research. I hope it will shed a practical light on development issues that many organizations face.

This research centers on executive development, specifically to understand complex reasoning and how it develops. I hope to further our understanding of the way executives reason about problems and facilitate the discussion among members of our profession. The purpose of this letter is to review some of the basic aspects of the research and provide you with the *Informed Consent Form*.

The research instrument that I am using is a questionnaire (approximately 10-15 minutes to complete). It centers on a theorized assignment preparation interaction between executives and their subordinates. I ask that you review and assess the differing interaction scenarios. Through the assessment responses I expect to learn the relative level of complex reasoning that is used. I hope to answer the question, *As the executive rises in the corporate hierarchy is there a concomitant increase in level of complex reasoning ability?* And, *what are the common developmental experiences of the development?* This is not a test of your ability as an individual. Rather, I wish to know how executives, in general, reason about the issues presented here.

I value your participation and thank you for your commitment of time, energy, and effort. Your responses will be considered as anonymous and confidential. If you have any questions about any aspect of this study or your involvement, I can be reached at my home telephone number (919) 676-8660, on my mobile (919) 522-5448, or via email at AIOEresearch@aol.com. You may also contact the supervising faculty if you have questions or concerns related to your participation in this study. The supervising faculty contact information has been copied at the bottom of this letter. If at any time you have questions or concerns about your rights as a research participant, contact the Fielding Graduate University IRB by email at irb@fielding.edu or by telephone at (805) 898-4033.

Respectfully,

Richard L. McElroy MA,ODE; MA,HOS; Ph.D. (Candidate)

Supervising faculty contact information:
Milton Lopes, Ph.D.
Fielding Graduate University
2112 Santa Barbara Street
Santa Barbara, CA 93105
805-687-1099

Appendix 5: Informed Consent Form

Executive-Subordinate Assignment Prep

2. INFORMED CONSENT FORM

INFORMED CONSENT FORM

You have been asked to participate in a research study conducted by Richard L. McElroy, a doctoral student in the School of Human and Organizational Development at Fielding Graduate University, Santa Barbara, CA. This study is supervised by Milton Lopes, Ph.D. This research involves the study of hierarchical levels of complex reasoning in executive development and is part of Mr. McElroy's Fielding dissertation.

The study employs a questionnaire. It is based on a theorized assignment preparation interaction between executives and their subordinates. Each set of interactions is followed by five questions and a three-question opinion poll. This will last approximately 10-15 minutes. Additionally, you are asked to provide identification and demographic information such as age, years of experience, and educational level. The total time involved will be approximately 15 minutes.

The information you provide will be kept strictly confidential. The informed consent forms and other identifying information will be kept separate from the data. All materials will be kept at the Researcher's home office in separate file systems. Any records that would identify you as a participant in this study will be destroyed (shredded) by Researcher approximately three years after the study is completed. You will be asked to provide a different name for any quotes that might be included in the final research report. If any direct quotes will be used, permission will be sought from you first. The results of this research will be published in my dissertation and possibly in subsequent journals or books.

You may develop greater personal awareness of stage-like executive development as a result of your participation in this research. The risks to you are considered minimal; there is no likelihood that you may experience emotional discomfort during or after your participation. However, if you should experience such discomfort, please contact your primary health provider.

You may withdraw from this study at any time, either during or after your participation, without negative consequences. Should you withdraw, your data will be eliminated from the study and will be destroyed. No compensation will be provided for participation. You may request a copy of the summary of the final results by indicating your interest at the end of the survey.

If you have any questions about any aspect of this study or your involvement, please tell the Researcher before indicating your consent by continuing with the survey. You may also contact the supervising faculty if you have questions or concerns related to your participation in this study. The supervising faculty has provided contact information at the bottom of this form. If at any time you have questions or concerns about your rights as a research participant, contact the Fielding Graduate University IRB by email at irb@fielding.edu or by telephone at (805)898-4033. The security of data transmitted over the Internet cannot be guaranteed, therefore, there is a slight risk that the information you send to me will not be secure. The collection of such data is not expected to present any greater risk than you would encounter in everyday life when sending and/or receiving information over the Internet. The Institutional Review Board of Fielding Graduate University retains the right to access all informed consent forms.

Supervising faculty contact information:
Milton Lopes, Ph.D.
Fielding Graduate University
2112 Santa Barbara Street
Santa Barbara, CA 93105
805-687-1099

By continuing you indicate your consent.

Appendix 6: Executive Development Inventory (EDI)

Executive-Subordinate Assignment Prep

3. EXECUTIVE DEVELOPMENT INVENTORY

EXECUTIVE DEVELOPMENT INVENTORY

Please complete the following executive development inventory...

providing identification and demographic information such as...

positions held, years of experience, educational level, age, and gender.

*** Please fill out the following information. It will be used to anonymously track your responses.**

First letter of your father's name:

First letter of your mother's name:

First letter of your birth town:

Your month of birth (mm, e.g., 01):

Appendix 6a: EDI – Company Info

Executive-Subordinate Assignment Prep

4. COMPANY / INDUSTRY

COMPANY / INDUSTRY

What is (was) your position, title?

What title most closely reflects your position or last organizational position?

◯ Board Chair	◯ COO	◯ VP
◯ Board Vice Chair	◯ Chief Knowledge Officer	◯ Director
◯ Board Member	◯ Chief Learning Officer	◯ Assistant Director
◯ CEO	◯ President	◯ Senior Manager
◯ CFO	◯ Executive VP	◯ Manager
◯ CIO	◯ Senior VP	

What is the name of your company or organization?

How many employees does your company have?

◯ 1 to 4 employees	◯ 100 to 499 employees	◯ 1,500 to 2,499 employees
◯ 5 to 9 employees	◯ 500 to 749 employees	◯ 2,500 to 4,999 employees
◯ 10 to 19 employees	◯ 750 to 999 employees	◯ 5,000 to 9,999 employees
◯ 20 to 99 employees	◯ 1,000 to 1,499 employees	◯ 10,000 employees or more

Appendix 6a: EDI – Company Info, Continued

Executive-Subordinate Assignment Prep

What size is your company?

Market capitalization (market cap):

The standard measure of company size. Market cap is computed by multiplying the number of outstanding shares by the current stock price. For example, if a company had one hundred million shares of common stock outstanding and a current stock price of $55 per share, its market cap would be $5.5 billion (100,000,000 x $55 = $5.5 billion).

- ◯ Private
- ◯ Government
- ◯ Academia
- ◯ Non-Profit
- ◯ < $99 million (Micro Cap I)
- ◯ $100 - $199 million (Micro Cap II)
- ◯ $200 - $299 million (Micro Cap III)
- ◯ $300 million - $1 billion (Small Cap)
- ◯ $1 - $8 billion (Mid Cap)
- ◯ $8 - $100 billion (Large Cap)
- ◯ Over $100 billion (Mega Cap)

In what industry is your company?

- ◯ Aerospace & Defense
- ◯ Agriculture
- ◯ Automotive & Transport
- ◯ Banking
- ◯ Beverages
- ◯ Business Services
- ◯ Charitable Organizations
- ◯ Computer Hardware
- ◯ Computer Services
- ◯ Computer Software
- ◯ Construction
- ◯ Consumer Products Manufacturing
- ◯ Consumer Services
- ◯ Cultural Institutions
- ◯ Education
- ◯ Electronics
- ◯ Energy & Utilities
- ◯ Environmental Services & Equipment
- ◯ Financial Services
- ◯ Food
- ◯ Foundations
- ◯ Government
- ◯ Health Care
- ◯ Industrial Manufacturing
- ◯ Insurance
- ◯ Leisure
- ◯ Media
- ◯ Membership Organizations
- ◯ Metals & Mining
- ◯ Pharmaceuticals
- ◯ Real Estate
- ◯ Retail
- ◯ Security Products & Services
- ◯ Telecommunications Equipment
- ◯ Telecommunications Services
- ◯ Transportation Services

Appendix 6b: EDI - Personal / Education

Executive-Subordinate Assignment Prep

5. PERSONAL / EDUCATION

PERSONAL / EDUCATION

What is your gender?

- ◯ Male
- ◯ Female

What is your age? (as of your last birthday)

Age: |

What is the highest degree or educational level that you have attained?

- ◯ Ph.D.
- ◯ MBA
- ◯ MA/MS
- ◯ BA/BS
- ◯ AA/AS or Some College
- ◯ HS
- ◯ Non-HS

Did you participate in any structured development, educational, or training programs?

- ☐ Supervisory and Managerial Training
- ☐ Management Development (linked to the current job goals)
- ☐ Executive Coaching
- ☐ Executive Development
- ☐ Leadership Development
- ☐ Career Development (linked to development beyond current job)

What was the cumulative amount of time in these programs?

Years |

Months |

Appendix 6c: EDI – Current Work

Executive-Subordinate Assignment Prep

6. CURRENT WORK

CURRENT WORK

Describe the type of work which you CURRENTLY manage.

- ◯ Routine
- ◯ Organizational Change, Performance (process- and productivity-oriented)
- ◯ Organizational Change, Restructuring (structure-and alignment-oriented)
- ◯ Organizational Change, Strategic (market-oriented mission and goal)
- ◯ Organizational Change, Transformational (people-oriented culture, behavior)
- ◯ Organizational Change, Org Crisis
- ◯ Organizational Change, Personnel Crisis
- ◯ Merger/Acquisition
- ◯ Start-Up

Select the functional department in which your CURRENT position is held.

- ◯ Administration
- ◯ Customer Support / Service
- ◯ Engineering
- ◯ Finance/Accounting
- ◯ HR, Personnel
- ◯ IT
- ◯ Logistics
- ◯ Marketing
- ◯ Ops/Manufacturing/Production
- ◯ Public Relations
- ◯ Purchasing
- ◯ R&D
- ◯ Sales
- ◯ Secretarial
- ◯ Shipping / Dispatch
- ◯ Technical support
- ◯ Training
- ◯ Warehousing

Appendix 6c: EDI – Current Work, Continued

Executive-Subordinate Assignment Prep

What kind of support has contributed to development in your CURRENT position?

- [ ] None/Alone
- [ ] Collegial Support (friend/ally)
- [ ] Task Support
- [ ] Boss Relationship
- [ ] Role Model
- [ ] Superior's Mentoring/Coaching

Enter the number of years and months of experience you have in your CURRENT position.

Years

Months

Appendix 6d: EDI – Previous Work

Executive-Subordinate Assignment Prep

7. PREVIOUS WORK

PREVIOUS WORK

Describe the type(s) of work which you PREVIOUSLY managed.

- ☐ Routine
- ☐ Organizational Change, Performance (process- and productivity-oriented)
- ☐ Organizational Change, Restructuring (structure-and alignment-oriented)
- ☐ Organizational Change, Strategic (market-oriented mission and goal)
- ☐ Organizational Change, Transformational (people-oriented culture, behavior)
- ☐ Organizational Change, Org Crisis
- ☐ Organizational Change, Personnel Crisis
- ☐ Merger/Acquisition
- ☐ Start-Up

Select the functional department(s) in which PREVIOUS position(s) were held.

- ☐ Administration
- ☐ Customer Support / Service
- ☐ Engineering
- ☐ Finance/Accounting
- ☐ HR, Personnel
- ☐ IT
- ☐ Logistics
- ☐ Marketing
- ☐ Ops/Manufacturing/Production
- ☐ Public Relations
- ☐ Purchasing
- ☐ R&D
- ☐ Sales
- ☐ Secretarial
- ☐ Shipping / Dispatch
- ☐ Technical support
- ☐ Training
- ☐ Warehousing

Appendix 6d: EDI – Previous Work, Continued

Executive-Subordinate Assignment Prep

What kind of support has contributed to development in your PREVIOUS position(s)?

- [ ] None/Alone
- [ ] Collegial Support (friend/ally)
- [ ] Task Support
- [ ] Boss Relationship
- [ ] Role Model
- [ ] Superior's Mentoring/Coaching

Enter the TOTAL number of years and months of experience you have in your CAREER.

Years
Months

What type of position(s) were held throughout your career?

- [ ] Board Chair
- [ ] Board Vice Chair
- [ ] Board Member
- [ ] CEO
- [ ] CFO
- [ ] CIO
- [ ] COO
- [ ] Chief Knowledge/Learning Officer
- [ ] President
- [ ] Executive VP
- [ ] Senior VP
- [ ] VP
- [ ] Director
- [ ] Assistant Director
- [ ] Senior Manager
- [ ] Manager

Appendix 7: Survey Guidelines

Executive-Subordinate Assignment Prep

8. QUESTIONNAIRE

QUESTIONNAIRE GUIDELINES

Please . . .

- Answer all parts of this questionnaire.
- Read each section and answer the questions in the order given.
- Do not go to the following section before you have finished the previous section.

Remember that this is not a test of your ability as an individual. Rather, I wish to know how executives, in general, reason about the issues presented here. The order of answering is essential to this study about executive reasoning. What is most important is not only ***what*** you consider to be good, but the ***reasons*** for your choices. Therefore, it is essential that you ***state your reasons why*** you make the choices that you make.

Appendix 8: Assignment Preparation – Ideal Interaction

Executive-Subordinate Assignment Prep

9. EXECUTIVE-SUBORDINATE INTERACTION

Please describe the *ideal* Executive-Subordinate assignment preparation session.

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1. What is your idea of an *ideal* Executive-Subordinate assignment preparation session?

2. Give the best reasons why that is an *ideal* assignment preparation session.

Appendix 8a: Assignment Preparation – Ideal Interaction

Executive-Subordinate Assignment Prep

3. What is your idea of an a *poor* Executive-Subordinate assignment preparation session?

4. Give the best reasons why that is a *poor* assignment preparation session.

5. Why does the Executive-Subordinate assignment preparation *matter* to you?

Appendix 8b: Assignment Preparation – Ideal Interaction

Executive-Subordinate Assignment Prep

6. Why are these things *important* to you and why do you care?

Appendix 9: Assignment Preparation

Executive-Subordinate Assignment Prep

10. ASSIGNMENT PREPARATION INTERACTION

ASSIGNMENT PREPARATION INTERACTION

In the following Execuitve-Subordinate interaction sets, each containing five stories, an Executive tried to help a Subordinate with an assignment to solve a given problem, setting a course of action. The assignment is important. It is time for the Subordinate to choose a course of action to improve the situation.

All of the Executives ***care*** for their Subordinates and the company ***equally*** . All of the Executives highly recommend the same basic recommendations. But, the Executives arrive at their choice of how to prepare the Subordinates in different ways. In every case, the problems worsen and the company suffers.

During a general review of these bad results, each Executive's ***method*** of choosing a course of action was looked at. Below, the Executives give accurate accounts of their usual talk with their Subordinates.

Read all five accounts carefully and then answer the five questions and three-item opinion poll that follow.

Appendix 10: Interaction Methods #1

Executive-Subordinate Assignment Prep

11. THE METHODS

Executive Flynn offers a course of action that has been studied and is shown to work well in the circumstances faced by the Subordinate. Flynn shares the fact that not everyone has had a positive outcome from this course of action. Flynn then reads a description of the course of action and its risk from an MBA text book. Flynn points out that the course of action will have risks. Flynn asks the Subordinate if they understand the course of action, its outcome possibilities, and are confident in taking action. After thinking carefully, Flynn's Subordinate feels comfortable with Flynn as a problem solver. Feeling that Flynn knows best, the Subordinate decides to take the course of action.

Executive Baker offers a course of action that is preferred by colleagues. Baker says that others who are friends and Executive colleagues have taken this course of action. Another Executive is called in to tell the Subordinate again about the course of action. With great concern, Baker asks if the Subordinate would like to hear a third Executive explain the course of action. Baker's Subordinate is told that these Executives have had good results from this course of action. Baker instructs the Subordinate to take the course of action. Baker's Subordinate thinks seriously about what Baker has said. Feeling that Baker knows best, Baker's Subordinate decides to take the course of action.

Executive Woods offers a course of action which performs relatively better than others. Woods relates the positive and negative consequences of each course of action, including taking no action. Then Woods asks the Subordinate questions about the various courses of action making sure that the Subordinate understands. Woods asks the Subordinate if they feel empowered to make a decision with the present information. Since the Subordinate is satisfied, Woods tells the Subordinate to think carefully before choosing a course of action. Woods's Subordinate thinks about what Woods has said. Feeling that Woods knows best, Woods's Subordinate decided to take the course of action.

Executive Simms recently completed training on a course of action that was designed for the circumstances faced by the Subordinate. Simms says that the best coaches recommend this course of action. Simms explains the course of action and tells the Subordinate that it will probably work for the Subordinate. Simms also tells the Subordinate about other courses of action that may work. The Subordinate is asked if they have any questions. The Subordinate does not have questions, and Simms asks them if they want to accept the recommended course of action. Feeling that Simms knows best, the Subordinate decides to take the course of action.

Executive Eagan offers a course of action that best meets the needs of the Subordinate. Eagan explains all aspects of the course of action and describes at length the pros and cons of alternates, including doing nothing. Eagan seeks to understand the Subordinates needs and concerns, and asks many questions in order to gain the Subordinates perspective and understanding. Eagan does not push the Subordinate to accept any course of action but rather encourages the Subordinate to choose a course of action that makes them feel comfortable, confident, and dedicated. The Subordinate considers this. Feeling that Eagan knows best, the Subordinate decides to take the course of action.

Appendix 11: Interaction Methods #2

Executive-Subordinate Assignment Prep

12. THE METHODS

Executive Barts offers a course of action that is highly regarded by many Executive colleagues and accepted in the industry at large. Barts fully explains the course of action to the Subordinate by describing the benefits and potential risks involved. Barts adds that the proposed course of action is liked by other Subordinates in this situation and that they have been pleased. Barts asks what the Subordinate is feeling about the course of action. Barts encourages the Subordinate to think about what they have heard but to pursue this course of action. The Subordinate thinks about the situation. Feeling that Barts knows best, the Subordinate decides to take the course of action.

Executive Brown offers an effective course of action that compares well to other course of actions for this problem. Brown explains the beneficial remedies of every course of action, and how each impacts the elements of the problem. Brown describes all the risks of these course of actions. Brown asks the Subordinate to relate back that explanation. Brown says it is up the Subordinate to support a course of action. Brown asks if the Subordinate supports the suggested course of action. Brown's Subordinate thinks about what Brown has said. Feeling that Brown knows best, Brown's Subordinate decides to take the course of action.

Executive Cabot offers a carefully thought out course of action based on personal experience. The Subordinate is told that the course of action has worked before with other Subordinates in similar circumstances, especially the last ten. Then, Cabot says that the experts whom Cabot knows well choose this course of action. To make sure the Subordinate understands, Cabot gives the Subordinate an easy multiple choice test. After the Subordinate passes the test, Cabot urges the Subordinate to agree to the course of action. Cabot's Subordinate thinks about what Cabot has said. Feeling that Cabot knows best, Cabot's Subordinate prepares to take the course of action.

Executive Smith meets with the Subordinate to discuss course of action. Smith and the Subordinate cover the benefits and risks of Smith's preferred course of action, including outside influences. They discuss other course of actions related to the Subordinates situation, including doing nothing, and the benefits and risks of each. Smith feels the Subordinate competently understands the discussion based on the Subordinates questions and body language. Smith asks the Subordinate whether they now feel ready to make a decision or they need more time to consider the information and options. Feeling that Smith knows best, the Subordinate decides to follow the course of action.

Executive Eaton offers a new effective course of action that has been researched with excellent results and published in different professional journals. Eaton explains the details of the course of action to the Subordinate along with its benefits and risks. Eaton then states that there are other options that could be looked at, including the possibility of doing nothing. Eaton reviewed the other course of actions with the Subordinate, but felt they would not be as effective as the newer course of action. Eaton asks the Subordinate if they feel secure with the course of action. Feeling that Eaton knows best, the Subordinate prepares to follow the course of action.

Appendix 12: Interaction Questions

Executive-Subordinate Assignment Prep

A. Rate the Executives' methods. A rating of 1 means you think that the Executive has the worst method. A rating of 6 means you think that the Executive has the best method. Not all the ratings need to be used and a particular rate may be given to more than one Executive.

	1 Worst Method	2 Worse	3 Slightly Worse	4 Slightly Better	5 Better	6 Best Method
Executive Barts	◯	◯	◯	◯	◯	◯
Executive Brown	◯	◯	◯	◯	◯	◯
Executive Cabot	◯	◯	◯	◯	◯	◯
Executive Smith	◯	◯	◯	◯	◯	◯
Executive Eaton	◯	◯	◯	◯	◯	◯

Why did you rate the Executives' methods the way you did? Explain as fully as you can.

B. Rate the Executives according to how well they consider the Subordinate's viewpoint, garnering the Subordinate's acceptance of action (conviction) and their awareness of circumstances and issues. A rating of 1 means you think that the Executive has very poor at considering the Subordinates viewpoint. A rating of 6 means that the Executive considered the Subordinates viewpoint very well. You may use the same rating for more than one Executive.

	1 Very Poor	2 Poor	3 Slightly Poorer	4 Slightly Better	5 Well	6 Very Well
Executive Barts	◯	◯	◯	◯	◯	◯
Executive Brown	◯	◯	◯	◯	◯	◯
Executive Cabot	◯	◯	◯	◯	◯	◯
Executive Smith	◯	◯	◯	◯	◯	◯
Executive Eaton	◯	◯	◯	◯	◯	◯

Appendix 12a: Interaction Questions, Continued

Executive-Subordinate Assignment Prep

Why did you rate the Executives' methods the way you dids?
Explain as fully as you can.

C. Rate the degree to which the Executives attuned or prepared the Subordinate.

	1 Very Poor	2 Poor	3 Slightly Poorer	4 Slightly Better	5 Well	6 Very Well
Executive Barts	◯	◯	◯	◯	◯	◯
Executive Brown	◯	◯	◯	◯	◯	◯
Executive Cabot	◯	◯	◯	◯	◯	◯
Executive Smith	◯	◯	◯	◯	◯	◯
Executive Eaton	◯	◯	◯	◯	◯	◯

Why did you rate the Executives the way you did?
Explain as fully as you can.

Appendix 12b: Interaction Questions, Continued

Executive-Subordinate Assignment Prep

D. Rate the how well the Executives aligned (informed, communicated with) their Subordinates.

	1 Very Poor	2 Poor	3 Slightly Poorer	4 Slightly Better	5 Well	6 Very Well
Executive Barts	◯	◯	◯	◯	◯	◯
Executive Brown	◯	◯	◯	◯	◯	◯
Executive Cabot	◯	◯	◯	◯	◯	◯
Executive Smith	◯	◯	◯	◯	◯	◯
Executive Eaton	◯	◯	◯	◯	◯	◯

Why did you rate the Executives the way you did?
Explain as fully as you can.

E. Rate the degree to which the Executives prepared the Subordinate to act (empowered, delegation, take risks) on the assignment.

	1 Very Poor	2 Poor	3 Slightly Poorer	4 Slightly Better	5 Well	6 Very Well
Executive Barts	◯	◯	◯	◯	◯	◯
Executive Brown	◯	◯	◯	◯	◯	◯
Executive Cabot	◯	◯	◯	◯	◯	◯
Executive Smith	◯	◯	◯	◯	◯	◯
Executive Eaton	◯	◯	◯	◯	◯	◯

Appendix 12c: Interaction Questions, Continued

Executive-Subordinate Assignment Prep

Why did you rate the Executives the way you did?
Explain as fully as you can.

F. Suppose you were listening to these Executives give their account of the course of action in a hearing. Rate the degree to which you believe the Executives to be telling the truth. How believable do you find their accounts?

	0 No Chance of Being True	4	27	77	96	100 Certainty of Being True
Executive Barts	◯	◯	◯	◯	◯	◯
Executive Brown	◯	◯	◯	◯	◯	◯
Executive Cabot	◯	◯	◯	◯	◯	◯
Executive Smith	◯	◯	◯	◯	◯	◯
Executive Eaton	◯	◯	◯	◯	◯	◯

Why these estimates?

Appendix 13: Opinion Poll

Executive-Subordinate Assignment Prep

G. Given that each Executive's course of action failed, how likely is it that each Executive's method makes him or her personally liable for damages?

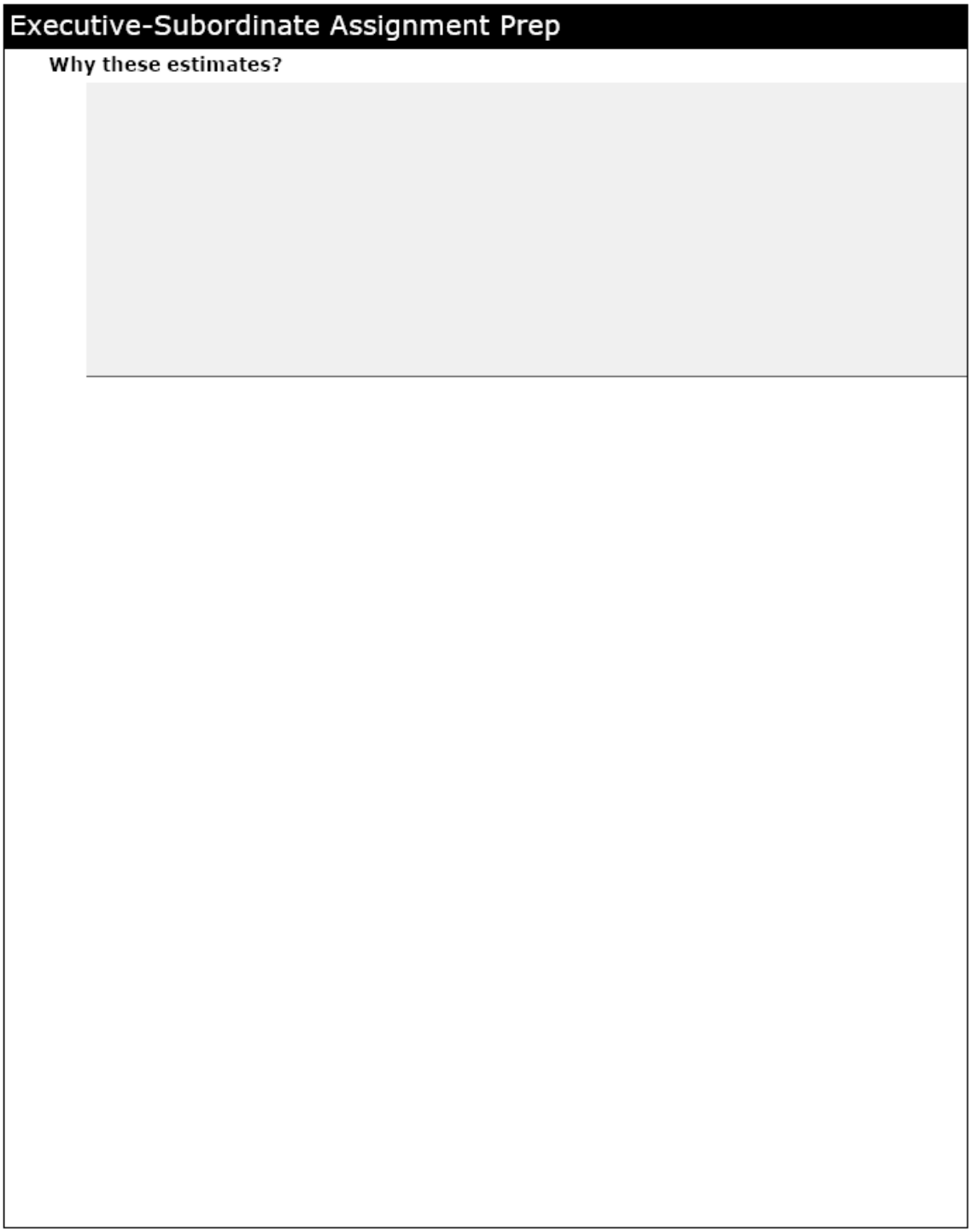
	0 No Chance of Being Liable	4	27	77	96	100 Certainty of Being Liable
Executive Barts	◯	◯	◯	◯	◯	◯
Executive Brown	◯	◯	◯	◯	◯	◯
Executive Cabot	◯	◯	◯	◯	◯	◯
Executive Smith	◯	◯	◯	◯	◯	◯
Executive Eaton	◯	◯	◯	◯	◯	◯

Why these estimates?

H. Given the degree to which you believed that the Executives were personally negligent, how likely is each of the Executives to be sued?

	0 No Chance	4	27	77	96	100 Certainty
Executive Barts	◯	◯	◯	◯	◯	◯
Executive Brown	◯	◯	◯	◯	◯	◯
Executive Cabot	◯	◯	◯	◯	◯	◯
Executive Smith	◯	◯	◯	◯	◯	◯
Executive Eaton	◯	◯	◯	◯	◯	◯

Appendix 13a: Opinion Poll, Continued



Appendix 14: Anticipated Responses

Dimension		Description	Behavior
a_1	Aware	RECOGNITION (identifies and distinguishes circumstances) KNOWLEDGEABLE (understands and appreciates issues)	Speaks to situation (*e.g.*, acknowledges, describes, voices opinion, explains).
a_2	Accept	CONVICTION (exhibits confidence in or dedication toward addressing situation)	Exhibits confidence. Repetition to issue-related activities. Voiced determination toward or belief in issue.
a_3	Attune	PERSONAL TRANSFORMATION (engage in personal change, "reinvent self")	Thinks differently (speaks to altered thought process or perspective), and/or acts differently exhibiting self-acknowledged new or modified norms, habits, characteristics, or traits. Repeats core stories about a different emerging identity.
		FOLLOWER EFFECT (change, influence, inspire others)	Provide vivid vision of the future and establish direction by, in part, telling inspiring stories. Prepares, communicates, convinces, persuades.
a_4	Align	COORDINATE (manage information as necessary to organize followers to common objective)	Increased, focused, situation-specific communication via verbal or written means. Centers attention on the situation in such a way as to bring about common understanding, alignment, and confidence in judgment relative to the situation as suggested in the resultant, observed behavior of the followers.
		SYMBOLIZE (reflects the necessary or desired behaviors as a mechanism for follower instruction)	Provides example, embodies or engages in "role modeling", acts in such as way as to exemplify expected norms.
a_5	Act	CHANGE (effects a transformation, modification, or altered formal or informal policies, procedures or practices leading to and as manifest in different group or individual behavior and performance)	Plans are exhibited in lists, journals, calendars. Exhibited behaviors reflect desired change. Situation-specific performance is recorded or monitored as to indicate effect of the change initiative. Corrections and guidance are provided in accordance with the resultant effects.
		EMPOWER (brings others into action in order to achieve change)	Executive behavior is seen as that contributing to "participatory management," "decentralized leadership" or other literature-suggested terminology suggesting a sharing with followers the power, responsibility, and accountability as a means to elicit their full participation and release of potential.
		RISK (challenges *status quo*)	Through speech and action accepted norms, long-accepted beliefs, attitudes, and common or routine practices are questioned. Efforts are orchestrated that confront the governing policies, procedures, and cultural norms that are situation-specific relative.

Appendix 15: Developmental Stage Representation

Level	Reasoning	Mathematical Formula
Technician, Line Staff	*Coordination* of "if, then" system elements	T $h_{10}(A) = (a_1 + a_2 + a_5)R$ = ACTION
Manager. Professional	*Cooperation* of elements in the enveloping system	M $h_{11}(A) = ((((a_5 = fa_4) = fa_3) = fa_2) = fa_1)R = S_1$
Executive	*Collaboration* across many contextual systems	E $h_{12}(A) = [S_1]\ R\ [S_2]$

Appendix 16: Solicitation eMail

Dear Energy Industry Professional,

As part of my doctoral research, I am researching the development of executives within the energy industry This is a very important study that hopefully will contribute much to our understanding of the developmental needs of future leaders in our industry. I encourage you to take the survey. Also, I encourage you to ask executives and senior managers of your organizations to take. It is a short questionnaire. I estimate that it will take less than 15 minutes to complete the survey (and some additional time for your explanation of survey responses dependant upon the depth of your answers; 5-30 minutes). It is completely anonymous. I greatly appreciate your help.

You'll find the Internet-based survey at:

http://www.surveymonkey.com/s.aspx?sm=S_2fBMTayHfCIUS7ZikwFGqw_3d_3d

If you experience problems linking directly to the survey (e.g., company's firewall), please copy and paste the link into your web browser.

I am turning to you for four reasons.

1. You **and your energy-industry executive colleagues represent the focus of this research**. It will be difficult to conduct such a study without your participation.
2. As Dr. Lyons, NRC Commissioner, stated in his August 27th, 2007 speech at the Joint IEEE Conference on Human Factors and Power Plants, "the 'optimal' degree of connectedness [between human cognition and plant equipment] should relate predominantly to overall plant safety. **Human development is central to operational safety**.
3. I am a **member of the energy industry** – veteran of the US Navy Nuclear Program (submarine service), formerly licensed NRC Reactor Operator, and staff with commercial nuclear power plants.
4. I am confident that this **research will benefit my colleagues in the energy and electric utility industry.**

The cognitive development research introduced here (survey link listed above) is my dissertation research. I am a doctoral student in the School of Human and Organizational Development at Fielding Graduate University, Santa Barbara, CA. This study centers on executive development, specifically to understand complex reasoning and how it develops. I hope, first, to further our understanding of the way that the energy executive reasons about problems and, thereby, facilitate the discussion among members of our profession. Second, I believe that this study will lead to enhanced cognitive development practices (complex reasoning ability), versus intellect-focused education and skill-based training. Third, you may develop greater personal awareness of stage-like executive development as a result of your participation in this research. Fourth, this research may shed a practical light on general development issues facing many organizations.

The research instrument that I am using is a questionnaire. It centers on a theorized assignment preparation interaction between an executive and their subordinate. Each of two such interaction sets is followed by eight questions (utilizing a six-point, multiple choice scale).

I value your participation and thank you for your commitment of time, energy, and effort. Your responses will be considered as anonymous and confidential. If you have any questions about any aspect of this study or your involvement, I can be reached at my home telephone number (919) 676-8660, on my mobile (919) 522-5448, or via email at McElroyAIOE@aol.com. Thank you in advance for your consideration and professional courtesy.

Respectfully,

Richard L. McElroy

P.S. It will be greatly appreciated if you will **forward this memo to other appropriate personnel in your organization or other industry executive colleagues that you think might be interested in helping me in this effort.**

Appendix 17: Initial Contact Telephone Script

Hello,

I'm following up on our recent email correspondence relative to participating in my research study. Thank you for your willingness to discuss the participation of your executives.

I am sure you recognize the importance of executive development. I believe this research will contribute to a better understanding of this, specifically the means to adequately measure development and a stronger understanding of what contributes to it. I appreciate the fact that your executives will play a part in this study.

The next step will be to gauge the interest of these executives. In that I recognize the inability to release direct contact information for these executives, I ask that you help me determine an appropriate coordination process: whom should I contact there?

This representative will be asked to gauge the interest of those individuals that meet the following criteria:

> For the purpose of this research, executive (senior, middle, or lower) is defined as active policy makers and heads of functional areas through general managers with executive-level authority over and responsibility for entire business entities or major divisions of such.

I will provide this coordinating representative a package of material for each participating executive.

Again, thank you for your interest, consideration, and assistance.

Appendix 18: Invitation to Participate in Research eMail

Richard McElroy, a doctoral student in the Fielding Graduate University's Human and Organization Development program, under the guidance of Dr. Michael Commons, Harvard Medical School's Department of Psychiatry, is conducting a cognitive development study to explore levels of ***complex reasoning*** in executives and managers.

He is asking for ***anonymous participation*** to complete his Internet-based research survey instrument (link listed below). He requests that all levels of executives and managers in the organization participate.

It is comprised of two sets of executive-subordinate interactions during which an assignment preparation is discussed (problem discussed, resolutions explored, decision made). Each of the two sets consists of five short vignettes, each consisting of a few sentences. You will be asked to read the vignettes and answer eight multiple choice questions. It also includes a development inventory (*e.g.,* years of experience, educational level, organizational positions held).

- The multiple choice section of the instrument will take less than ***15 minutes to complete***.
- You can begin the instruments and ***take a break at anytime***, coming back later to complete.
- The ***instructions for doing the survey are included*** in the instrument.
- Your responses will be considered as ***strictly anonymous and confidential***.
- This ***study has been reviewed and approved*** by the Fielding Institutional Review Board.

You'll find the Internet-based survey at:
http://www.surveymonkey.com/s.aspx?sm=VUmY82q3w_2fnunmgFXt6Hyg_3d_3d

If you experience problems linking directly to the survey (*e.g.,* company's firewall), please copy and paste the link into your web browser.

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Appendix 20: Calculating Stage Scores: HC Stages

In order of HC Rank

MEASURE	RANK	
0.68	08-Ba	8
1.02	08-Bb	
0.74	08-Bc	
0.79	08-Bd	
0.82	08-Be	
0.5	08-Ja	
0.66	08-Jb	
0.45	08-Jc	
0.4	08-Jd	
0.51	08-Je	
0.47	09-Aa	9
0.81	09-Ab	
0.68	09-Ac	
0.54	09-Ad	
0.6	09-Ae	
0.28	09-Sa	
0.3	09-Sb	
0.24	09-Sc	
0.2	09-Sd	
0.2	09-Se	
0.54	10-Fa	10
0.62	10-Fb	
0.56	10-Fc	
0.45	10-Fd	
0.42	10-Fe	
0.92	10-Ya	
0.86	10-Yb	
0.86	10-Yc	
0.72	10-Yd	
0.89	10-Ye	
-1.26	11-Ea	11
-1.74	11-Eb	
-1.23	11-Ec	
-1.49	11-Ed	
-1.21	11-Ee	
-0.58	11-Ga	
-0.3	11-Gb	
-0.48	11-Gc	
-0.5	11-Gd	
-0.48	11-Ge	
-1.25	12-Ma	12
-1.31	12-Mb	
-1.19	12-Mc	
-1.01	12-Md	
-1.03	12-Me	
-0.66	12-Wa	
-0.54	12-Wb	
-0.42	12-Wc	
-0.52	12-Wd	
-0.56	12-We	

Average of HC Stage
Ordered by Rank

8	0.657	Concrete
9	0.432	Abstract
10	0.684	Formal
11	-0.927	Systematic
12	-0.849	Metasystematic

Average of HC Stage
Ordered by Measure

10	**0.684**	Formal
8	**0.657**	Concrete
9	**0.432**	Abstract
12	**-0.849**	Metasystematic
11	**-0.927**	Systematic

In order of Raw Measure

MEASURE	RANK	
1.02	08-Bb	Low
0.92	10-Ya	
0.89	10-Ye	
0.86	10-Yb	
0.86	10-Yc	
0.82	08-Be	
0.81	09-Ab	
0.79	08-Bd	
0.74	08-Bc	
0.72	10-Yd	
0.68	08-Ba	
0.68	09-Ac	
0.66	08-Jb	
0.62	10-Fb	
0.6	09-Ae	
0.56	10-Fc	
0.54	09-Ad	
0.54	10-Fa	
0.51	08-Je	
0.5	08-Ja	
0.47	09-Aa	
0.45	08-Jc	
0.45	10-Fd	
0.42	10-Fe	
0.4	08-Jd	
0.3	09-Sb	
0.28	09-Sa	
0.24	09-Sc	
0.2	09-Sd	
0.2	09-Se	
-0.3	11-Gb	High
-0.42	12-Wc	
-0.48	11-Gc	
-0.48	11-Ge	
-0.5	11-Gd	
-0.52	12-Wd	
-0.54	12-Wb	
-0.56	12-We	
-0.58	11-Ga	
-0.66	12-Wa	
-1.01	12-Md	
-1.03	12-Me	
-1.19	12-Mc	
-1.21	11-Ee	
-1.23	11-Ec	
-1.25	12-Ma	
-1.26	11-Ea	
-1.31	12-Mb	
-1.49	11-Ed	
-1.74	11-Eb	

Average of HC Stage
In order of HC Rank & Measure

8, 9, 10	**0.591**	Concrete-Abstract-Formal
11, 12	**-0.888**	Systematic-Metasystematic

Appendix 21: Calculating Stage Scores: Participants' Stage

Rasch Score	PARTICIPANT	HC Level
1.25	JNN03	10
1.10	AJN02	10
0.90	PLR08	10
0.79	MMJ02	10
0.70	ALS04	10
0.65	FBN10	10
0.65	SMP02	10
0.59	HPC11	10
0.59	RJT11	10
0.58	FKW09	10
0.55	JML03	10
0.49	TMC09	10
0.48	DST12	10
0.48	VDH12	10
0.45	RME06	10
0.35	VPN08	10
0.32	GSN02	10
0.32	MPW12	10
0.31	TRC08	10
0.29	FIP09	10
0.29	HSD07	10
0.28	HMM02	10
0.26	FFC01	10
0.25	WSO21	10
0.24	JSP12	10
0.24	KLP06	10
0.23	JTS05	10
0.22	SBS10	10
0.20	DJM09	10
0.20	MCF12	10
0.18	FEJ08	10
0.18	ROC11	10
0.17	ACO03	10
0.17	RSK09	10
0.16	AAM01	10
0.15	JGN02	10
0.14	PKF08	10
0.13	CVS03	10
0.13	DMC10	10
0.13	DRC01	10
0.10	JPC09	10
0.09	JEO13	10
0.07	ARP03	10
0.07	DEE03	10
0.05	WBT01	10
0.02	FMD07	10
0.02	JPV11	10
0.01	GJT02	10
0.01	VSG06	10
0.01	WFJ09	10
0.01	YIB02	10
0.00	DMC04	10
0.00	RRL10	10
0.00	STM05	10
-0.01	GRC09	12
-0.03	ERP08	12
-0.03	JJS05	12
-0.03	LJD12	12
-0.04	LEW04	12
-0.04	MRN02	12
-0.06	LAC09	12
-0.07	HLL11	12
-0.07	JMA11	12
-0.09	JDO03	12
-0.09	LMC06	12
-0.09	RRC08	12
-0.11	RJH06	12
-0.11	RWT02	12
-0.13	GRP11	12
-0.13	HET01	12
-0.14	JMC07	12
-0.16	MMO04	12
-0.19	CDW05	12
-0.22	KMJ06	12
-0.25	HNA11	12
-0.29	MED05	12
-0.32	FES12	12
-0.32	LHT05	12
-0.32	MAP12	12
-0.32	RTK02	12
-0.35	DHN04	12
-0.46	TBD11	12
-0.49	LAB08	12
-0.53	BBG01	12
-0.55	MDB12	12
-0.65	RNW10	12
-0.67	MMS07	12
-0.71	RBD09	12
-0.88	RJA07	12
-0.90	FDA04	12

Average of HC Stage			
In order of HC Rank & Measure			
8, 9, 10	0.591	10	Concrete-Abstract-Formal
11, 12	-0.888	11	Systematic-Metasystematic

$$\text{Statge of Person} = \frac{\text{PersonRaschScore} - \text{StageMean}_1}{\text{StageMean}_2 - \text{StageMean}_1} + \text{ItemHC}$$

Appendix 22: Complete Bivariate Correlation Review

Correlations

			HC	Degree	DEVpro	DEVyrs	CARwork	CARfunc	CARspt	CARyrs
Spearman's rho	HC	Correlation Coefficient	1.000	-.108	.004	.150	-.003	-.065	-.071	.037
		Sig. (2-tailed)	.	.333	.970	.175	.978	.560	.524	.743
		N	83	83	83	83	83	83	83	83
	Degree	Correlation Coefficient	-.108	1.000	-.138	-.144	.000	-.039	.055	-.052
		Sig. (2-tailed)	.333	.	.214	.194	1.000	.727	.620	.642
		N	83	83	83	83	83	83	83	83
	DEVpro	Correlation Coefficient	.004	-.138	1.000	**.553****	.136	.185	.083	.172
		Sig. (2-tailed)	.970	.214	.	.000	.221	.094	.457	.119
		N	83	83	83	83	83	83	83	83
	DEVyrs	Correlation Coefficient	.150	-.144	**.553****	1.000	.115	.120	-.022	.002
		Sig. (2-tailed)	.175	.194	.000	.	.300	.279	.842	.987
		N	83	83	83	83	83	83	83	83
	CARwork	Correlation Coefficient	-.003	.000	.136	.115	1.000	**.294****	**.264***	.131
		Sig. (2-tailed)	.978	1.000	.221	.300	.	.007	.016	.239
		N	83	83	83	83	83	83	83	83
	CARfunc	Correlation Coefficient	-.065	-.039	.185	.120	**.294****	1.000	.212	.209
		Sig. (2-tailed)	.560	.727	.094	.279	.007	.	.054	.057
		N	83	83	83	83	83	83	83	83
	CARspt	Correlation Coefficient	-.071	.055	.083	-.022	**.264***	.212	1.000	.200
		Sig. (2-tailed)	.524	.620	.457	.842	.016	.054	.	.070
		N	83	83	83	83	83	83	83	83
	CARyrs	Correlation Coefficient	.037	-.052	.172	.002	.131	.209	.200	1.000
		Sig. (2-tailed)	.743	.642	.119	.987	.239	.057	.070	.
		N	83	83	83	83	83	83	83	83

**** Correlation is significant at the 0.01 level (2-tailed).**

* Correlation is significant at the 0.05 level (2-tailed).

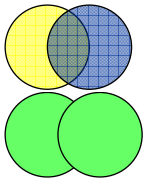
FOOTNOTES

1. Mathematical representation

Stage	Mathematical Example
10: Formal	The general left hand distribution relationship: $x * (y + z) = (x * y) + (x * z)$
11: Systematic	The right hand distribution law is not true for numbers but is true for proportions and sets: $x + (y * z) \neq (x * y) + (x * z)$ numbers $x \cup (y \cap z) = (x \cap y) \cup (x \cap z)$ proportions and sets
12: Metasystematic	The system of propositional logic and elementary set theory are isomorphic: $x \,\&\, (y \; or \; z) = (x \,\&\, y) \; or \; (x \,\&\, z)$ Logic $\Leftrightarrow x \cap (y \cup z) = (x \cap y) \cup (x \cap z)$ Sets $T(False) \Leftrightarrow \Phi$ Empty set $T(True) \Leftrightarrow \Omega$ Universal set

Where:

- * multiplication (product of values),
- + addition (sum of a few values)
- = equal to,
- $\neq$ not equal to, inequality (indicates two values are different)
- $\cap$ intersection (only the common elements of sets; x = a AND x = b),
- $\cup$ union (inclusive of all elements of sets; x = a OR x = b)
- Φ empty set (a set with no members)
- Ω universal set (volume of an object, all sets under consideration)
- ( ) parenthesis (denotes a quantity, list, set of coordinates)
- $\Leftrightarrow$ logical equivalence (logical statements)



2. We want to have a linear measure of hierarchical complexity that reflects how many actions, subactions, subsubactions, etc., are coordinated. We start by defining the measure of complexity at order n, denoted by φ_n, as the minimum number of simple actions required to complete an action of order n. The advantage of defining it this way is it directly reflects that the actions are organized. By using 2^n, one can then take the log and get an equally spaced ordinal scale. By axioms (HC2) and (HC3), an action of order n organizes at least two actions of order n –1, each of which in turn organizes at least two actions of order n –2, and so forth, until we reach the lowest-order, simple actions. Consequently, given the inductive definition of the hierarchical complexity orders, it is not surprising that $\varphi n = 2n$. Formally, a zero-order action, consists of at least one simple action, so $\varphi 0 = 1 = 20$. For the inductive case, suppose $\varphi n - 1 = 2n - 1$. Because by axioms (HC2) and (HC3), an action of order n is either a coordination of at least two actions of order n –1 or a chain which includes an action of order n (and hence eventually is composed of at least two actions of order n – 1), we have $\varphi_n = 2\varphi_{n-1} = 2^n$] by induction. Discerning the relationship between properties of stimulus

inputs and their corresponding responses can provide us with a great deal of knowledge about how people, animals and machines work. In the field of psychophysics, for example, investigations into these types of interconnections has led to advances in our understanding of sensory, perceptual, and cognitive processes. Naturally, a more comprehensive understanding of the properties of inputs facilitates this fruitful research into the relationship between stimuli and responses. These studies reported here examine how successfully The Model of Hierarchical Complexity (MHC) characterizes the input of the complexity of mathematical problems. A successful model would explain the developmental trajectory of problem solving skills–at least for these kinds of tasks over a greater developmental range, in greater detail and with more accuracy than now exists. This information could possibly aid in future research on how individuals may acquire more advanced skills for accurately solving these problems.

3. Bond and Fox explain log odds scales as "a *log*arithmic transformation of the *odds* of success" (2007, p. 24)
4. Synergetics is a frontier branch of science revealing general tendencies in the processes of formation, stability, and destruction of ordered temporal and spatial structures in complex systems of various nature, which are far from equilibrium. The models of Synergetics are models of non-equilibrium systems in the presence of fluctuations.
5. Ratio of managers to workers, expressing the number of workers that one manager is considered to be able to supervise effectively in a particular situation.
6. Rasch Analysis Background
   a. (Jean Piaget Society: http://www.piaget.org/Rasch/jps.rasch.home.html)

      This growing group of researchers owes its informal origin to a meeting between Trevor Bond from Australia and Gerald Noelting of Quebec (former collaborator of Inhelder and Piaget) at the annual JPS Symposium held in Montreal in 1992. Noelting and his team had been working with on the analysis of data from a series of Piagetian style tests they had developed--in particular they were trying to find statistical ways of identifying stages in their developmental data. Bond reported on the success he had in applying Item Response Theory--in this case, Rasch analysis--to Piagetian style tests developed by himself in Australia and by Shayer et al.. in England.

      As a result of the interest generated at the JPS presentations in 1992, Bond was invited to organise two Rasch analysis workshops in conjunction with future JPS Symposia. The first was conducted by Ben Wright of the University of Chicago (collaborator of Georg Rasch) in Philadelphia in '93; the second, by Trevor Bond and Mark Wilson of UC - Berkeley, at Berkeley, in 1995. These workshops were responsible for adding new members to the research team - in particular, Ulrich Mueller (member of Bill Overton's group at Temple U), Gino Coudé and Jean-Pierre Rousseau (members of Noelting's équipe at U Laval). As the success of the application of Rasch analytical procedures to Piagetian problems was made evident at symposia given by the team at Chicago and Berkeley, they were joined by Bill Gray from the University of Toledo, Theo L. Dawson from the University of California at Berkeley and Betsey Grobecker, Auburn University.

      The evolution of the group has been rather interesting: From the start, Trevor Bond has provided the bridging link between the developmentalists on the one hand and the experts in Rasch Analysis on the other. He was introduced to Rasch analysis by Geoff

Masters (Australian Council for Educational Research) and Mark Wilson, and more recently, has been working with Ben Wright and Mike Linacre [creator of the Rasch analysis software Winsteps] of the University of Chicago. The involvement of Theo Dawson has now strengthened the links with Mark Wilson, while Bill Gray brings with him the collaboration of statistician Christine Fox from the University of Toledo..

7. Dr. John Michael Linacre is a professor at the MESA Psychometric Laboratory, University of Chicago.