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Problem solving effectiveness : the relationship of divergent and convergent thinking.

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PROBLEM SOLVING EFFECTIVENESS: THE RELATIONSHIP OF DIVERGENT AND CONVERGENT THINKING

A Dissertation Presented

by

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DEDICATION

This dissertation is dedicated to my father, Oliver James Lane. His interest and joy in learning lasted throughout his long life and opened the door for me to see learning as a great adventure. Forced by the onset of World War I to leave school in England with only a sixth grade education, he spent his entire life in the pursuit of information through both formal and informal means. It is to his spirit of curiosity and love of the unknown I dedicate this work.

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Finally, a loving thank you is due my long-suffering husband, David, who was with me all the way, and my sons, Michael and Patrick, whose belief that I could do it made a difference.

ABSTRACT

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MAY 1994

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This dissertation analyzes the utilization of two distinct modes of thinking, divergent and convergent, in the problem solving process. The concept for this study was developed from seminal work done by J. P. Guilford, Alex Osborn, and Sidney Parnes. Based on the assumption that problem solving requires these two distinct modes of thinking, it was hypothesized that a relationship exists between the modes and certain personality types.

Two instruments, the Kolb Learning Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI), were used to gather quantitative data from 177 volunteer subjects. The LSI determined Converger/Diverger styles and the MBTI indicated personality type preferences of Sensing/Intuition (S/N) and Judging/Perceiving (J/P). The responses were analyzed by means of the Pearson chi-square test for significance.

As predicted, a significant relationship between LSI Converger/Diverger styles and MBTI personality type preferences for Judging/Perceiving (J/P) was demonstrated.

No significant relationship was demonstrated between the Converger/Diverger styles and the personality preferences of Sensing/Intuition (S/N). However, a relationship was shown to exist between Converger/Diverger styles and the combinations of Intuition-Perceiving (NP) and Sensing-Judging (SJ).

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C H A P T E R I

INTRODUCTION

Problem solving is a major activity in all aspects of life in the twentieth century. The crush of problems generated by modern day technology, population growth, economic imbalances, and environmental destruction demands that the process of solving problems becomes the most effective possible. In order to meet the needs of the future, to assure there is a future, it is of particular importance that the effectiveness of the process be increased. Of as great importance is that this improved problem-solving technology be communicated and utilized. In order to meet the requirements of our rapidly changing world, the need for greater problem-solving success is immediate and critical.

Chapter I will introduce the background of the problem and provide a statement of the problem, the purpose and significance of this study, a definition of terms used in the study, the six governing hypotheses and an overview of the methodology and limitations of the study.

Background of the Problem

In spite of attention paid to problem solving in the way of public and privately offered courses, books, articles, and the like, organizations frequently find that solutions surfaced by individual employees, consultants,

and problem-solving teams and groups are, at best, no more than adequate. A great deal of time, money, and individual effort is continually expended in meetings, training materials and events, and task force work. Responses by well-meaning individuals and teams in all areas of organizations and at all levels often result in solutions that are short term, misuse resources, and lack commitment and support. As a result, many organizations find themselves successively repeating their efforts, dealing with the same problems again and again after solutions have failed. A cycle of solution search and failure occurs as new people are involved and new efforts undertaken to re-solve problems already supposedly resolved.

Statement of the Problem

Most commonly employed problem-solving approaches focus on limited and rapid problem definition, solution search, decision making, and implementation. The intent and resulting activity is to converge on a solution as efficiently as possible. Individuals who present information or ideas that diverge too far from the norm are seen as not being realistic or goal oriented. Often they are identified as not being team players within their organization. Pressures of time and money coupled with lack of vision make this scenario understandable, but the results have the potential to and have, in fact, cost organizations dearly, especially from a long-range point of

view. Rarely is attention paid to the use of divergent thinking, activities, or procedures aimed at opening up the problem-solving process in order to obtain the best results. Concern about the use of resources such as time, money, and people, takes precedence over the possibility of effective, long-range solutions.

The benefit of the activities that are convergent in nature is that decisions are made and implementations are put in place. Action is taken for better or for worse. The loss caused by too great an emphasis on convergence is that the best solutions are usually not surfaced and if surfaced are not processed with the thoroughness necessary to develop their strengths. However, the infusion of divergent thinking and action as replacements for the present convergent processes seems equally unhealthy. Outstanding ideas and thorough processes without action and implementation are equally ineffective.

What, then, is the healthy balance of convergent and divergent thinking and how can it be obtained? Can the effectiveness of problem solving be improved by utilizing both of these modes of thinking? It is to the benefit of those engaged in the job of problem resolution to examine the possibility of a new mix of convergent and divergent thought and the availability of both through the diverse problem-solving styles of individuals. By understanding how people use these two thinking modes in dealing with everyday problems, it may be possible to harness the

strengths of each mode to the problem-solving process and create a vehicle with enhanced capabilities, one that will take us successfully into the future.

Purpose of the Study

This research was undertaken in order to provide information to individuals, groups, and organizations about their problem-solving capabilities. It is expected that the findings will be of particular use to those who wish to improve the results of solution searches and problem resolutions.

The primary purpose of this study was to examine the relationship of convergent and divergent thinking, personality styles, and problem solving. This study sought to discover whether certain personality styles as determined by the Myers-Briggs Type Indicator (MBTI) show positive correlations to divergent and convergent thinking. The relationship of these two modes of thinking to personality style was established through the use of the Kolb Learning Style Inventory (LSI).

By correlating the subjects' responses to these two instruments it was the intent of this study to demonstrate that a relationship exists between the LSI problem-solving categories identified as Converger and Diverger and the Myers-Briggs personality types, particularly those with preferences for Intuition/Perception (NP) and Sensing/Judgment (SJ).

The overall goal of this study was to improve the problem-solving process and its results by producing data which support and encourage the appropriate use and balance of divergent and convergent thinking.

Significance of the Study

This study makes available to human resource professionals, trainers, facilitators, managers, and organizational consultants research-based data on the relationship of convergent and divergent thinking to personality styles and problem solving. The information surfaced about these two modes of thinking, which is critical to the understanding and improvement of individual and group problem-solving processes, will assist these professionals in bringing about positive change. An additional benefit to change agents is the ability to disseminate the research data to a broad range of populations wanting to see improved results of problem-solving efforts.

This study provides documentation about the relationship of convergent and divergent thinking to personality types as indicated by the Myers-Briggs Type Indicator (MBTI). This information provides a basis for the construction of more effective problem-solving groups by showing the usefulness of different personality types to the process. The ability to develop reasonable guidelines to help individuals access the non-preferred elements of

their personality styles in order to strengthen their personal problem-solving effectiveness benefits counselors and those in guidance functions.

Future studies in this area of interest will be aided by this research. Since problem solving is a major day-to-day activity for organizations of all types as well as for individuals, the benefits of this study could be far reaching.

Methodology

This study gathered quantitative data about problem-solving styles and personality preferences and types from 177 volunteer subjects. Two separate, well-established, research-based instruments were used: the Myers-Briggs Type Indicator (MBTI) and the Kolb Learning Style Inventory (LSI). An important consideration in the selection of these two instruments was that both the MBTI and the LSI emphasize in their instructions that there are no right or wrong answers to the questions posed. This was of particular value to this study due to the nature of divergent thinking.

The Myers-Briggs Type Indicator (MBTI), developed by Isabel Briggs Myers from work started by her mother Katherine Briggs and first published in manual form in 1962, is based on Carl Jung's theory of psychological types.

> The aim of the MBTI is to identify, from self-report of easily recognized reactions, the

> basic preferences of people in regard to perception and judgment, so that the effects of each preference, singly and in combination, can be established by research and put to practical use. (Myers & McCaulley, 1985, p. 1)

Form G of the MBTI instrument, which was used for this study, is comprised of 126 forced-choice questions and is deemed appropriate for adults who can read at an eighth-grade level or above. Form G is designed so that items that best predict total type are at the beginning; this provides for relative accuracy of type even when the questionnaire is not completed. The MBTI has construct validity (Myers & McCaulley, 1985).

The Learning Style Inventory (LSI), designed by David Kolb to assess how an individual deals with day-to-day situations, provides information about the individual's problem-solving abilities. The LSI 1985, which was used for this study, is the revised and improved version. The instrument is a 12-item self-administering questionnaire. Respondents rank order four given responses for each of the 12 items in the order that best describes them as they see themselves.

The two instruments were administered to a sample of 177 volunteer adult participants who had a minimum of a high school education. Responses to the instruments were collected anonymously and identification of the responses was done by code and demographic information. A letter from the researcher explaining the study and a human

subjects consent form accompanied the instruments (see Appendix).

Scoring of the LSI 1985 was done by the researcher and verified by a trained assistant. Two approved MBTI practitioners assisted the researcher in verifying the responses to the Myers-Briggs instrument Form G. Correlations between subjects' results on the MBTI and the LSI were made using the Pearson chi-square test for statistical significance. By the end of the study, each participant had his/her results from the LSI and the MBTI. A copy of the summation of the research findings was sent to participants who requested it.

Limitations and Delimitations

This study is limited by the fact that indications of divergent and convergent thinking must be inferred from the self-reporting of respondents since actual problem-solving thought processes cannot be observed directly. In this way, through the process of self-reporting, some level of objectivity and accuracy due to respondents' lack of personal awareness, self understanding, and/or ability to recollect may have been lost. An additional limitation is that the two instruments used, the Myers-Briggs Type Indicator (MBTI) and the Learning-Style Inventory (LSI), are exclusively language-based. Subjects with poor language skills may have responded with inaccurate answers due to faulty interpretation of words or questions.

The delimitations of this study include the specification of a sample of an adult population of 177 people with no less than a high school education. Twenty-six percent of the sample had Master's degrees. The study relies on this population's responses to the two selected instruments, the LSI and the MBTI.

Of the four LSI problem-solving styles described by David Kolb, only two have been examined herein, the Converger and the Diverger styles. This study looked at the relationship of these two styles to the Myers-Briggs personality preferences and ignored the remaining two LSI problem-solving styles. It is recognized by the researcher that this is just one of the many ways in which a study of problem solving can be approached.

Definition of Terms

For the purpose of this study, the terms which were used are described as follows.

Learning-Style Inventory (LSI)

Diverger refers to a person whose learning style includes generation of ideas, imagination, and broad interests. "The Diverger's problem-solving strengths lie in identifying the multitude of possible problems and opportunities that exist in reality" (Smith & Kolb, 1986, p. 58).

Converger refers to a person whose learning style includes deductive reasoning, the search for correct answers, and specific problem focus. "The Converger's strengths lie in the evaluation of solution consequences and solution selection" (Smith & Kolb, 1986, p. 58).

Myers-Briggs Type Indicator (MBTI)

Sensing (S) refers to a person whose type preference is to work with known facts. In problem solving, "Use sensing to gather the relevant facts and face them realistically" (Myers & McCaulley, 1985, p. 55).

Intuitive (N) refers to a person whose type preference is to think about possibilities. In problem solving, "Use intuition to discover new possibilities and all the actions that might be taken to improve the matters" (Myers & McCaulley, 1985, p. 55).

Judging (J) refers to a person whose type preference is for order and decision making. He/she is "concerned with making decisions, seeking closure, planning operations, or organizing activities" (Myers & McCaulley, 1985, p. 14).

Perceptive (P) refers to a person whose type preference is for spontaneity and flexibility. He/she is "open, curious, and interested" (Myers & McCaulley, 1985, p. 14).

Research Hypotheses

The following research hypotheses for this study are based on two areas of background information: (1) the descriptions provided by the LSI and MBTI instrument designers and researchers, David Kolb about problem-solving styles and Isabel Briggs Myers about personality types, and (2) prior studies describing relationships between the Converger/Diverger styles and the Sensing, Intuitive, Judging, and Perceptive types.

The results of this study were hypothesized to be the following:

HO 1. That a correlation will be demonstrated to exist between LSI Convergers and MBTI Sensing (S) types.

HO 2. That a correlation will be demonstrated to exist between LSI Divergers and MBTI Intuitive (N) types.

HO 3. That a correlation will be demonstrated to exist between LSI Convergers and MBTI Judging (J) types.

HO 4. That a correlation will be demonstrated to exist between LSI Divergers and MBTI Perceptive (P) types.

HO 5. That the combinations of MBTI Intuitive/ Perceptive (N/P) types will have the highest correlation with the LSI Diverger style.

HO 6. That the combinations of MBTI Sensing/Judging (S/J) types will have the highest correlation with the LSI Converger style.

Organization of Dissertation

The remainder of this dissertation consists of Chapter II, Review of the Literature; Chapter III, Methodology; Chapter IV, Presentation and Analysis of Data; and Chapter V, Summary, Conclusions, and Recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Standard problem-solving models in use today by a large number and variety of organizations have followed a nearly identical pattern for at least the last half century. This pattern, categorized by a step-by-step format, focuses its energy in one direction, that of convergency. The steps commonly prescribe taking the problem and information close at hand and working through an ever narrowing process of definition, solution search, evaluation, and implementation. A typical example of such a model is outlined by management consultant and author Peter Drucker as follows:

1. "The classification of the problem."
2. "The definition of the problem."
3. "The specifications which the answer to the problem must satisfy."
4. "The decision as to what is 'right,'. . ."
5. "The building into the decision the action to carry it out."
6. "The feedback which tests the validity and the effectiveness of the decision . . ." (1983, p. 465).

A dawning awareness that narrowly defined problems and rigid solution searches have produced less than

successful answers to the new social, economic, and technological needs of our rapidly changing world has resulted in a strong desire to find a more effective model. This awareness most likely was the impetus which brought about the connection of creative thinking concepts, a new area of study, and the more established concepts and models of problem solving. The breakdown of the creative thinking process into distinct stages, introduced by Wallas in the 1920s, has resulted in methods of problem solving the components of which include processes that encourage divergence in conjunction with activities aimed at converging on "right" solutions. The goal of this combination is to expand problem solving so that solutions will be derived from a larger universe of thinking methods and information. The hope is that this breadth, which reflects the diversity of today's environment, will result in more effective solutions to our increasingly complex problems.

The purpose of this paper is to explore the roles of divergent and convergent thinking in problem solving, the relationship between these two thinking processes, and the connection to effective problem solving. This paper will examine the concepts of divergency and convergency by reviewing existing studies and thought. The topics covered include: defining divergent and convergent thinking; development of these concepts; results of past

studies; and creative problem-solving applications and techniques.

The Beginning of Creativity Research

When psychologist Graham Wallas wrote The Art of Thought (1926) and proposed his now well known four stages of thought it is unlikely he expected his work would be a cornerstone for the study of creativity and creative problem solving for the remainder of the twentieth century. His purpose was to define the conscious and unconscious processes necessary for productive thought so that they might be deliberately utilized. To do this, he examined the writings of several great thinkers among them Hermann von Helmholtz, an eminent 19th century German physicist, and Henri Poincaré, an outstanding French mathematician of the same period.

Wallas called the four stages Preparation, Incubation, Illumination, and Verification. Although the terms divergent and convergent thinking were not part of the vocabulary of his times, his definitions of the four stages imply a relationship to these later developed concepts. Wallas believed the mental processes that lead to new ideas were higher forms of thought not easily controlled by human will. In fact, he felt that a reduced level of consciousness, for example day dreaming, produced a greater openness to possibilities and options. This reduced level of consciousness weakened the power of critical thought developed by education and experience and

allowed the imagination greater freedom to work on solutions.

Wallas defined the first stage of the thought process, Preparation, as a conscious accumulation of knowledge and the adoption of a "problem attitude" (Wallas, 1926, p. 10). He referenced Helmholtz who speaking in 1891 described how new ideas came to him. Helmholtz said his thought process started with an investigation of a problem "in all directions" (Wallas, 1926, p. 80). Helmholtz said that his next event was not a conscious processing of the information gathered by this wide ranging investigation but rather that "happy ideas come unexpectedly without effort" (p. 80), frequently prompted by a peaceful walk in the woods. Wallas divided this description into two stages: Incubation, during which a person can either consciously think of subjects other than the problem or relax conscious thought by means of physical activity, the latter of which might be necessary for complex problems; and Illumination, which he described as a "flash." Wallas proposed that to control Illumination it was important to be aware of what he called "fringe-conscious" psychological events or Intimations that the flash was imminent (Wallas, 1926, p. 11). He emphasized the importance of being alert to these fringe conscious events in order to encourage and protect the oncoming flash of Illumination. Using the writing of Henri Poincaré, who had captured his own thought process

in an article entitled "Mathematical Creation," Wallas continued his examination of the stages of thought. Similar to Helmholtz, Poincaré said that a period of intense conscious work frequently had to be followed by a period of unconscious work during which the mind was either at rest or unknowingly working on the problem. This, he said, resulted in the sudden revelation of a solution, which was the result of this unconscious and often long prior work. In regard to these revelations Poincaré was careful to observe:

> All that we can hope from these inspirations, which are the fruit of unconscious work, is to obtain points of departure for such [algebraic] calculations. As for the calculations themselves, they must be made in the second period of conscious work which follows the inspiration, and in which the results of the inspiration are verified. (Wallas, 1926, p. 81)

Wallas adopted the term Verification for the fourth stage, describing it as a fully conscious state during which the rules of logic are used.

It was Wallas' thought that the four stages continually overlapped each other and at times might not be distinct. He suggested some guidelines for improving the effectiveness of each stage. For Preparation, a person could either follow directive, systematic rules of information gathering or approach the problem openly and freely. During Incubation Wallas recommended allowing a large amount of time for mental relaxation, which might include or even require physical activity; his personal belief was that both mind and body needed to relax during

this stage. For Illumination he encouraged watching for fringe events which might come before, during, or even after a flash. These fringe events were vague feelings or premonitions about the flash. Since they lay at the edge of full consciousness and were therefore accessible, they could be used to assist Illumination. Once Illumination had occurred and been captured, it was necessary to move to the Verification stage where the idea would be tested and reduced to a more precise form.

Wallas additionally suggested the development of habits that would encourage the thinking process, such as arranging specific times for intellectual work or employing sensory stimulus, as did Charles Dickens when arranging his desk top before writing. However, Wallas warned against becoming a slave to habit and recommended purposefully making breaks in routine in order to refresh the thinking process. He also advised seeking stimulus to open up the thought process and recording fringe thoughts to explore later, a technique reportedly used by Darwin, Hobbes, and Helmholtz.

Later authors Harman and Rheingold (1984), among others, found more examples that substantiated the four stages proposed by Wallas. They tell of Elias Howe spending many years working on the invention of the lockstitch sewing machine. A critical design solution eluded him until he had a nightmare in which he saw warriors carrying spears with heads that had eye shaped

holes. Upon awakening, Howe made a model of a needle with an eye, the solution he had been seeking for such a long time. Another case was Robert Louis Stevenson who deliberately used his dreams to stimulate his writing, as he recounted regarding "The Strange Case of Dr. Jekyll and Mr. Hyde." Stevenson wanted to write about the two sides of human nature, good an evil, but had been unsuccessful until the following series of events occurred:

> For two days I went about racking my brains for a plot of any sort; and on the second night I dreamed the scene at the window, and a scene afterward split in two, in which Hyde, pursued for some crime, took the powder and underwent the change [to Jekyll] in the presence of his pursuers. All the rest [of the story] was made awake, and consciously. (Harman & Rheingold, 1984, p. 38)

A First Step in Development

In the 1930s and 1940s, little research was done on creativity, although creativity training appeared in business and industry during this period (Mayer, 1983). What may have been the first course designed to raise the level of creativity in professionals was R. P. Crawford's "attribute listing" course which he introduced in 1931. Crawford's course taught participants to first list the most important attributes of a product, then the modifications that could be made to each attribute. Transferring attributes from one object to another was another phase of his technique. Crawford described his approach: "Each time we take a step, we do it by changing

an attribute or a quality of something, or else by applying that same quality or attribute to some other thing" (Mayer, 1983, p. 331). Attribute listing helps the problem solver see the problem's many parts, each of which once identified is available to be dealt with independently. This expanded view in turn stimulates a larger quantity of solutions. (Shallcross, 1985, pp. 87-88) Crawford's attribute listing encouraged divergent thinking during problem analysis and solution search.

Brainstorming as a Tool for Problem Solving

Following World War II, it became apparent that innovative new approaches to scientific invention would be critical for the future of the leading powers. This newly perceived need stimulated research into the nature of creativity and creative problem solving. By the 1950s, new information and methods based on research in the field of creativity were becoming popular. Alex Osborn's brainstorming technique introduced in Applied Imagination in 1953 was being used in a number of different industries, for the perception was gradually developing that "a business leader has to combine creative thinking with judicial thinking in arriving at decisions." (Osborn, 1961, p. 345) Osborn's four brainstorming principles, derived from his extensive work with many different organizations, are now well known. These principles in his own words are:

(1) Criticism is ruled out. Adverse judgment of ideas must be withheld until later.

(2) "Free-wheeling" is welcomed. The wilder the idea, the better; it is easier to tame down than to think up.

(3) Quantity is wanted. The greater the number of ideas, the more the likelihood of winners.

(4) Combination and improvement are sought. In addition to contributing ideas of their own, participants should suggest how ideas of others can be turned into better ideas; or how two or more ideas can be joined into still another idea. (Osborn, 1961, p. 84)

Of these four, it is generally agreed by practitioners today that the importance of the first principle, now commonly called "deferred judgment," cannot be underestimated. By 1961, Osborn referred to it as "The Brainstorming Principle" (p. xix) citing research by Arnold Meadow and Sidney Parnes at the University of Buffalo which showed ideation to be 70% more productive when judgment was suspended during brainstorming than when judgment was concurrent (Osborn, 1961, p. xix). Judgement by definition is convergent and, when applied prematurely to a divergent thinking activity such as brainstorming, will bring it to a halt before a sufficient number of different ideas have surfaced. Despite the demonstrated importance of the first principle, the remaining three have continued to prove valuable. For example, regarding quantity of ideas, principle three, Osborn (1961) wrote: "In case after case, the last 50 ideas produced at a brainstorm session have averaged higher in quality than the first 50" (p. 228). It is of note that brainstorming

continues to be a mainstay of creative problem solving as evidenced by the number of references by current authors in the field; LeBoeuf (1980), Shallcross (1985), Adams (1986), and Goman (1989) are only a few of those writing about the technique today.

Osborn had several suggestions for improving the effectiveness of brainstorming. He felt the ideal combination started with individual brainstorming, followed by group brainstorming, ending with a return to individual brainstorming (1961, p. xx). For group work, he recommended a panel made up of a leader, an associate leader, 5 regular members, and 5 guests. The role of the leader was in effect convergent, to keep the group focused on the task and to assure the principles were adhered to. Panel guests needed to have specific knowledge about the topic being brainstormed, whereas regular members should be selected for their "fluency" or ability to produce numerous ideas. To support this Osborn, noting that "fluency" was becoming a common psychological term, quoted J. P. Guilford, then President of the American Psychological Association: "The person who is capable of producing a large number of ideas . . . has a greater chance of having significant ideas" (1961, p. 317).

Imagination and Judgment

Based on more than a decade of observation and research, Osborn concluded that two major types of

thinking were necessary for effective problem solving. These were what he termed imagination and judgment, now recognized as divergent thinking and convergent thinking processes. To show how both could be used while maintaining their necessary separateness he outlined an alternating sequence of imagining and deciding, ten steps which started with "Think up all phases of the problem." and ended with "Decide on the final answer" (1961, p. 257). This was later modified by Sidney Parnes into the Osborn-Parnes Creative Problem-solving model actively in use today.

Osborn felt the brainstorming technique was critical to the search for successful solutions, but from his experience with organizations like General Electric and the United States Air Force he determined there were other important components of the problem-solving process. Additional ideas needed to be collected from panel members following a brainstorming meeting; these would be the result of incubation stimulated by the activity of brainstorming. Panel guests should be replaced periodically to prevent the development of group thinking patterns. A screening committee should be set up separate from the brainstorming committee to reprocess the brainstormed ideas by combining and elaborating on them. The screening committee would also perform the convergent tasks of judging and selecting the best ideas.

Osborn recognized the advisability of two committees, one for each of the two major thinking processes, imagination and judgment, but he acknowledged the necessity for people to act on an individual basis "as if we were two people - at one time, a thinker upper; at another time a judge" (1961, p. 258). He reiterated the importance of the principle of deferred judgment by concluding:

> Of the many ways in which we can guide our thinking, the most important is to guard against being both critical and creative at one and the same time.
>
> Inevitably, if we let our judgment intrude prematurely, we tend to abort ideas which could prove to be the most valuable of all. (1961, p. 77)

Two Problem-Solving Techniques

Brainstorming is what Osborn is probably best known for; however, he had a profound and lasting impact on problem solving in many other ways. He outlined 75 idea stimulating questions to induce divergence and convergence through imagination and direction. To obtain quantity of ideas he asked questions during each step of the problem-solving process, augmenting the classic why, where, when, who, what, and how with "What about . . .?", "What if . . .?", and "What else?". Manipulating ideas in a variety of ways was another of his strategies to expand possibilities. To do this, Osborn combined his questions with a check list of key words: adaptation, modification, substitution, addition, multiplication, subtraction,

division, rearrangement, reversal, and combination (1961, chaps. XXII, XXIII, XXIV). More recent authors in the field of creative problem solving have constructed their own versions of these lists (Eberle, 1971; Adams, 1986).

The Creative Problem-Solving Model

Osborn's concept of alternating divergent and convergent thinking was transformed into the Osborn-Parnes Creative Problem-solving model (commonly called CPS) by Sidney Parnes, Professor Emeritus of Creative Studies at the State University of New York at Buffalo. Parnes, who had worked with Osborn, felt that new thoughts resulting from the use of Osborn's checklist would change the way people looked at a problem. This altered perspective would cause in turn additional new thoughts. While ideas surfaced during the early stages of the problem-solving process might not produce the most useful solutions, Parnes believed they would stimulate more applicable ideas as the process progressed (1977, p. 193).

The Osborn-Parnes CPS model, currently in use by business, educational, and scientific organizations and by the Creative Education Foundation, starts by "Looking at 'The Mess' to find problems" and moves to "Finding a 'Fuzzy Problem'" (Parnes, Noller, & Biondi, 1977, p. 147, article by McPherson, 1968). Following this are the five core steps of CPS: (1) Fact-Finding, (2) Problem-Finding, (3) Idea-Finding, (4) Solution-Finding, and (5)

Acceptance-Finding. Each step has two stages: a divergent stage encouraging a constant flow of thoughts, ideas, and facts and a convergent stage focusing on more traditional activities such as judging and selecting. The five steps, writes Parnes in 1988,

> are probably not as important as the extent to which the imagination is stretched as one alternates throughout the process. You react first with imaginative play, then with tempered reality to the new fact, viewpoint, or idea." (p. 13)

The resulting model is a balance of convergent and divergent thinking, of judgment and imagination.

In an article for the "Journal of Creative Behavior" in 1976, Parnes described deferred judgment as a "turnpike" which encourages the expression of ideas (1977, p. 193). He proposed that often this must be augmented by techniques, such as checklists, which "trigger" new ideas by breaking habitual thinking patterns and accessing information buried deep within us. Parnes, noting these new ideas are only the starting point in the creative problem-solving process, said, "A great deal of refinement and development are usually necessary to make the ideas workable within the realities that exist." He concluded by emphasizing "that divergent production - the creation of many alternatives at each stage - is not an end in itself but only a 'means' to an end" (1977, p. 194). His final point is that the best solutions come from aggressive idea generation combined with appropriately timed evaluation.

Challenges to Brainstorming

Although brainstorming was already actively in use by the 1950s (Mayer, 1983) and has continued to be a popular problem-solving technique into the present (Adams, 1986; Miller, 1987), there have been some challenges as to its value. In 1958, a study by Taylor, Berry, and Block reported that four people working separately generated more ideas that four people working as a group (Mayer, 1983). In 1961, research by Weisskopf-Joelson and Eliseo showed that brainstorming groups did not produce more "good" ideas than groups using traditional problem-solving techniques (Mayer, 1983; Weisberg, 1986). In 1963, Dunnette, Campbell, and Jaastad reported that deferred judgment instructions were not effective (Mayer, 1983). In the study by Dunnette et al. in which twelve groups of four participants brainstormed while 48 different individuals solved problems alone the results indicated that working in groups was less effective than working alone. The groups tended to stay in a pattern of thought longer than individuals (Weisberg, 1986). A limitation of this study is that the groups were comprised of four people not the twelve Osborn recommended.

The possibility of group thought patterning (groups falling into habits or patterns of thinking) which was recognized by Osborn was prevented in his work by periodic replacement of members thus breaking existing patterns. Weisberg in Creativity (1986), significantly subtitled

Genius and Other Myths, acknowledged that Osborn showed evidence from his work with leading organizations such as IBM and the thousands of people attending his courses at the State University of New York at Buffalo of brainstorming's success. However, Weisberg contends that since control groups were not set up to test against the brainstorming groups that Osborn's results are inconclusive. It is important to note when evaluating the studies cited by Weisberg that, "One purpose of this book [Creativity] is to demonstrate that much of what we believe about creativity is not based on hard data but is more or less folklore" (1986, p. 3). It seems likely that Weisberg's goal of destroying what he considers to be myths may have reduced his objectivity.

Divergent and Convergent Thinking

During the 1950s, J. P. Guilford, Professor of Psychology at the University of Southern California, proposed a theoretical model organizing intellectual abilities. The model, known as "The Structure of Intellect" (SI), is in the form of a cube with three visible sides or dimensions: operations, contents, and products. Each mini-cube or cell within the cube represents one intellectual ability or function and there are 120 possible abilities, each different from all the others (Guilford, 1959). (In Way Beyond the IQ, 1977, Guilford expands the model to contain 150 possible

abilities.) The operations dimension consisted of 5 kinds of operations: cognition, memory, divergent thinking, convergent thinking, and evaluation. Guilford explained the factors of divergent and convergent thinking as follows:

> Divergent thinking is defined as the kind that goes off in different directions. It makes possible changes of direction in problem solving and also leads to a diversity of answers, where more than one answer may be acceptable. (1959, p. 381)
>
> The convergent-thinking class of abilities takes its name from the kinds of tests involved. In general, they call for one right answer . . . which can be determined closely, if not exactly from the information given. (1959, p. 376)

Guilford continued over the next two decades to reexamine and modify his Structure of Intellect (SI) model and its underlying concepts. With the help of colleagues he developed tests to measure various factors of the SI model and added to the developing language of creativity some now well known terms used in testing for giftedness: Fluency, the ability to produce many responses; Flexibility, the ability to produce a diversity or variety of responses; Originality, the ability "to produce uncommon, remotely associated, or clever responses" (1959; p. 388), and Elaboration, the ability "to supply details to complete a given outline . . . the specification of details that contribute to the development of an idea or the variations of an idea" (1959, p. 389). These four

factors are in the divergent thinking category. In 1977 he wrote:

> The greatest importance of divergent production abilities [divergent thinking] is in connection with creative thinking, where many alternative ideas need to be brought to light with ease. Since creative thinking is an important aspect of problem solving, these abilities are also important in that connection. (p. 108)

Guilford believed the best opportunity to see how intellectual abilities work together is in the closely affiliated processes of problem solving and creative thinking (1977). A true problem exists, he said, when intellectual activity, not just information, is required; therefore in problem solving productive thinking (divergent and convergent) is of major importance. Since creative thinking and problem solving both involve the production of new outcomes, he deduced that the problem-solving process must have creative aspects, which he equated primarily with divergent thinking. Guilford's problem solving model (1977, p. 163) included divergent thinking, convergent thinking, and evaluation, and he made the case that all three can and should be employed at any time during the process in order to arrive at the best solutions.

Two Cognitive Modes for Problem Solving

In 1962, Jacob Getzels and Philip Jackson, working in the field of educational psychology at the University of Chicago, published Creativity and Intelligence which

discussed their findings about the relationship of creativity and intelligence in adolescents. Getzels and Jackson equated Guilford's terms convergent thinking and divergent thinking to their own: "intellectual acquisitiveness and conformity" and "intellectual inventiveness and innovation. One focuses on knowing what is already discovered, the other focuses on discovering what is yet to be known" (p. 14). They worked from an assumption that there are two basic cognitive modes, one "retaining the known, learning the predetermined, and conserving what is" and the other "revising the known, exploring the undetermined, and constructing what might be" (pp. 13-14). Both modes are found in every person in varying degrees; neither mode is better than the other; both have application and value. They determined that standard, widely used IQ tests, by seeking and rewarding (through scoring) predetermined correct answers, primarily evaluated the conserving mode and ignored the constructing mode.

In order to look beyond the conserving mode and its extensive documentation Getzels and Jackson tested adolescent children for creative potential, scoring their responses on number (fluency), variety (flexibility), originality, appropriateness, and complexity. They studied two categories of students, those who scored high in creativity but not high in intelligence and those who scored high in intelligence but not high in creativity.

They found that Guilford's factors of convergent and divergent thinking, which reinforced their cognitive modes assumption, were extremely helpful in understanding the students. Like Guilford, they believed that when a problem requires a stretch for its solution, when more than repetition and memory are necessary, creative production is vital. Citing MacKinnon, they speculated that when goals are set realistically high the resulting initial frustration can stimulate creative thinking by leading to withdrawal which starts the process of incubation, insight, illumination, and invention.

Getzels and Jackson provided stimulus themes for stories to be written by the students. They found the high creatives used the stimulus as a departure point for their stories whereas the high intelligence students focused on the stimulus itself. The result was that the high creatives came up with stories that were more fantastic and expressive. Rather than conserving the stimulus theme, they constructed a theme that satisfied them. The high creatives had more unexpected endings, humor, playfulness, incongruities, and even more violence than the high intelligence students. Getzels and Jackson discovered that high intelligence students knew what teachers wanted and had similar wants. High creativity students also knew what teachers wanted but often did not have the same wants. Using Guilford's descriptors, they concluded that high intelligence students were convergent

thinkers whose thinking was channeled toward seeking one conclusion or answer and that high creativity students were divergent thinkers, less goal bound and more able to seek answers in a variety of different directions. While both conservative cognition (convergent thinking) and constructive cognition (divergent thinking) were socially valuable to Getzels and Jackson, they saw particular value in the contribution of fresh and unique ideas by the high creative, divergent thinking students.

Based on their research Getzels and Jackson proposed numerous changes in education and a major change in the intellectual climate of both education and society in general. These changes would focus on fostering creative thinking, the "shaking [of] ideas together, and selecting from among [them]" (p. 129), while continuing to reward intellectual acquisitiveness and conformity. They felt that the stretch required by new problems to find new answers produced a need for both of the two basic cognitive modes, intellectual and creative. They affirmed their agreement with Guilford that education can actively encourage divergent thought and concluded:

> Criticism is indeed important, but so is perceptive openmindness. It is the duty of teachers to teach, but it is also their duty to encourage their students to be open to all ideas, even those that may threaten the teachers' as well as the students' own preconceptions. (p. 129)

Divergent Thinking and the Creative Personality

Creativity is "the process of forming ideas or hypotheses, testing hypotheses, and communicating the results. Implied in this definition is the creation of something new" (Torrance, 1962a, p. 32). Writing about his studies of creative behavior in children in Guiding Creative Talent (1962b), E. Paul Torrance called divergent thinking one of the essentials of the creative personality and one of the reasons creative thinkers often feel excluded. He hypothesized that attitude can help or stifle the development of creative thinking. A person having a creative attitude wants to seek answers, explore, and experiment; a person having a critical attitude looks for defects and to criticize. He found that gifted classes had an attitude and culture which resulted in more positive stories by creative children than those they produced in regular classes.

To evaluate children's creative thinking, Torrance converted Osborn's uses for a brick activity to a task asking children to think of unusual uses for a toy dog. Guilford's convergent operation of Redefinition, defined by Torrance as "defining or perceiving in a way different from the usual, established, or intended" (1962b, p. 37), was required in the toy dog task because the child must redefine the object in order to think of ways to improve it. To measure creativity of responses Osborn's check list of verbs (Change, Combine, Adapt, etc.) was applied

as were Guilford's divergent thinking factors of Fluency, Flexibility, Originality, and Elaboration.

Torrance used the terms convergent operations to mean behavioral norms that support the right attitude and solution and divergent operations to mean norms supporting independent, constructive, and inquiring attitudes and solutions. Referencing 1950s studies by Guilford, Thurstone, and Getzels and Jackson, Torrance concluded, as they did, that intelligence tests emphasized convergent thinking and ignored divergent thinking, adding that there were societal sanctions against divergency as well. He wrote

> Many of our society's coercive influences against divergency, even against outstanding performance, are reflected in the imaginative stories concerning flying monkeys and silent lions [that the children composed for his study]. (1962b, p. 105)

The animals selected for the children's stories were chosen for their unusual, divergent characteristics and the creative children's stories reflected some of the problems they experienced because of their own divergency.

From various personality studies, Torrance compiled a list of 84 characteristics of creative persons, many of which could be considered divergent traits (Torrance, 1962b; Arieti, 1976). A few of the characteristics from Torrance's list are: attracted to disorder; disturbs organization; independence of judgment; non-conforming; receptive to external stimuli and to ideas of others; a visionary; versatile. Torrance believed that the highly

creative person, like the story animals, is constantly faced with the problem of "being a minority of one" because of his/her divergency (1962b, p. 124). He reported that teachers, parents, and other children feel threatened when creative children express their creativity because it involves questioning, experimenting, and unusual ideas, all of which are unsettling and can be perceived as hostile.

The development of creative thinking was important to Torrance because he believed it contributed to a healthy mentality, encouraged the processes of information acquisition and use of knowledge for problem solving, and was therefore vitally important to society as a whole. In order to encourage creative expression and the development of divergent abilities Torrance suggested a better understanding of creativity and divergency should be undertaken.

Analogical and Logical Thought Processes

Psychologist Frank Barron embarked on the study of creativity in 1949 at the University of California, Berkeley, under the leadership of Donald MacKinnon, Director of the new Institute of Personality Assessment and Research (IPAR). Based on his nearly forty years of experience, Barron wrote in 1988 this detailed definition of creativity.

> Creativity is an ability to respond "adaptively" to the needs for new approaches and new products. It is essentially the ability to bring something new into existence purposefully, though the process may have unconscious, or subliminally conscious, as well as fully conscious components. . . . The "something new" is usually a "product" resulting from a "process" initiated by a "person." (p. 80)

During the early 1950s, Barron designed the Symbol Equivalence Test which was given to a broad range of artists and scientists including the first American team of mountain climbers to climb Mount Everest (Barron, 1988). Using this test Barron measured a key component of creativity, originality, which he described as the capacity to produce responses which are both adaptive to reality and unusual (1963a). Barron's findings from the Symbol Equivalence Test revealed analogical thought processes. Using this information, he proposed that creativity comes from the tension between the two opposing processes, analogical and logical. Moreover, he said, "Creative people are equally capable of the logical and the analogical, are open alike to the rational and the nonrational" (1988, p. 91). It seems reasonable to connect Barron's terms analogical and nonrational with divergent thinking and rational and logical with convergent thinking.

Writing for "Scientific American" in 1958, Barron described creative artists as: especially observant; seeing things other people do not; independent thinkers; having greater ability to remember and compare many ideas;

experiencing a complex universe; in contact with the unconscious and imagination; and both "more destructive and more constructive . . . than the average person" (Adams, 1986a, p. 126). Several of these characteristics match those found in creative children by Getzels and Jackson. In 1983, using the Inventory of Personal Philosophy (IPP), Barron found a positive correlation between Originality, Independence of Judgement, and Complexity of Outlook (1988). The IPP data supported his view that the combination of preference for complexity and drive to find simple order is critical to creativity. The theme of complexity coupled with simplicity was central to Barron's study of the creative personality.

Tests like Symbol Equivalences and "What-Ifs" (What would happen if . . .), Barron said, can be used in almost any area of problem solving to awaken imagination (divergent thinking) and focus on the realistic (convergent thinking). He gave the following example of using symbols and imagery in order to expand practical thinking (he calls this "thinking-aside" the problem): two committees were problem solving; one worked directly on the problem while the other read a poem before starting on the problem. The committee which used the poem demonstrated more originality (adaptive and unusual responses) in solving the problem according to Barron's findings (1988).

Thirty years after his article for "Scientific American" Barron distilled and strengthened his description of the creative personality to read:

> Openness to new ways of seeing, intuition, alertness to opportunity, a liking for complexity as a challenge to find simplicity, independence of judgment that questions assumptions, willingness to take risks, unconventionality of thought that allows odd connections to be made, keen attention, and a drive to find pattern and meaning - these, coupled with the motive and the courage to create, give us a picture of the creative self. (1988, p. 95)

Barron felt our creative resources were being wasted and he suggested ways to identify and nurture creative potential: classroom instruction in creative thinking; supportive organizational structures; national measurement and recognition; and ongoing research. He said, "The transformative power of imagination, coupled with the will to apply it . . . is the main source of hope to counter what may otherwise become a pessimism about the human future as the millennium comes to an end" (1988, p. 97).

Frank Barron's emphasis on the desire for coexistent complexity and simplicity as a key component of the creative personality relates to the need for both divergent and convergent thinking as reported by Guilford, Getzels and Jackson, and others. Divergent factors of Fluency, Flexibility, and Elaboration clearly contribute to the creative person's ability to experience a complex universe. One of Guilford's definitions of convergent thinking, "one conclusion or answer that is regarded as

unique [the only right answer], and thinking is . . . channeled or controlled in the direction of that [one] answer" (Getzels & Jackson, 1962, p. 51), reveals the purest example of simplicity possible, that of one right answer. The important difference between a creative thinker and a conventional thinker is that while the conventional thinker is looking for the simplicity of an accepted or preselected right answer, the creative thinker is looking for a "right" answer that is not necessarily the "truth" of others but is a truth derived from the problem as he/she sees it. The creative thinker combines complexity and simplicity, divergent and convergent thinking, in order to open and close options so that all solutions are not traditional solutions and new problems can be processed with originality in the search for better answers. "Innovations need to be entertained with criticism, wisdom, and responsibility if they are to serve human purposes" (Barron, 1988, p. 81).

Problem Solving with Analogy, Analysis and Generalization

In 1960, in Cambridge, Massachusetts, George Prince and W. J. J. Gordon started Synectics Incorporated, a client based company focused on invention, research into the creative process, and teaching (Prince, 1970). Their goal was to identify the procedures that lead to creative problem solving and help clients learn to apply them. Prince, who had a strong personal interest in creativity,

came from a marketing background; Gordon was in the Invention Design Group of an industrial research company when they first met. The two partners separated in 1965, each continuing to teach the Synectics problem-solving process.

Prince described the process as having two basic approaches: procedures that stimulate imagination and specific methods of valuing and encouraging speculation. Although these appear to be divergent, only the step by step process and guidance of a trained leader bring simplicity and convergency to the group problem-solving event. Prince, reacting as other researchers have to divergent thinking, wrote, "Free speculation and disciplined reaction to it is of urgent importance, for there is a relentless gravity-like force [justified as realistic thinking] working against speculation" (1970, p. 9). Barron's concept of originality being both adaptive and unusual is reflected in Prince's phrase "Directed Originality" and indicates his awareness of the need to focus divergent production. The Synectics problem-solving process by its use of analogical thinking actively engages Transformations which include adaptive flexibility (divergent thinking) and redefinition (convergent thinking).

A major focus of Synectics is analogical thinking, termed Model-seeking, to "make the strange familiar" and "make the familiar strange." Model-seeking or Analogy is

combined with Analysis, "breaking down complexity into its component parts," and Generalization, "the intellectual act of identifying significant patterns among the component parts" (Prince, 1977, p. 156). The purpose of using analogies, which are drawn from areas unrelated to the problem, is to cause new views and disrupt existing expectations about the problem and possible solutions; these are divergent operations. Generalization, on the other hand, utilizes convergent thinking abilities by reorganizing details into new patterns. The leader, similar to Osborn's brainstorming leader, functions primarily in a convergent capacity and brings, to use Barron's term, "simplicity" to the group effort by keeping the problem investigation on track.

The Synectics process starts with a statement of the problem to the group. This is followed by Analysis, an explanation of the problem by the participant expert, and then Purge, an airing of immediate suggestions and solutions. At this point, the Excursion phase is started as participants restate the problem from their perspectives or write their visions of desirable goals. The problem owner now selects the problem statement to be used for the remainder of the process. The Synectics group leader moves the group into analogical thinking by selecting an Evocative Question which will cause "constructive psychological strain" (Prince, 1977, p. 157); that is, it will stimulate originality (divergent

production) and transformations (convergent and divergent) by its unrelatedness to the problem.

Evocative Questions produce three different types of analogies: (1) Example (Direct Analogy) drawn from participants' experiences and knowledge; (2) Personal Analogy in which participants speculate on how another person or a non-human entity might feel and act in the problem; and (3) Book Title (Symbolic Analogy), in which key words from the problem statement are transformed into brief phrases often containing a paradox (example: Receptivity = Involuntary Willingness) (Prince, 1977, p. 158). This is followed by Examination of a selected idea Example to produce descriptive and speculative facts about it, similar in nature to attribute listing. The final step of the Excursion phase is a Force Fit of the analogies to the problem in order to redefine it in totally new ways.

The Excursion phase is thus completed and the final step, Viewpoint, is undertaken to capture solution possibilities which have surfaced by means of the process. Prince recognized that, in spite of the work accomplished to this point, converting Viewpoints into workable solutions was not an easy task. He said "developing promising Viewpoints is perhaps 5 percent of the job. Implementation is the other 95 percent: the first 5 percent is vital, but difficult hurdles remain" (1970, p. 97). The difficulty of implementation undoubtedly depends

on the degree of receptivity to the type of divergent and convergent thinking that has gone on during the Synectics problem-solving process. To explain resulting solutions within the frame of the analogical process, for example, to traditional thinking organizations, organizations that expect linear and predictable problem-solving processes, might well jeopardize implementation of even outstanding ideas.

Lateral and Vertical Thinking

Edward deBono, like others who found a pervasive emphasis on convergent thinking and the recall of existing answers, concluded that education focused exclusively on what he called "vertical thinking," the development and utilization of existing ideas. He proposed that the need for new ideas and innovative methods and products will increase as computer technology assumes vertical thinking tasks and that this need requires the deliberate utilization of a different type of thinking. His book, Lateral Thinking (1970), is designed to explain and teach how to access this alternate but natural way of thinking the functions of which are the breaking of existing concept boundaries and the generation of new ideas. Lateral thinking, he insisted, is essential to progress and can be practiced and used by anyone successfully.

DeBono introduced his concept with his view of the thinking process, two completely different but

complementary stages of information processing both of which are necessary. The first stage, which determines the final outcome, includes creativity and insight restructuring; these are the components of lateral thinking. Logic and mathematics are valuable but non-creative second stage information processing methods. They assist the step by step, "high probability sequential development" of ideas which deBono termed vertical thinking (1977, p. 196). Lateral thinking, which is not sequential, when used deliberately is able to improve problem-solving capabilities by compensating for the limitations, such as pattern rigidity, of the second stage.

In order to understand the need for both types of thinking it is important to review deBono's descriptions of each. The two as he presents them are opposites which when both are utilized create a competent whole. Lateral thinking, he wrote in 1970, enhances vertical thinking by providing it with more possibilities from which to choose and is made more effective by vertical thinking's ability to develop the idea it has chosen. Using an analogy he later wrote: "Vertical thinking is concerned with digging the same hole deeper. Lateral thinking is concerned with digging the hole somewhere else. The aim of both is effectiveness" (1977, p. 195).

Many of the characteristics deBono described relate to factors of divergent and convergent thinking. For

example vertical thinking selects one approach to a problem and follows it. This mirrors Guilford's description of convergent thinking as being "goal directed" (1959, p. 455). Lateral thinking "sets out to generate as many alternative approaches as possible. . . . Success is measured by the number of alternatives that have been produced" (deBono, 1977, p. 197). The divergent factor of Fluency, therefore, is a vital part of lateral thinking.

Vertical thinking moves in one planned direction, toward one answer, and seeks to exclude outside influences. Lateral thinking may move in order to find direction and welcomes outside influences because they can disrupt fixed ideas or patterns constructed by vertical thinking. "The more irrelevant such influences are the more chance there is of altering the established pattern. To look for things that are relevant means perpetuating the current pattern" (deBono, 1970, p. 42). The key features of lateral thinking are its ability to restructure concept patterns, which deBono termed "insight," that have been developed by vertical thinking, and to discover new patterns. The discovery of new patterns deBono called creativity (1970).

DeBono suggested cross-disciplinary fertilization and the use of analogies (as did Prince and Gordon), brainstorming, and random word stimulation as some useful techniques to break down old patterns (lateral and

divergent thinking functions) and stimulate the formation of new patterns (vertical and convergent thinking functions). However, he believed that lateral thinking was more than techniques; he saw it as both a habit and an attitude, a constant expectation that no idea is wrong, no pattern is permanent. From a problem-solving perspective he proposed that problems requiring information reorganization, original ideas, new viewpoints, or potential problem awareness (Guilford's "sensitivity to problems" factor) could not depend solely on the logic of vertical thinking for effective solutions but must engage the strengths of lateral thinking as well. The characteristics of these two thinking processes encompass the factors found in divergent and convergent thinking.

Popularizing Creative Thinking and Problem Solving

The 1970s and 1980s saw the popularization of creativity. Books on how to be creative found their way into mall and shopping center bookstores. Some of these are entertaining; some focus on one aspect of creativity, imagery for example; some have been aimed at the business community; some unfortunately demonstrate very little understanding of the subject.

The cover of Creative Visualization, written by Shakti Gawain (1978), proclaims "Use the power of your imagination to create what you want in life." Ten years later, in 1988, Ronald Stone's book with the same title

promises his techniques will help you succeed in business and excel in sports. Creativity in Business, by Michael Ray and Rochelle Myers (1986), is based on their course at Stanford University. Some of their advice includes breaking tasks into small pieces, changing your attitude, using a mantra, and asking dumb questions. The same title by Goman (1989) in workbook format briskly describes Wallas' stages and a variety of techniques for idea generation including analogies, brainstorming, and forced connections.

Well known books include Betty Edwards' Drawing on the Artist Within (1986), in which she connects creative thinking with drawing skills and Roger von Oech's visually entertaining A Whack on the Side of the Head (1983). James Adams' popular Conceptual Blockbusting, printed from 1974 through 1986 (and possibly more recently), covers a broad range of techniques and ideas including visual imagery and the use of the five senses, the concepts of Fluency and flexibility, Osborn's checklist and other research based information. The most recent years have seen a broad range of business focused books like Creating Excellence (Hickman & Silva, 1984), which is more about management than creativity; William Miller's The Creative edge (1987) with useful and relatively complete information and techniques; Managing Creativity (1991), a collection of business case studies by John Kao of Harvard Business School; and 99% Inspiration (Mattimore, 1994),

which has a chapter subtitled "How to Brainstorm Cost-Cutting Ideas." Many of these new offerings have useful ideas and exercises for solving problems with creativity but the wide range of quality makes "buyer beware" a wise approach.

Summary and Conclusion

This paper has attempted to review the work of the major contributors to the field of creative thinking and problem solving, particularly convergent and divergent thinking. The terms used by these researchers, theorists, and teachers are various but the concepts and related findings parallel the factors originally outlined in Guilford's Structure of Intellect. To review those factors briefly: divergent thinking factors include Fluency, Flexibility, Originality, and Elaboration; convergent factors include redefinition, ordering, visualization, and symbol substitution. The category of transformations is found in both convergent and divergent thinking. Evaluation factors, which are separate in Guilford's model, are not covered in this paper except as they overlap into some of the studies and techniques.

There is an overwhelming pattern of agreement among those reviewed herein that both convergent and divergent factors are critical to effective problem solving and that the problem-solving process is significantly strengthened by the inclusion of both. Many of those discussed raised

the issue that convergent thinking is accented in education and some of them indicated that they believe this is a reflection of societal emphasis and a bias against divergent thinking. Another area of general agreement is that skills in divergent thinking can be taught and, because of the existing focus on convergent thinking, the addition of divergent education for both children and adults would be of major benefit to all.

The concepts and techniques developed by this group of contributors to the field of creativity have to a large degree stood the test of many years. Brainstorming, for example, is in constant use by diverse groups as a divergent problem-solving tool. The Osborn-Parnes Creative Problem-solving model, which alternates divergent and convergent thinking, has grown in use as has Synectics analogical thinking model of problem solving. Torrance's tests continue to assist in the selection of creative children for gifted programs, programs which often include future problem solving. Books aimed at the general public have recently grown in number. It is to be hoped that this ongoing interest and application indicate a broad based recognition of the need for the advantages of problem solving that combines divergent and convergent thinking.

New ideas and new ways of dealing with the world are being required at every moment. Problems that are now common place, the impact of a world community, technology,

pollution, and shrinking resources to name a few, demand solutions that cannot rely solely on traditional, convergent thinking processes, processes which depend primarily on old patterns and existing information. In order to solve the problems of the future the strengths of convergent thinking, the ability to bring order to information for example, must be integrated with the strengths of divergent thinking and its ability to see and project the complexities of life that exist and will exist. It is the conclusion of this paper that any problem-solving process in order to be effective must deliberately utilize and maintain a balance of convergent and divergent thinking.

C H A P T E R I I I

METHODOLOGY

Introduction

This chapter describes the research approach that was taken in this study. It covers the following information: Design of the Study, Study Sample and Procedure, Instrumentation, and Method of Data Analysis.

Design of the Study

This study was designed to investigate the relationship between two distinctly different problem solving styles of thinking, divergent and convergent, and four basic personality type preferences: sensing, intuitive, judging, and perceptive. To accomplish this two instruments were utilized, the Kolb Learning-Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI).

Quantitative data about problem solving styles and personality types was gathered from 177 volunteer subjects who answered the questions on both the LSI and MBTI instruments. The results of these responses were analyzed using a Chi-Square test. This research approach was selected to bring statistical objectivity to a subject, the relationship of personality and problem solving style, that is except in studies such as this one most frequently treated in a subjective manner.

Data collected by means of the LSI and the MBTI instruments were used to address the following hypotheses.

HO 1. That a correlation will be demonstrated to exist between LSI Convergers and MBTI Sensing (S) types.

HO 2. That a correlation will be demonstrated to exist between LSI Divergers and MBTI Intuitive (N) types.

HO 3. That a correlation will be demonstrated to exist between LSI Convergers and MBTI Judging (J) types.

HO 4. That a correlation will be demonstrated to exist between LSI Divergers and MBTI Perceptive (P) types.

HO 5. That the combinations of MBTI Intuitive/Perceptive (N/P) types will have the highest correlation with the LSI Diverger style.

HO 6. That the combinations of MBTI Sensing/Judging (S/J) types will have the highest correlation with the LSI Converger style.

In formulating the six hypotheses of this study, the researcher reviewed prior studies showing relationships between the Kolb Learning-style categories and the MBTI personality preferences. Studies cited by Smith and Kolb (1986) identified validity relationships between the four Learning-style categories and various career fields. Occupations that fell within the Converger and Diverger categories showed matches to occupation studies cited by Myers and McCaulley (1985) for Sensing/Intuition and Judging/Perceiving. Some examples follow.

Examples of these MBTI career matches for the Diverger style include: Psychology (Intuition), Languages (Intuition and Perception), Arts (Intuition and Perception). Examples of MBTI career matches to the Converger style include: Business (Sensing), Technical Trades (Sensing), and Physical Sciences (Judging). The sources cited by Myers and McCaulley for the occupational correlations referenced for the purpose of formulating the hypotheses of this study are the Strong-Campbell Interest Inventory (Campbell & Hansen, 1981), and the Kuder Occupational Interest Survey (Kuder, 1968).

Study Sample and Procedure

The 1985 version of the Kolb Learning-Style Inventory (LSI) and Form G of the Myers-Briggs Type Indicator (MBTI) were administered to a sample of 177 volunteer adult subjects, each with a minimum of a high school education. An explanation of the method and purpose of the study was given subjects by the researcher. A human subjects consent form for signature accompanied the instruments (see Appendix A). A form to collect subjects' demographic information was also included (see Appendix B). Responses to the instruments were collected and coded for analysis. Analysis was accomplished using the Pearson Chi-Square test for significance.

Description of Sample

One hundred and seventy-seven volunteers responded to the two selected instruments. Of the 177, 78 (44%) were male and 99 (56%) were female. The sample was drawn primarily from a mixture of graduate and undergraduate classes at two New England universities and from businesses in the same geographic area. Sixty-four percent of the respondents had Bachelor's degrees and 26% had Master's degrees. The majority (88%) fell into the 20-49 age range. English was the first language for 77% of the subjects (see Appendix C).

Procedure

Subjects from education and industry were invited to complete the Kolb Learning-Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI). Those responding were informed of the purpose and methodology of the study and asked to sign a consent form if they were willing to have their results included in the study. A demographics form was provided to gather information on gender, age group, level of education, and whether English was the respondent's first language.

The LSI and MBTI results for those agreeing to be included were scored and coded by the researcher assisted by a LSI experienced colleague and an approved MBTI practitioner. Correlations between subjects' results on the LSI and the MBTI were made using the Pearson Chi-Square

test for statistical significance. By the end of the study each subject had his/her results from the LSI and the MBTI. A copy of the summation of the research findings was sent to subjects requesting that information.

Instrumentation

To surface data of significant value to the study of problem solving, particularly with an emphasis on divergent and convergent thinking modes, the selection of instruments was of major importance to the research. The two instruments chosen, the Learning Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI), were of merit for several reasons. Both were explicit in their instructions to respondents that there were no right and no wrong answers. This was seen by the researcher as reassurance to those participating in the study that their answers would not be either evaluated or judged. To achieve accuracy of responses it was critical that respondents felt free to answer without concern for ramifications.

Other perceived strengths of the two instruments were information on the history, development, and theoretical foundations of each instrument; documentation of previous studies; guidelines for administering, scoring, and interpreting; and feedback to participants that was seen as useful and empowering.

A concern about both instruments needs to be raised, however. An unconscious bias exists in many

questionnaires, especially in some of those that have been used historically to study learning and learning processes in the United States, towards the dominant culture. This dominant culture, which is generally white and Western European in its roots, frequently reflects male values and often includes a predisposition towards English-speaking respondents.

Since both instruments were administered in English to all participants, those for whom English was a second language as well as those for whom it was the first, it is important to identify that the possibility existed for this latter bias. It is of further note that the population for whom English was a second language was comprised of many members visiting from outside the United States. Based on the fact that cultural and racial biases against diverse groups living in the United States have been established as a concern in the design and use of instrumentation, it is conceivable that these same biases were active by means of the instruments used for this study.

To address the issue of bias, the Learning Style Inventory (LSI) User's Guide (Smith & Kolb, 1986) and the Myers-Briggs Type Indicator (MBTI) Manual (Myers & McCaulley, 1985) provided background information. The LSI's normative sample, comprised of 638 men and 801 women, is identified as ethnically diverse and representative of a broad range of careers. The demographic analysis of the LSI 1985 normative sample shows percentage for sex, age,

and education but not for ethnic diversity. The MBTI advises which populations may be suitable for testing. It specifies that caution should be used when using the MBTI with non-English-speaking people. The MBTI was initially developed using large samples of high school students. The ethnic demographics of this sample are not identified.

Learning Style Inventory (LSI)

The Learning Style Inventory (LSI), designed by David Kolb based on experiential learning theory, provides information about individuals' learning and problem solving abilities. The revised version of the LSI, LSI 1985, was used for this study (see Appendix D).

The LSI 1985 instrument is a 12 item self-administering questionnaire. For each of the 12 questions respondents rank order the four given responses in the order that they perceive best describes the way in which they process new information. This ranking produces a first level of scores. To determine which learning style quadrant respondents fall into, a second calculation is made from the first level scores. The two quadrants from this second calculation that are labeled Converger and Diverger were the focus of this study.

The first level scores and the combination scores derived from the second calculation show very good internal reliability (Smith & Kolb, 1986).

Myers-Briggs Type Indicator (MBTI)

The Myers-Briggs Type Indicator (MBTI), which was developed by Isabel Briggs Myers from the Jungian based typology of her mother Katherine Briggs, was first published in 1962. The questionnaire gathers data about attitudes, feelings, perceptions, and behaviors of sixteen psychological types.

Form G of the MBTI instrument, published in 1977 and currently in use, was employed for this study (see Appendix E). It is comprised of 126 forced choice questions and is designed for adults who can read at an eighth grade level or above. Since type theory postulates dichotomies, all questions offer a choice within the same preference: Sensing (S) or Intuitive (N), Judging (J) or Perceptive (P), for example.

To provide for relative accuracy of personality type identification in the event the questionnaire is not completed, questions that best predict type are placed at the beginning. The MBTI has construct validity and reliabilities consistent with other personality instruments (Myers & McCaulley, 1985).

The inclusion of the MBTI as a test instrument by Donald MacKinnon, director of the Institute of Personality Assessment and Research at the University of California, in studies of creative people (Myers & McCaulley, 1985) lends support to its selection for this study.

Method of Data Analysis

Responses to the Learning Style Inventory (LSI) and Myers-Briggs Type Indicator (MBTI) were analyzed using a correlational test, the Pearson Chi-Square. Subjects' response scores from the MBTI were converted to personality types E/I, S/N, T/F, and J/P. LSI scores were calculated to determine learning quadrants: Converger, Diverger, Accommodator, and Assimilator. Cross tabulations were made of the MBTI types with the LSI learning quadrants. Comparisons corresponding to the six problem hypotheses concerning the relationship of the S/N and J/P types to the Converger and Diverger learning quadrants were made.

The computer statistical analysis system used to process the data from this study was the Statistical Package for the Social Sciences. In all comparisons the level of significance was determined by $p \leq 0.05$. The results are shown on tables in Chapter IV and in the Appendices.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The results of this study will be covered in two sections. The first section will present the demographic information gathered about the study sample and the research findings in relation to each of the study's six hypotheses. The second section will analyze the findings of the study.

Presentation of Data

Demographic Characteristics of the Study Sample

The sample population for this study was chosen to meet several criteria. They are: sample of adequate size to ensure the possibility of significant results, a balance of male and female respondents, an education level per subject of no less than high school graduate or equivalent, exposure to or experience in a work environment, and a willingness to participate in the research. Willingness to participate was indicated by signing a Human Subject Consent Form (see Appendix A).

The sample was made up of 177 volunteer subjects who were willing to have their results from the two designated instruments, the most recent available version (1985) of the Kolb Learning Style Inventory (LSI) (see Appendix D) and Form G of the Myers-Briggs Type Indicator (MBTI) (see

Appendix E), included in this study. The respondents were given anonymity by means of a code assigned to the data prior to its entry into the statistical tabulation and analysis process.

Attached to each Human Subject Consent Form was a Demographic Features of Participants Form (see Appendix B) which asked for the following information: Gender, Age Group, Level of Education, and "Is English your first language?" Table 4.1 contains the information obtained from participants completing this form.

An acceptable balance of male and female respondents was obtained with 44% men and 56% women participating in the study. These percentages match those of the 1985 Learning Style Inventory (LSI) normative sample (Smith & Kolb, 1986). Most subjects in the study sample were between the ages of 20-50 (88.1%). Bachelor's degrees were held by 63.8% of the respondents in this study as compared to 5.5% of the 1985 LSI normative sample.

English was the first language of most of the subjects (76.8%); however, a substantial number of respondents (23.2%) reported that English was not their first language. Since all respondents at the time of the study were either working, going to college, or doing both in the New England area of the United States, the researcher has assumed the 41 subjects who indicated their first language was not

Table 4.1

Demographic Characteristics of the Study Sample Expressed as Frequency (Count) and Percent of Respondents in Each Category (N = 177)

	Count	Percent
Sex		
Male	78	44.1
Female	99	55.9
Age		
20-29	66	37.3
30-39	45	25.4
40-49	45	25.4
50-59	15	8.5
60-69	5	2.8
70-79	1	.6
Level of Education		
Diploma	8	4.5
B.A.	59	33.3
B.S.	54	30.5
M.S.	46	26.0
Doc.	6	3.4
Other Deg.	4	2.3
First Language		
English	136	76.8
Other	41	23.2

English were able to read and respond to both instruments with an adequate level of understanding.

Tabulation of respondents by Kolb learning style quadrants Converger, Diverger, Assimilator, and Accommodator was also done. Table 4.2 shows the total distribution of respondents among the four LSI quadrants.

Table 4.2

Total Distribution of Respondents
Expressed as Frequency (Count) and Percent
in Each Kolb LSI Type
(N = 177)

	Count	Percent
Kolb LSI Type		
Converger	48	27.1
Diverger	32	18.1
Assimilator	55	31.1
Accommodator	42	23.7

The two LSI quadrants of interest to this research are the Converger and the Diverger. Comparisons of the 48 Converger types and 32 Diverger types with the Myers-Briggs Type Indicator categories of Sensing/Intuitive (S/N) and Judging/Perceiving (J/P) were made to match the problem hypotheses.

A total distribution of respondents among the Myers-Briggs 16 personality types is found in Table 4.3. The sample size of 177 used for this study was anticipated to not be large enough to obtain significant results for the 16 major types. The six problem hypotheses and the data analysis are focused therefore on the S/N and J/P categories. The distribution of the 16 personality types are presented as here as a frame of reference.

Figures on Table 4.3 labeled Normative Sample Percent are derived from MBTI Form G data provided by the MBTI data

Table 4.3

Total Distribution of Respondents
Expressed as Frequency (Count) and Percent
in Each of 16 MBTI Personality Types
(N = 177)

MBTI Personality Type	Count	Study Percent	Male Normative Sample Percent	Female Normative Sample Percent
ISTJ	18	10.2	15.45	9.77
ISFJ	15	8.5	4.42	10.30
ISTP	5	2.8	6.07	2.67
ISFP	4	2.3	3.00	4.27
INFJ	3	1.7	2.63	4.77
INTJ	17	9.6	7.28	4.00
INFP	8	4.5	4.76	6.32
INTP	14	7.9	7.05	3.30
ESTP	3	1.7	5.90	2.78
ESFP	4	2.3	3.12	5.73
ESTJ	16	9.0	14.01	10.07
ESFJ	10	5.6	4.39	10.66
ENFP	23	13.0	5.38	9.80
ENTP	12	6.8	6.86	4.11
ENFJ	8	4.5	2.74	6.38
ENTJ	17	9.6	6.93	5.17

bank (Myers & McCaulley, 1990). For the Form G male normative sample, N = 15,791. For the Form G female normative sample, N = 16,880.

Tables 4.4, 4.5, and 4.6 show the distribution of respondents in relation to the MBTI Sensing (S), Intuition (N), Judging (J), and Perceiving (P) categories.

Table 4.4 illustrates the distribution of combinations of Sensing/Intuition (S/N) and Judging/Perceiving (J/P)

Table 4.4

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Sensing/Intuition (S/N) with
Judging/Perceiving (J/P) Combinations
(N = 177)

	Count	Percent
SJ	59	33.3
SP	16	9.0
NP	57	32.2
NJ	45	25.4

Table 4.5

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Sensing (S) and Intuition (N)
(N = 177)

	Count	Percent
Sensing (S)	75	42.4
Intuition (N)	102	57.6

Table 4.6

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Judging (J) and Perceiving (P)
(N = 177)

	Count	Percent
Judging (J)	104	58.8
Perceiving (P)	73	41.2

preferences. Since each preference is dichotomous, responses may only be Sensing (S) or Intuition (N), Judging

(J) or Perceiving (P). Combinations therefore may only be 1. Sensing (S) with Judging (J) or Perceiving (P), or 2. Intuition (N) with Judging (J) or Perceiving (P).

Estimated distribution of SJ and SP combinations of are: SJ = 38%, SP = 38%; no estimates are given for NP or NJ (Keirsey & Bates, 1978). The disparity between the percentage of SP's, 9%, in this study and the referenced estimate of 38% indicates this is not a representative sample. This conclusion assumes the estimated percentage was accurate in 1978 and continues to be so.

Table 4.5 shows the distribution of respondents to the Myers-Briggs Type Indicator relating to the independent preferences for Sensing (S) and Intuition (N).

Based on her research, in 1962 Isabel Briggs Myers estimated type preference in the general population to be S = 75%, N = 25% (Myers & McCaulley, 1990; Keirsey & Bates, 1978). The number of Intuition (N) preferences, 57.6%, in this study compared to the estimate of 25% indicates that in this category (S/N) the sample was not representative.

Table 4.6 shows the distribution of respondents between the preferences for Judging (J) and Perceiving (P).

Myers' 1962 estimate of preference for the Judging/Perceiving category was J = 55% to 60% of the population, and P = 40% to 45% (Myers & McCaulley, 1990). Keirsey and Bates report an even division of 50% for each category, J and P (1978). The sample in this study is representative of the distribution estimated by Myers.

Research Findings

Six hypotheses were explored in this study. The findings of this research will be discussed in relation to each hypothesis. Each table, 4.7 through 4.12, is examined vis-a-vis the hypothesis it seeks to support. In all comparisons, significance was determined by $p \leq 0.05$. Actual level of significance is noted for each table.

Table 4.7 pertains to Hypothesis 1. It shows that the frequency (count) of responses identifying a preference for Sensing (S) was 75 out of 177 or 42.4% of the total sample. Table 4.7 compares these 75 Sensing (S) responses to the four LSI styles, Converger, Diverger, Assimilator, and Accommodator.

Hypothesis 1 proposed that a relationship would be seen between the categories of Converger and Sensing (S). The data analysis indicates the variables are independent. There was no significant difference in the responses.

Table 4.8 pertains to Hypothesis 2. It shows that the frequency (count) of responses identifying a preference for Intuition (N) was 102 out of 177 or 57.6% of the total sample. Table 4.8 compares these 102 Intuition (N) responses to the four LSI styles.

Hypothesis 2 proposed that a relationship would be seen between the categories of Diverger and Intuition (N). The data analysis indicates the variables are independent. There was no significant difference in the responses.

Table 4.7

Responses of Sample Relevant to
Hypothesis 1: That a correlation exists between LSI
Convergers and MBTI Sensing (S) preference

MBTI	Sensing (S)	Preference	Count 75 (42.4% of N)
LSI	Count	Exp Val	Pct. of n
Converger	24	20.3	32.0
Diverger	10	13.6	13.3
Assimilator	28	23.3	37.3
Accommodator	13	17.8	17.3
Total	75	75.0	99.9

Actual Level of Significance: .08395

Table 4.8

Responses of Sample Relevant to
Hypothesis 2: That a correlation exists between LSI
Divergers and MBTI Intuitive (N) preference

MBTI	Intuitive (N) Type	Count 102 (57.6% of N)	
LSI	Count	Exp Val	Pct. of n
Converger	24	27.7	23.5
Diverger	22	18.4	21.6
Assimilator	27	31.7	26.5
Accommodator	29	24.2	28.4
Total	102	102.0	100.0

Actual Level of Significance: .08395

Table 4.9

Responses of Sample Relevant to
Hypothesis 3: That a correlation exists between LSI
Convergers and MBTI Judging (J) preference

MBTI	Judging (J) Preference	Count 104 (58.8% of N)
LSI	Count	Exp Val	Pct. of n
Converger	29	28.2	27.9
Diverger	17	18.8	16.3
Assimilator	42	32.3	40.4
Accommodator	16	24.7	15.4
Total	104	104.0	100.0

Actual Level of Significance: .00190

Table 4.10

Responses of Sample Relevant to
Hypothesis 4: That a correlation exists between LSI
Divergers and MBTI Perceptive (P) preference

MBTI	Perceptive (P) Type	Count 73 (41.2% of N)
LSI	Count	Exp Val	Pct. of n
Converger	19	19.8	26.0
Diverger	15	13.2	20.5
Assimilator	13	22.7	17.8
Accommodator	26	17.3	35.6
Total	73	73.0	99.9

Actual Level of Significance: .00190

Table 4.11

Responses of Sample Relevant to Hypothesis 5: That the combinations of MBTI Intuitive Perceptive (NP) preferences will have the highest correlation with the LSI Diverger style.

MBTI	NP Preference	Count 57 (32.2% of N)	
LSI	Count	Exp Val	Pct. of n
Converger	13	15.5	22.8
Diverger	12	10.3	21.1
Assimilator	10	17.7	17.5
Accommodator	22	13.5	38.6
Total	57	57.0	100.0

Actual Level of Significance: .02559

Table 4.12

Responses of Sample Relevant to Hypothesis 6: That the combinations of MBTI Sensing Judging (SJ) preferences will have the highest correlation with the LSI Converger style.

MBTI	S/J Type	Count 59 (33.3% of N)	
LSI	Count	Exp Val	Pct. of n
Converger	18	16.0	30.5
Diverger	7	10.7	11.9
Assimilator	25	18.3	42.4
Accommodator	9	14.0	15.3
Total	59	59.0	100.1

Actual Level of Significance: .02559

Table 4.9 pertains to Hypothesis 3. It shows that the frequency (count) of responses identifying a preference for Judging (J) was 104 out of 177 or 58.8% of the total

sample. Table 4.9 compares these 104 Judging (J) responses to the four LSI styles.

Hypothesis 3 proposed that a relationship would be seen between the categories of Converger and Judging (J). The data, although significant, does not support the hypothesis in the predicted direction. A greater percentage of Judging (J) types proved to be Assimilators (40.4%) than Convergers (27.9%). In addition, the difference between the Converger: Judging expected value and count is +.8, whereas the difference between the Assimilator: Judging expected value and count is +9.7. There was a significant difference in the responses.

Table 4.10 pertains to Hypothesis 4.It shows that the frequency (count) of responses identifying a preference for Perception (P) was 73 out of 177 or 41.2% of the total sample. Table 4.10 compares these 73 Perceptive (P) responses to the four LSI styles.

Hypothesis 4 proposed that a relationship would be seen between the categories of Diverger and Perceptive (P). The data, although significant, does not support the hypothesis in the predicted direction. A greater percentage of Perceptive (P) types proved to be Accommodators (35.6%) and Convergers (26.0%) than Divergers (20.5%). In addition, the difference between the Diverger: Perceptive expected value and count is +1.8, whereas the difference between the Accommodator: Perceptive expected

value and count is +8.7. There was a significant difference in the responses.

Table 4.11 pertains to Hypothesis 5. It shows that the frequency (count) of responses identifying a preference for the combination of Intuition/Perception (N/P) was 57 out of 177 or 32.2% of the total sample. Table 4.11 compares these 57 Intuitive/Perceptive (N/P) responses to the four LSI styles.

Hypothesis 5 proposed that the strongest relationship would be seen between the categories of Diverger and Intuitive/Perceptive (N/P). The data, although significant, does not support the hypothesis in the predicted direction. A greater percentage of Intuitive/Perceptive (N/P) types were demonstrated to be Accommodators (38.6%) and Convergers (22.8%) than Divergers (21.1%). The difference between the Diverger: Intuitive/Perceptive (N/P) expected value and count is +1.8, in contrast to the difference between the Accommodator: Intuitive/Perceptive (N/P) expected value and count of +8.7. There was a significant difference in the responses.

Table 4.12 pertains to Hypothesis 6. It shows that the frequency (count) of responses identifying a preference for the combination of Sensing/Judging (S/J) was 59 out of 177 or 33.3% of the total sample. Table 4.12 compares these 59 Sensing/Judging (S/J) responses to the four LSI styles.

Hypothesis 6 proposed that the strongest relationship would be seen between the categories of Converger and Sensing/Judging (S/J). The data, although significant, does not support the hypothesis in the predicted direction. A greater percentage of Sensing/Judging (S/J) types were demonstrated to be Assimilators (42.4%) than Convergers (30.5%). The difference between the Converger: Sensing/Judging (S/J) expected value and count is +2, in contrast to the difference between the Assimilator: Sensing/Judging (S/J) expected value and count of +6.7. There was a significant difference in the responses.

Analysis of Data

The findings of this study were disappointing to the researcher in that none of the six problem hypotheses were supported by the results of the Pearson Chi-Square test. Although the sample was of an adequate size to obtain significance, and significant differences in responses were demonstrated in four of the hypotheses: 3, 4, 5, and 6, the predictions made were not supported.

The research hypotheses were largely based on a comparison of the descriptors for the four learning styles and the personality preferences. The learning style descriptors were taken from the Kolb Learning Style Inventory (1985) and supporting documentation (Kolb, 1984; Smith & Kolb, 1986; McCarthy, 1987; Kolb, Rubin, & Osland, 1991). The personality preference descriptors were

similarly taken from material provided by the Myers-Briggs Type Indicator Manual (Myers & McCaulley, 1990) and other MBTI theory and research (Myers, 1980; McCarthy, 1987; Lawrence, 1982).

The results of the study do, however, provide some valuable and interesting information for those using or planning to use the Learning Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI) in problem solving situations. Where a preference for Judging(J) has been determined, it may be predicted based on this study (see Table 4.9) that in 40.4% cases the learning style as indicated by the LSI will be Assimilator. "The Assimilator excels in the abstract model building necessary to choose a high-priority problem and alternative solutions." (Smith & Kolb, 1986, p.58) An even greater relationship (42.4%) is shown to exist in this study between S/J and Assimilators (see Table 4.12).

Other predictions based on this study also may be helpful to those working on problem solving. MBTI Perceptive (P) personality types may be predicted to be primarily Accommodators (see Table 4.10) as may be Intuitive/Perceptive (N/P) personality types (see Table 4.11), 35.6% and 38.6% respectively. "The Accommodator's problem-solving strength lies in executing solutions and in initiating problem finding, based on some goal or model about how things should be." (Smith & Kolb, 1986, p.58)

It is worthwhile to note at this point a study by Margerison and Lewis done in 1979 with 220 managers and M.B.A.students (Kolb, 1984).The sample for that study has a demographic resemblance in size and education to the sample for this present study. A correlation done between the LSI and the MBTI in the 1979 study shows Judging (J) related to the Converger style, as was hypothesized for this study although not supported by the data analysis. The 1979 study, however, does not support any of the remaining hypotheses of this study.

The results of the Margerison and Lewis study indicate a strong relationship between Sensing(S) and the Accommodator style and weaker relationships between Intuition (N) and the Assimilator style and Perception (P) and the Accommodator style. The relationship between the latter, Perception (P) and the Accommodator style, is supported by the findings of this study.

The following chapter will summarize the findings of this study, draw conclusions about the work accomplished, and make recommendations for future areas of study and research.

C H A P T E R V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Review of the Problem

This study grew out of a perceived need for improved problem solving abilities in a world of rapid change. Too often problems are resolved with more attention to time and cost efficient resolution than to quality and longer range effectiveness. It is the contention by the researcher that both efficiency and effectiveness are requisite for successful problem solving and need to be combined with the search for innovative, high quality solutions to meet ever arising new problems. It was the foundation of this study that this desirable combination of approaches to problem solving can be obtained by the use of two major modes of thinking, convergent and divergent.

It was the intent of this study to examine the use of convergent and divergent thinking as a way to strengthen and enhance the problem solving process. In order to accomplish this goal, this study relied on two well established instruments, the Kolb Learning Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI) to gather data about people's convergent and divergent processes.

Summary of Findings

Using a quantitative research design involving the Kolb Learning Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI), this study gathered information about divergent and convergent modes of thinking and personality types and preferences from a volunteer sample of 177 men (44.1%) and women (55.9%). The age range of the sample was from 20 to 80 years old, with the majority falling in the 20 to 50 age range. More than 60% of the subjects had a Bachelor's degree and nearly 30% held a graduate degree. Twenty-three percent of the sample reported English was their second language.

Each of the 177 respondents answered the questions on both the LSI and MBTI instruments. In order to evaluate convergent and divergent thinking, the LSI learning style quadrants that were selected as the focus of this study were the Converger and Diverger. An assumption was made based on the descriptors of each learning style quadrant that these two styles were enough similar to Guilford and other researchers' descriptions of convergent and divergent thinking to warrant their use. These responses in these two quadrants equaled 45.2% of the sample. The two remaining LSI quadrants, Assimilator and Accommodator, were included in the data, equaling 54.8% of the sample.

The type preferences of the MBTI that were identified for purposes of this research were Sensing (S), Intuition (N), Judging (J), and Perceiving (P). Of the preference

for either Sensing (S) or Intuition (N), responses in this study were S=42.4% and N=57.6%. Based on long standing estimates by the designer of the MBTI instrument (S=75%, N=25%) Isabel Briggs Myers, this was not a representative sample on this dimension. The distribution of responses for Judging (J) or Perceiving (P) preferences was J=58.8% and P= 41.2%. The sample in this study was similar to Myers' estimates and therefore can be considered representative on this dimension.

The responses to the LSI and the MBTI were coded and analyzed using the Pearson Chi-Square test for significance. The results of the Chi-Square test were then compared to the six problem hypotheses with the outcome that two of the hypotheses, HO 1 and HO 2, showed no significant difference in the responses. Data analyzed in relation to the remaining four hypotheses showed significance of $p \leq 0.05$. However, the results did not support the hypotheses in the predicted direction.

The LSI Converger and Diverger learning styles did not demonstrate any of the predicted relationships with the MBTI personality preferences of Sensing/Intuition (S/N) or Judging/Perceiving (J/P). Instead, relationships were shown to exist between the LSI Assimilator and Accommodator learning styles. Primary relationships were established between Sensing (S) and the Assimilator style and between Judging (J) and the Assimilator style. Relationships were

also established between Intuition and the Accommodator style and between Perceiving and the Accommodator style.

Conclusions and Implications

This study has attempted to clarify the relationship between the processes of divergent and convergent thinking and problem solving. To do so the research relied on data gathered about personalities and their related learning styles.

Analysis of the data showed that Kolb Learning Style Inventory (LSI) Convergers made up slightly more than one fourth of the population surveyed (27.1%) while LSI Divergers were less than one fifth of the survey population (18.1%). This small percentage of Divergers matches with the perception of the researcher based on nearly 25 years of organizational problem solving experience. It is supported by creativity research which has established that convergent thinking is encouraged and divergent thinking discouraged starting in childhood (Getzels & Jackson, 1962; Torrance, 1962b).

It may be concluded that the problem solving process is a complex one involving many thinking skills and abilities. Based on this research it is worth considering that these skills and abilities may not lend themselves to a dichotomous distribution. It may be that in addition to divergent and convergent thinking, other types of thinking

must and do occur during the various activities clustered under the term "problem solving."

A further conclusion is that more research needs to be done on problem solving and on convergent and divergent thinking as they are used in the process of seeking solutions. Although the data analysis did not support the hypotheses of this study, the researcher believes this area of interest is worth pursuing. Many other researchers, including those covered in this study's review of the literature, have made a case for the need for and usefulness of these two modes of thinking during the process of solving problems. While continued work correlating LSI and MBTI results would be valuable, another approach, the use of qualitative research for example, might provide additional and possibly new insights.

Receiving information from the instruments and participating in the study were highly desirable outcomes in the view of many of the subjects. Implications of this high level of interest may include support for the belief that improved problem solving is an important issue and that information about people, one's self individually and as a member of a larger universe, is meaningful and most welcome.

Recommendations for Future Research

Future research into the areas of problem solving, divergent and convergent thinking, and the relationship of

the Kolb Learning Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI) to these topics and to each other is highly recommended. Each of these areas holds promise for more information and insights to be revealed and put to the use of improved problem definition, solution search, and resolution.

A sample large enough to test the relationship of each of the 16 Myers-Briggs Type Indicator personality types to the Kolb LSI learning styles would be an extremely beneficial goal of future research. The impact of the four preferences not included in this research, Extraversion/Introversion (E/I) and Thinking/Feeling (T/F) on the preferences studied, Sensing/Intuition (S/N) and Judging/Perceiving (J/P) might be substantial. The results of such a study might show that the preferences cannot be considered independently and must be reviewed within the context of the whole personality type in order for relationships to the LSI quadrants to be accurately established.

A larger sample in future studies would also allow for analysis of demographic components such as race or age in relation to the MBTI and LSI. The examination of these specific elements of interest, and others to be determined by future researchers, might reveal information that has significant bearing on correlations of the MBTI and LSI which were not able to be determined by this study. A more thorough and complete study of the impact of these

variables and others could be obtained by means of a sample the size of which would assure statistical validity.

It is recommended that the structure of future studies be designed to result in data that are more differentiated in nature than this study. One criticism of this study is that there are no finer breakdowns of the major categories due to the restrictive size of the sample. All participants, for example, in this study who do not speak English as a first language are grouped together under "Other Language," although their languages and cultures are various. This inclusive grouping does not provide data for the study of any independent language based ethnic, racial, or cultural group, such as Chinese or Russian. Because of this artificial integration of data, results from the study as pertains to language and, by extension, culture are most likely not of particular value. Another structural design to be considered would be the use of multivariate analysis. A correlation matrix of the LSI, MBTI, and demographics of gender, for example, would be a worthwhile approach.

Another benefit of a larger sample would be the ability to look at strengths of learning styles and preferences and to compare the level of strength of each response. Conceivably, Divergers placing high within the LSI learning-style quadrant might show a different relationship to Intuitives placing high on the MBTI preference scores than would be shown by those with moderate strength in either or both categories.

Conversely, borderline or weak LSI style and MBTI preference scores might show different relationships due to their closer similarities to the adjacent categories.

Studies involving problem solving, modes of thinking, and personality types in different categories of organizations including non-profit, manufacturing, education, service, and volunteer organizations would be of great value. The results of such studies would provide useful information to a wide range of organizations which, by their nature, might prove to have inherently different factors in their demographic make up and problem solving capabilities.

Another area for future research is that of specific types of departments within organizations. Connections that have been made between careers and MBTI personality types (Tieger & Barron-Tieger, 1992; Myers, 1980; Myers & McCaulley, 1985) could be enhanced by data collected within units with clearly defined organizational responsibilities and tasks. By including the components of this study: modes of thinking, learning styles, and personality, this new data would be particularly powerful in aiding problem solving, communications, team building, and issues of quality among others.

If improved problem solving is one of the keys to a better future and if, as is proposed herein, effective problem solving requires the use of both divergent and convergent thinking, then the need for studies on how we

think, how we work to resolve our problems, and how our personalities relate to these functions is critical. It is the hope of this researcher that this study has contributed in some small way to this body of information and to the development of future studies.

APPENDIX A

HUMAN SUBJECT CONSENT FORM

Mel Lane Donoghue
11 Twilight Drive, Granby, CT 06035

HUMAN SUBJECT CONSENT FORM

I volunteer to serve as a subject in this research project undertaken by Mel Lane Donoghue.

I understand the nature and purpose of this research which have been explained by the researcher. I understand the primary purpose of this research is to identify problem solving thinking styles.

I understand that confidentiality and anonymity of responses to the Kolb Learning Style Inventory (LSI) and the Myers-Briggs Type Indicator (MBTI) will be maintained. My name will not be used, nor will I be identified personally in any way or at any time.

I understand that the results of this study will be included in the researcher's doctoral dissertation and may also be included in manuscripts submitted to professional journals for publication.

I am free to participate or not to participate without prejudice.

I certify that I have read and fully understand the above consent statement and that I agree to participate in this study.

_____ _____
Participant Signature Date

I certify that the nature and purpose of the research have been fully explained to the subject named above.

_____ _____
Researcher Signature Date

Mel (Mary) L. Donoghue
Doctoral candidate, School of Education
University of Massachusetts, Amherst

APPENDIX B

DEMOGRAPHIC FEATURES OF PARTICIPANTS FORM

Mel Lane Donoghue
11 Twilight Drive, Granby, CT 06035

Demographic Features of Participants

Please place a check mark in the space in front of the appropriate answer for each item. Fill in the blanks for additional information where needed.

Gender: ___Female(2) ___Male(1)

Age Group: ___20-29 ___30-39 ___40-49

___50-59 ___60-69 ___70-79

___Other age group (please specify)_____

Level of Education (check highest reached):

___High School(1)

___BA(2) ___BS(3) Major_____

___Masters in _____

___Doctorate in _____

___Other degree(s)_____

_____

Your profession:_____

Current or most recent job title:_____

Is English your first language? ___Yes ___No

Thank you for completing this form.

APPENDIX C

DISTRIBUTION TABLES (C.1-C.11)

Table C.1

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in Combinations of MBTI Preferences
Extraversion/Introversion (E/I),
Sensing/Intuition (S/N), and Thinking/Feeling (T/F)
(N = 177)

	Count	Percent
IST	23	13.0
ISF	19	10.7
INF	11	6.2
INT	31	17.5
EST	19	10.7
ESF	14	7.9
ENF	31	17.5
ENT	29	16.4

Table C.2

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in Combinations of MBTI Preferences
Sensing/Intuition (S/N), Thinking/Feeling (T/F),
and Judging/Perceiving (J/P)
(N = 177)

	Count	Percent
STJ	34	19.2
SFJ	25	14.1
NFJ	11	6.2
NTJ	34	19.2
STP	8	4.5
SFP	8	4.5
NFP	31	17.5
NTP	26	14.7

Table C.3

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in Combinations of MBTI Preferences
Extraversion/Introversion (E/I),
Thinking/Feeling (T/F), and Judging/Perceiving (J/P)
(N = 177)

	Count	Percent
ITJ	35	19.8
IFJ	18	10.2
ITP	19	10.7
IFP	12	6.8
ETP	15	8.5
EFP	27	15.3
ETJ	33	18.6
EFJ	18	10.2

Table C.4

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in Combinations of MBTI Preferences
Extraversion/Introversion (E/I),
Sensing/Intuition (S/N), and Judging/Perceiving (J/P)
(N = 177)

	Count	Percent
ISJ	33	18.6
ISP	9	5.1
INJ	20	11.3
INP	22	12.4
ESJ	26	14.7
ESP	7	4.0
ENJ	25	14.1
ENP	35	19.8

Table C.5

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Extraversion/Introversion (E/I)
with Sensing/Intuition (S/N) Combinations
(N = 177)

	Count	Percent
IS	42	23.7
IN	42	23.7
ES	33	18.6
EN	60	33.9

Table C.6

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Extraversion/Introversion (E/I) with
Thinking/Feeling (T/F) Combinations
(N = 177)

	Count	Percent
IT	54	30.5
IF	30	16.9
ET	48	27.1
EF	45	25.4

Table C.7

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Extraversion/Introversion (E/I) with
Judging/Perceiving (J/P) Combinations
(N = 177)

	Count	Percent
IJ	53	29.9
IP	31	17.5
EJ	51	28.8
EP	42	23.7

Table C.8

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Sensing/Intuition (S/N) with
Thinking/Feeling (T/F) Combinations
(N = 177)

	Count	Percent
ST	42	23.7
SF	33	18.6
NT	60	33.9
NF	42	23.7

Table C.9

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Thinking/Feeling (T/F) with
Judging/Perceiving (J/P) Combinations
(N = 177)

	Count	Percent
TJ	68	38.4
FJ	36	20.3
TP	34	19.2
FP	39	22.0

Table C.10

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Extraversion (E) and Introversion (I)
(N = 177)

	Count	Percent
Extraversion (E)	93	52.5
Introversion (I)	84	47.5

Table C.11

Distribution of Respondents
Expressed as Frequency (Count) and Percent
in MBTI Thinking (T) and Feeling (F)
(N = 177)

	Count	Percent
Thinking (T)	102	57.6
Feeling (F)	75	42.4

APPENDIX D

KOLB LEARNING STYLE INVENTORY

Kolb Learning-Style Inventory (1985)

Instructions:

The Learning-Style Inventory describes the way you learn and how you deal with ideas and day-to-day situations in your life. Below are 12 sentences with a choice of four endings. Rank the endings for each sentence according to how well you think each one fits with how you would go about learning something. Try to recall some recent situations where you had to learn something new, perhaps in your job. Then, using the spaces provided, rank a "4" for the sentence ending that describes how you learn best, down to a "1" for the sentence ending that seems least like the way you would learn. Be sure to rank all the endings for each sentence unit. Please do not make ties.

Example of completed sentence set:

0. When I learn:	_4_ I am happy.	_1_ I am fast.	_2_ I am logical.	_3_ I am careful.

---

1. When I learn:	__ I like to deal with my feelings.	__ I like to watch and listen.	__ I like to think about ideas.	__ I like to be doing things.
2. I learn best when:	__ I trust my hunches and feelings.	__ I listen and watch carefully.	__ I rely on logical thinking.	__ I work hard to get things done.
3. When I am learning:	__ I have strong feelings and reactions.	__ I am quiet and reserved.	__ I tend to reason things out.	__ I am responsible about things.
4. I learn by:	__ feeling.	__ watching.	__ thinking.	__ doing.

5. When I learn:	__ I am open to new experi-ences.	__ I look at all sides of issues.	__ I like to analyze things, break them down into their parts.	__ I like to try things out.
6. When I am learning:	__ I am an intuitive person.	__ I am an observing person.	__ I am a logical person.	__ I am an active person.
7. I learn best from:	__ personal relation-ships.	__ observa-tion.	__ rational theories.	__ a chance to try out and practice.
8. When I learn:	__ I feel personally involved in things.	__ I take my time before acting.	__ I like ideas and theories.	__ I like to see results from my work.
9. I learn best when:	__ I rely on my feelings.	__ I rely on my observa-tions.	__ I rely on my ideas.	__ I can try things out for myself.
10. When I am learning:	__ I am an accepting person.	__ I am a reserved person.	__ I am a rational person.	__ I am a responsible person.
11. When I learn:	__ I get involved.	__ I like to observe.	__ I evaluate things.	__ I like to be active.

12.
I learn
best when:

__ I am receptive and open-minded.	__ I am careful.	__ I analyze ideas.	__ I am practical.

APPENDIX E

MYERS-BRIGGS TYPE INDICATOR FORM G BOOKLET

FORM G BOOKLET
by Katharine C. Briggs and Isabel Briggs Myers
Consulting Psychologist Press, Inc.

Seventeenth printing, 1991

DIRECTIONS:

There are no "right" or "wrong" answers to these questions. Your answers will help show how you like to look at things and how you like to go about deciding things. Knowing your own preferences and learning about other people's can help you understand where your special strengths are, what kinds of work you might enjoy and be successful doing, and how people with different preferences can relate to each other and be valuable to society.

Read each question carefully and mark your answer on the separate answer sheet. Make no marks on the question booklet. Do not think too long about any question. If you cannot decide on a question, skip it but be careful that the next space you mark on the answer sheet has the same number as the question you are then answering.

Read the directions on you answer sheet, fill in your name and any other facts asked for and, unless you are told to stop at some point, work through until you have answered all the questions you can.

PART I. Which Answer Comes Closer to Telling How You Usually Feel or Act?

1. When you go somewhere for the day, would you rather
   (A) plan what you will do and when, or
   (B) just go?

2. If you were a teacher, would you rather teach
   (A) fact courses, or
   (B) courses involving theory?

3. Are you usually
   (A) a "good mixer," or
   (B) rather quiet and reserved?

4. Do you prefer to
   (A) arrange dates, parties, etc., well in advance, or
   (B) be free to do whatever looks like fun when the time comes?

5. Do you usually get along better with
   (A) imaginative people, or
   (B) realistic people?

6. Do you more often let
   (A) your heart rule your head, or
   (B) your head rule your heart?

7. When you are with a group of people would you usually rather
   (A) join in the talk of the group, or
   (B) talk with one person at a time?

8. Are you more successful
   (A) at dealing with the unexpected and seeing quickly what should be done, or
   (B) at following a carefully worked out plan?

9. Would you rather be considered
   (A) a practical person, or
   (B) an ingenious person?

10. In a large group, do you more often
   (A) introduce others, or
   (B) get introduced?

11. Do you admire more the people who are
   (A) conventional enough never to make themselves conspicuous, or
   (B) too original and individual to care whether they are conspicuous or not?

12. Does following a schedule
   (A) appeal to you, or
   (B) cramp you?

13. Do you tend to have
   (A) deep friendships with a very few people, or
   (B) broad friendships with many different people?

14. Does the idea of making a list of what you should get done over a weekend
   (A) appeal to you, or
   (B) leave you cold, or
   (C) positively depress you?

15. Is it a higher compliment to be called
   (A) a person of real feeling, or
   (B) a consistently reasonable person?

16. Among your friends, are you
    (A) one of the last to hear what is going on, or
    (B) full of news about everybody?

[On this next question only, if two answers are true, mark both.]

17. In your daily work, do you
    (A) rather enjoy an emergency that makes you work against time, or
    (B) hate to work under pressure, or
    (C) usually plan you work so you won't need to work under pressure?

18. Would you rather have as a friend
    (A) someone who is always coming up with new ideas, or
    (B) someone who has both feet on the ground?

19. Do you
    (A) talk easily to almost anyone for as long as you have to, or
    (B) find a lot to say only to certain people or under certain conditions?

20. When you have a special job to do, do you like to
    (A) organize it carefully before you start, or
    (B) find out what is necessary as you go along?

21. Do you usually
    (A) value sentiment more than logic, or
    (B) value logic more than sentiment?

22. In reading for pleasure, do you
    (A) enjoy odd or original ways of saying things, or
    (B) like writers to say exactly what they mean?

23. Can the new people you meet tell what you are interested in
    (A) right away, or
    (B) only after they really get to know you?

24. When it is settled well in advance that you will do a certain thing at a certain time, do you find it
    (A) nice to be able to plan accordingly, or
    (B) a little unpleasant to be tied down?

25. In doing something that many other people do, does it appeal to you more to
(A) do it in the accepted way, or
(B) invent a way of your own?

26. Do you usually
(A) show your feelings freely, or
(B) keep your feelings to yourself?

Go on to Part II.

PART II. Which Word in Each Pair Appeals to You More? Think what the words mean, not how they look or how they sound.

27.	(A)	scheduled	unplanned	(B)
28.	(A)	gentle	firm	(B)
29.	(A)	facts	ideas	(B)
30.	(A)	thinking	feeling	(B)
31.	(A)	hearty	quiet	(B)
32.	(A)	convincing	touching	(B)
33.	(A)	statement	concept	(B)
34.	(A)	analyze	sympathize	(B)
35.	(A)	systematic	concept	(B)
36.	(A)	justice	mercy	(B)
37.	(A)	reserved	talkative	(B)
38.	(A)	compassion	foresight	(B)
39.	(A)	systematic	casual	(B)
40.	(A)	calm	lively	(B)
41.	(A)	benefits	blessings	(B)
42.	(A)	theory	certainty	(B)
43.	(A)	determined	devoted	(B)
44.	(A)	literal	figurative	(B)
45.	(A)	firm-minded	warm-hearted	(B)
46.	(A)	imaginative	matter-of-fact	(B)
47.	(A)	peacemaker	judge	(B)
48.	(A)	make	create	(B)
49.	(A)	soft	hard	(B)
50.	(A)	sensible	fascinating	(B)

51.	(A)	forgive	tolerate	(B)
52.	(A)	production	design	(B)
53.	(A)	impulse	decision	(B)
54.	(A)	who	what	(B)
55.	(A)	speak	write	(B)
56.	(A)	uncritical	critical	(B)
57.	(A)	punctual	leisurely	(B)
58.	(A)	concrete	abstract	(B)
59.	(A)	changing	permanent	(B)
60.	(A)	wary	trustful	(B)
61.	(A)	build	invent	(B)
62.	(A)	orderly	easygoing	(B)
63.	(A)	foundation	spire	(B)
64.	(A)	quick	careful	(B)
65.	(A)	theory	experience	(B)
66.	(A)	sociable	detached	(B)
67.	(A)	sign	symbol	(B)
68.	(A)	party	theater	(B)
69.	(A)	accept	change	(B)
70.	(A)	agree	discuss	(B)
71.	(A)	known	unknown	(B)

Go on to Part III.

PART III. Which Answer Comes Closer to Telling How You Usually Feel or Act?

72. Would you say you
(A) get more enthusiastic about things than the average person, or
(B) get less excited about things than the average person?

73. Do you feel it is a worse fault to be
(A) unsympathetic, or
(B) unreasonable?

74. Do you
(A) rather prefer to do things at the last minute, or
(B) find doing things at the last minute hard on the nerves?

75. At parties, do you
(A) sometimes get bored, or
(B) always have fun?

76. Do you think that having a daily routine is
(A) a comfortable way to get things done, or
(B) painful even when necessary?

77. When something new starts to be the fashion, are you usually
(A) one of the first to try it, or
(B) not much interested?

78. When you think of some little thing you should do or buy, do you
(A) often forget it till much later, or
(B) usually get it down on paper to remind yourself, or
(C) always carry through on it without reminders?

79. Are you
(A) easy to get to know, or
(B) hard to get to know?

80. In your way of living, do you prefer to be
(A) original, or
(B) conventional?

81. When you are in an embarrassing spot, do you usually
(A) change the subject, or
(B) turn it into a joke, or
(C) days later, think of what you should have said?

82. Is it harder for you to adapt to
(A) routine, or
(B) constant change?

83. Is it higher praise to say someone has
(A) vision, or
(B) common sense?

84. When you start a big project that is due in a week, do you
(A) take time to list the separate things to be done and the order of doing them, or
(B) plunge in?

85. Do you think it is more important to be able
(A) to see the possibilities in a situation, or
(B) to adjust to the facts as they are?

86. Do you think the people close to you know how you feel
(A) about most things, or
(B) only when you have had some special reason to tell them?

87. Would you rather work under someone who is
(A) always kind, or
(B) always fair?

88. In getting a job done, do you depend on
(A) starting early, so as to finish with time to spare, or
(B) the extra speed you develop at the last minute?

89. Do you feel it is a worse fault
(A) to show too much warmth, or
(B) not to have warmth enough?

90. When you are at a party, do you like to
(A) help get things going, or
(B) let the others have fun in their own way?

91. Would you rather
(A) support the established methods of doing good, or
(B) analyze what is still wrong and attack unsolved problems?

92. Are you more careful about
(A) people's feelings, or
(B) their rights?

93. If you were asked on a Saturday morning what you were going to do that day, would you
(A) be able to tell pretty well, or
(B) list twice too many things, or
(C) have to wait and see?

94. In deciding something important, do you
(A) find you can trust your feeling about what is best to do, or
(B) think you should do the <u>logical</u> thing, no matter how you feel about it?

95. Do you find the more routine parts of your day
(A) restful, or
(B) boring?

96. Does the importance of doing well on a test make it generally
(A) easier for you to concentrate and do your best, or
(B) harder for you to concentrate and do yourself justice?

97. Are you
(A) inclined to enjoy deciding things, or
(B) just as glad to have circumstances decide a matter for you?

98. In listening to a new idea, are you more anxious to
(A) find out all about it, or
(B) judge whether it is right or wrong?

99. In any of the ordinary emergencies of everyday life, would you rather
(A) take orders and be helpful, or
(B) give orders and be responsible?

100. After being with superstitious people, have you
(A) found yourself slightly affected by their superstitions, or
(B) remained entirely unaffected?

101. Are you more likely to speak up in
(A) praise, or
(B) blame?

102. When you have a decision to make, do you usually
(A) make it right away, or
(B) wait as long as you reasonably can before deciding?

103. At the time in your life when things piled up on you the worst, did you find
(A) that you had gotten into an impossible situation, or
(B) that by doing only the necessary things you could work your way out?

104. Out of all the good resolution you may have made, are there
(A) some you have kept to this day, or
(B) none that have really lasted?

105. In solving a personal problem, do you
(A) feel more confident about it if you have asked other people's advice, or
(B) feel that nobody else is in as good a position to judge as you are?

106. When a new situation comes up which conflicts with your plans, do you try first to
(A) change your plans to fit the situation, or
(B) change the situation to fit your plans?

107. Are such emotional "ups and downs" as you may feel
(A) very marked, or
(B) rather moderate?

108. In your personal beliefs, do you
(A) cherish faith in things that cannot be proved, or
(B) believe only those things that can be proved?

109. In your home life, when you come to the end of some undertaking, are you
(A) clear as to what comes next and ready to tackle it, or
(B) glad to relax until the next inspiration hits you?

110. When you have a chance to do something interesting, do you
(A) decide about it fairly quickly, or
(B) sometimes miss out through taking too long to make up your mind?

111. If a breakdown or mix-up halted a job on which you and a lot of others were working, would your impulse be to
(A) enjoy the breathing spell, or
(B) look for some part of the work where you could still make progress, or
(C) join the "trouble-shooters" in wrestling with the difficulty?

112. When you don't agree with what had just been said, do you usually
(A) let it go, or
(B) put up an argument?

113. On most matters, do you
(A) have a pretty definite opinion, or
(B) like to keep an open mind?

114. Would you rather have
(A) an opportunity that may lead to bigger things, or
(B) an experience that you are sure to enjoy?

115. In managing your life, do you tend to
(A) undertake too much and get into a tight spot, or
(B) hold yourself down to what you can comfortably handle?

116. When playing cards, do you enjoy most
(A) the sociability, or
(B) the excitement of winning, or
(C) the problem of getting the most out of each hand, or
(D) don't you enjoy playing cards?

117. When the truth would not be polite, are you more likely to tell
(A) a polite lie, or
(B) the impolite truth?

118. Would you be more willing to take on a heavy load of extra work for the sake of
(A) extra comforts and luxuries, or
(B) a chance to achieve something important?

119. When you don't approve of the way a friend is acting, do you
(A) wait and see what happens, or
(B) do or say something about it?

120. Has it been your experience that you
(A) often fall in love with a notion or project that turns out to be a disappointment - so that you "go up like a rocket and come down like a stick", or do you
(B) use enough judgment on your enthusiasms so that they do not let you down?

121. When you have a serious choice to make, do you
(A) almost always come to a clear-cut decision, or
(B) sometimes find it so hard to decide that you do not wholeheartedly follow up either choice?

122. Do you usually
(A) enjoy the present moment and make the most of it, or
(B) feel that something just ahead is more important?

123. When you are helping in a group undertaking, are you more often struck by
(A) the cooperation, or
(B) the inefficiency,
(C) or don't you get involved in group undertakings?

124. When you run into an unexpected difficulty in something you are doing, do you feel it to be
(A) a piece of bad luck, or
(B) a nuisance, or
(C) all in the day's work?

125. Which mistake would be more natural for you:
(A) to drift from one thing to another all your life, or
(B) to stay in a rut that didn't suit you?

126. Would you have liked to argue the meaning of
(A) a lot of these questions, or
(B) only a few?

APPENDIX F

REMAINING PEARSON CORRELATIONS

Table F.1

Cross Tabulation of
LSI Learning-Style Types and
MBTI Extraversion/Introversion (E/I) Preferences
(N = 177)

MBTI Preference	E			I		
LSI Type	n	Exp Val	Pct. of N	n	Exp Val	Pct. of N
Converger	22	25.2	12.4	26	22.8	14.7
Diverger	16	16.8	9.0	16	15.2	9.0
Assimilator	23	28.9	13.0	32	26.1	18.1
Accommodator	32	22.1	18.1	10	19.9	5.6
Total	93	93.0	52.5	84	84.0	47.4

Actual Level of Significance: .00485

There was a significant difference in the responses.

Table F.2

Cross Tabulation of
LSI Learning-Style Types and
MBTI Thinking/Feeling (T/F) Preferences
(N = 177)

MBTI Preference	T			F		
LSI Type	n	Exp Val	Pct. of N	n	Exp Val	Pct. of N
Converger	36	27.7	20.3	12	20.3	6.8
Diverger	13	18.4	7.3	19	13.6	10.7
Assimilator	42	31.7	23.7	13	23.3	7.3
Accommodator	11	24.2	6.2	31	17.8	17.5
Total	102	102.0	57.5	75	75.0	42.3

Actual Level of Significance: .00000

There was a significant difference in the responses.

Table F.3

Cross Tabulation of
LSI Learning-Style Types and
MBTI Sensing and Perceiving (SP) Preference
(N = 177)

MBTI	SP Preference	Count n = 16 (9.0% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	6	4.3	37.5
Diverger	3	2.9	18.8
Assimilator	3	5.0	18.8
Accommodator	4	3.8	25.0
Total	16	16.0	100.1

Cells with Expected Frequency < 5 - 4 of 16 (25.0%)

Actual Level of Significance: .02559

There was a significant difference in the responses.

Table F.4

Cross Tabulation of
LSI Learning-Style Types and
MBTI Intuition and Judging (NJ) Preference
(N = 177)

MBTI	NJ Preference	Count n = 45 (25.4% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	11	12.2	24.4
Diverger	10	8.1	22.2
Assimilator	17	14.0	37.8
Accommodator	7	10.7	15.6
Total	45	45.0	100.0

Cells with Expected Frequency < 5 - 4 of 16 (25.0%)

Actual Level of Significance: .02559

There was a significant difference in the responses.

Table F.5

Cross Tabulation of
LSI Learning-Style Types and
MBTI Thinking and Judging (TJ) Preference
(N = 177)

MBTI	TJ Preference	Count n = 68 (38.4% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	22	18.4	32.4
Diverger	7	12.3	10.3
Assimilator	33	21.1	48.5
Accommodator	6	16.1	8.8
Total	68	67.9	100.0

Actual Level of Significance:.00000

There was a significant difference in the responses.

Table F.6

Cross Tabulation of
LSI Learning-Style Types and
MBTI Feeling and Judging (FJ) Preference
(N = 177)

MBTI	FJ Preference	Count n = 36 (20.3% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	7	9.8	19.4
Diverger	10	6.5	27.8
Assimilator	9	11.2	25.0
Accommodator	10	8.5	27.8
Total	36	36.0	100.0

Actual Level of Significance: .00000

There was a significant difference in the responses.

Table F.7

Cross Tabulation of
LSI Learning-Style Types and
MBTI Thinking and Perceiving (TP) Preference
(N = 177)

MBTI	TP Preference	Count n = 34 (19.2% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	14	9.2	41.2
Diverger	6	6.1	17.6
Assimilator	9	10.6	26.5
Accommodator	5	8.1	14.7
Total	34	34.0	100.0

Actual Level of Significance: .00000

There was a significant difference in the responses.

Table F.8

Cross Tabulation of
LSI Learning-Style Types and
MBTI Feeling and Perceiving (FP) Preference
(N = 177)

MBTI	FP Preference	Count n = 39 (22.0% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	5	10.6	12.8
Diverger	9	7.1	23.1
Assimilator	4	12.1	10.3
Accommodator	21	9.3	53.8
Total	39	39.1	100.0

Actual Level of Significance: .00000

There was a significant difference in the responses.

Table F.9

Cross Tabulation of
LSI Learning-Style Types and
MBTI Sensing and Thinking (ST) Preference
(N = 177)

MBTI	ST Preference	Count n = 42 (23.7% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	14	11.4	33.3
Diverger	3	7.6	7.1
Assimilator	21	13.1	50.0
Accommodator	4	10.0	9.5
Total	42	42.1	99.9

Actual Level of Significance: .00000

There was a significant difference in the responses.

Table F.10

Cross Tabulation of
LSI Learning-Style Types and
MBTI Sensing and Feeling (SF) Preference
(N = 177)

MBTI	SF Preference	Count n = 33 (18.6% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	10	8.9	30.3
Diverger	7	6.0	21.2
Assimilator	7	10.3	21.2
Accommodator	9	7.8	27.3
Total	33	33.0	100.0

Actual Level of Significance: .00000

There was a significant difference in the responses.

Table F.11

Cross Tabulation of
LSI Learning-Style Types and
MBTI Intuition and Thinking (NT) Preference
(N = 177)

MBTI	NT Preference	Count n = 60 (33.9% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	22	16.3	36.7
Diverger	10	10.8	16.7
Assimilator	21	18.6	35.0
Accommodator	7	14.2	11.7
Total	60	59.9	100.1

Actual Level of Significance: .00000

There was a significant difference in the responses.

Table F.12

Cross Tabulation of
LSI Learning-Style Types and
MBTI Intuition and Feeling (NF) Preference
(N = 177)

MBTI	NF Preference	Count n = 42 (23.7% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	2	11.4	4.8
Diverger	12	7.6	28.6
Assimilator	6	13.1	14.3
Accommodator	22	10.0	52.4
Total	42	42.1	100.1

Actual Level of Significance: .00000

There was a significant difference in the responses.

Table F.13

Cross Tabulation of
LSI Learning-Style Types and
MBTI Introversion and Judging (IJ) Preference
(N = 177)

MBTI	IJ Preference	Count n = 53 (29.9% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	17	14.4	32.1
Diverger	8	9.6	15.1
Assimilator	25	16.5	47.2
Accommodator	3	12.6	5.7
Total	53	53.1	100.1

Actual Level of Significance: .00147

There was a significant difference in the responses.

Table F.14

Cross Tabulation of
LSI Learning-Style Types and
MBTI Introversion and Perceiving (IP) Preference
(N = 177)

MBTI	IP Preference	Count n = 31 (17.5% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	9	8.4	29.0
Diverger	8	5.6	25.8
Assimilator	7	9.6	22.6
Accommodator	7	7.4	22.6
Total	31	31.0	100.0

Actual Level of Significance:.00147

There was a significant difference in the responses.

Table F.15

Cross Tabulation of
LSI Learning-Style Types and
MBTI Extraversion and Judging (EJ) Preference
(N = 177)

MBTI	EJ Preference	Count n = 51 (28.8% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	12	13.8	23.5
Diverger	9	9.2	17.6
Assimilator	17	15.8	33.3
Accommodator	13	12.1	25.5
Total	51	50.9	99.9

Actual Level of Significance:.00147

There was a significant difference in the responses.

Table F.16

Cross Tabulation of
LSI Learning-Style Types and
MBTI Extraversion and Perceiving (EP) Preference
(N = 177)

MBTI	EP Preference	Count n = 42 (23.7% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	10	11.4	23.8
Diverger	7	7.6	16.7
Assimilator	6	13.1	14.3
Accommodator	19	10.0	45.2
Total	42	42.1	100.0

Actual Level of Significance:.00147

There was a significant difference in the responses.

Table F.17

Cross Tabulation of
LSI Learning-Style Types and
MBTI Introversion and Thinking (IT) Preference
(N = 177)

MBTI	IT Preference	Count n = 54 (30.5% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	21	14.6	38.9
Diverger	7	9.8	13.0
Assimilator	22	16.8	40.7
Accommodator	4	12.8	7.4
Total	54	54.0	100.0

Actual Level of Significance:.00000

There was a significant difference in the responses.

Table F.18

Cross Tabulation of
LSI Learning-Style Types and
MBTI Introversion and Feeling (IF) Preference
(N = 177)

MBTI	IF Preference	Count n = 30 (16.9% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	5	8.1	16.7
Diverger	9	5.4	30.0
Assimilator	10	9.3	33.3
Accommodator	6	7.1	20.0
Total	30	29.9	100.0

Actual Level of Significance:.00000

There was a significant difference in the responses.

Table F.19

Cross Tabulation of
LSI Learning-Style Types and
MBTI Extraversion and Thinking (ET) Preference
(N = 177)

MBTI	ET Preference	Count n = 48 (27.1% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	15	13.0	31.3
Diverger	6	8.7	12.5
Assimilator	20	14.9	41.7
Accommodator	7	11.4	14.6
Total	48	48.0	100.1

Actual Level of Significance:.00000

There was a significant difference in the responses.

Table F.20

Cross Tabulation of
LSI Learning-Style Types and
MBTI Extraversion and Feeling (EF) Preference
(N = 177)

MBTI	EF Preference	Count n = 45 (25.4% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	7	12.2	15.6
Diverger	10	8.1	22.2
Assimilator	3	14.0	6.7
Accommodator	25	10.7	55.6
Total	45	45.0	100.1

Actual Level of Significance:.00000

There was a significant difference in the responses.

Table F.21

Cross Tabulation of
LSI Learning-Style Types and
MBTI Introversion and Sensing (IS) Preference
(N = 177)

MBTI	IS Preference	Count n = 42 (23.7% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	14	11.4	33.3
Diverger	8	7.6	19.0
Assimilator	16	13.1	38.1
Accommodator	4	10.0	9.5
Total	42	42.1	99.9

Actual Level of Significance: .01286

There was a significant difference in the responses.

Table F.22

Cross Tabulation of
LSI Learning-Style Types and
MBTI Introversion and Intuition (IN) Preference
(N = 177)

MBTI	IN Preference	Count n = 42 (23.7% of N)	
LSI Type	Count	Exp Val	Pct. of n
Converger	12	11.4	28.6
Diverger	8	7.6	19.0
Assimilator	16	13.1	38.1
Accommodator	6	10.0	14.3
Total	42	42.1	100.0

Actual Level of Significance: .01286

There was a significant difference in the responses.

Table F.23

Cross Tabulation of
LSI Learning-Style Types and
MBTI Extraversion and Sensing (ES) Preference
(N = 177)

MBTI	ES Preference	Count n = 33 (18.6% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	10	8.9	30.3
Diverger	2	6.0	6.1
Assimilator	12	10.3	36.4
Accommodator	9	7.8	27.3
Total	33	33.0	100.1

Actual Level of Significance: .01286

There was a significant difference in the responses.

Table F.24

Cross Tabulation of
LSI Learning-Style Types and
MBTI Extraversion and Intuition (EN) Preference
(N = 177)

MBTI	EN Preference	Count n = 60 (33.9% of N)
LSI Type	Count	Exp Val	Pct. of n
Converger	12	16.3	20.0
Diverger	14	10.8	23.3
Assimilator	11	18.6	18.3
Accommodator	23	14.2	38.3
Total	60	59.9	99.9

Actual Level of Significance: .01286

There was a significant difference in the responses.

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