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TRAINING CONTINUING EDUCATORS FOR DIVERGENT THINKING

University of Washington

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Training Continuing Educators for
Divergent Thinking

by

PHILIP EDWARD MOIR

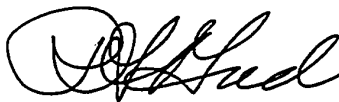
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Abstract

Training Continuing Educators
for Divergent Thinking

by

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This study investigated the effects of training in lateral thinking as a strategy for stimulating the divergent production of ideas. The 74 volunteer subjects were continuing educators from institutions of higher education in the Greater Vancouver area. Forty-nine female and twenty-five male subjects were randomly assigned to three groups. Each of two treatment groups were given four hours of training in deBono's lateral thinking techniques. The two groups differed on method, one was competency-based (directive), the other was developmentally-based (nondirective). A control group was given training in vertical thinking exercises. The experiment contrasted the divergent production scores of subjects trained in lateral thinking techniques with subjects trained in vertical thinking exercises (Contrast 1); and the scores of subjects trained in lateral thinking on directive and nondirective methods (Contrast 2).

The two independent variable contrasts; three moderator variables (field independence, age and gender), a covariate, verbal comprehension, and a set of interactions, comprised the regression model, on each of four divergent production dependent variables: fluency (FLUENT), flexibility (FLEXBL), creativity (TCREATE), and originality (ORIGNL). Dependent variable scores were derived from the results of a battery of three of Guilford's tests of divergent thinking.

Major findings were as follows: (a) Contrast 1 was significant ($p < .05$) for the treatment over the control group on the production of original ideas, controlling for fluency; (b) the cognitive style variable, field independence, was positively and significantly related to flexibility; (c) there were no significant differences between directive and nondirective methods; (d) middle career-age subject scores were not significantly different from early and late career-age subject scores. The covariate, verbal comprehension, demonstrated its influence on divergent production with significant results on originality, creativity, and flexibility, but not on fluency.

This research study presented limited evidence to support the positive influence of training in lateral thinking for the production of original ideas, and the conclusion that individual differences among learners in workshop settings may be as important as the training itself.

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CHAPTER I

INTRODUCTION

If we are to make the most of our intellectual resources to meet the challenging problems in this complex world, it is imperative that we know more about the processes of human thinking (J.P. Guilford, 1979a, 95).

Society and organizations face complex issues and problems which defy simple solutions. In the transition from decades of expansion and uneven growth, in economics and education, to the present period of scarcity, slow growth and accountability, the survival of organizations is increasingly dependent upon the resourcefulness, creativity and decisiveness of the individuals who function within them (Viola, 1977; van Gigch, 1978, Bakalis, 1981; Whetten, 1981).

Laszlo (1972) concluded that the capacity of social organizations to survive depends in very great measure on their resourcefulness in adapting to changing realities. The socialized tendency to restrict creativity and divergence of thought, to avert new ideas and resort to ingrained values and behavior, is identified with rigid, unimaginative thinking and aversion to change (deBono, 1969, 299; Browne, 1978, 208; Argyris, 1982, 487).

The issues of a nation and society, such as the reality of resource limitations and an aging population, are the problems of educational organizations. The difficulties confronting educational institutions are apparent in the dual reality of rising social expectations and reduced resources for education. One major response

option for educational institutions resides in their reserves of intellectual talent. The challenge is to learn how to more efficiently tap the abundant, high value, brain power, in ways that will economize resources, and which, in a contingency sense, will reverse the forces of dis-integration by the resourceful application of the collective brain power of the individuals comprising the institution (Wolfe, 1969; Mintzberg, 1983).

The mandate of the educational system is to conserve cultural values, to support social, cultural and economic life, and to provide leadership in the continuous responsibility to prepare individuals to learn how to learn, and to be flexible and adaptive in the face of change. In this social-educational context, continuing educators of adults share in this mission to conserve and enrich cultural values, on the one hand, and to stimulate new forms of cultural and intellectual pursuits on the other.

Continuing educators have the responsibility for developing links between the educational institution and the communities of part time adult learners. This interactive adult education role has been recognized as a vital function of institutions of higher education. In the face of deepening economic and social problems, changing technology and the reality of an aging population, continuing education services to the professions and the public have become increasingly important (Coppedge, 1980; Long, 1983). It is this new urgency to advance adult and continuing education, and the problem of resource limitations, which stimulated this creativity training on divergent thinking.

Divergent thinking, or the divergent production of ideas, is the essence of creativity. It is the kind of thinking that occurs in the predecisional phase of problem solving, where the mind moves freely in generating and exploring ideas and options. In order for continuing educators to respond more imaginatively to the complex problems facing them in their program development work, research on creativity training, and opportunities for professional development, should be focussed on nurturing the divergent production of ideas for creative decision making and problem solving (Feldhusen and Guthrie, 1979; Guilford, 1977, 1979a).

Lateral thinking is related to divergent thinking in its similar purpose to encourage fluency and originality in the production of ideas. One key characteristic of deBono's (1971) lateral thinking program is his use of specific, structured techniques or tools, as defined in Appendix A, for reserving judgment and consciously stimulating the production of new and unusual, even nonsensical ideas.

The research literature provided evidence that short term training in divergent or lateral thinking was relatively effective for increasing both the volume of ideas (fluency), and for improving the quality of ideas (originality) and problem solutions (Klawiter, 1976; Rosenthal, 1977; Durio, 1978; Dirkes, 1980). A number of researchers have concluded that knowledge of concepts and techniques for divergent or lateral thinking is prerequisite to the conscious, as distinct from the intuitive, generation of new ideas to identify problems, and make resourceful decisions in problem situations (deBono, 1971, 1978; Werdell, 1974; Guilford, 1977, 1979a; Kozmetsky, 1980). Initiatives

for training continuing educators in creative thinking would, in an applied sense, stimulate a ripple-effect expansion of opportunities for new educational growth for adult learners.

In support of this creativity training study, aimed at stimulating the divergent production abilities of continuing educators in an experimental setting, research planning called upon theory from several literatures. Information from cognitive psychology, of which creativity training is a sub-field, was augmented by references from cognitive science, organizational development, adult education, and open systems and contingency theory. Information from these several fields provided an interdisciplinary perspective for the key cognitive psychology and creativity training research component, and supported the logic in the selection of variables, the development of hypotheses, and the conduct of the experiment.

The works of Argyris, deBono and Guilford, in a congruent pattern, called attention to the deficiencies of traditional, logical approaches to problem solving in the face of resource limitations and the rising pressures of accumulating problems. They also offered options for relief, in the development of theory, strategies and techniques for divergent and lateral thinking to improve the quality of decision making.

Argyris' (1982) recent organizational development interests centered on the concept of double-loop learning; that is, knowing how to learn and being aware of one's own motives and behavior. These capacities are essential for adjusting to change, and for stimulating personal development and organizational productivity. DeBono's (1969,

1971, 1978) extensive work to encourage lateral thinking and creativity, by means of consciously applied techniques, have widely challenged the business, professional and educational communities to improve the quality of decision making and problem solving for personal, institutional and social gain (Smith, 1985). Guilford's (1967, 1979) Structure of Intellect model, and factor analyzed tests, comprised of problems requiring divergent thinking abilities, provided the main theoretical basis for this research study into the effects of training in lateral thinking concepts and techniques on the divergent thinking skills of continuing educators.

Purpose. This creative training study was based on the premise that stimulating the divergent thinking capacities of continuing educators would improve the cognitive skills of individuals in their work to sustain organizational resilience, and to discover new opportunities for advancing adult learning (deBono, 1978, 105; Guilford, 1977, 180-1; 1979a). If the future quality of life depends on creativity and the production of new ideas, if there is a growing need for fluency, flexibility and originality in thinking, decision making and problem solving, it follows that society and institutions would benefit from training continuing educators, as one professional group, in divergent or lateral thinking.

Accepting the premise of the importance of the divergent thinking phase in decision making and problem solving, this study took as its central experimental purpose the investigation of the effects on divergent thinking, or the divergent production of ideas, of directly training continuing educators in deBono's lateral thinking concepts

and techniques. The treatment component was to contrast laterally-trained subjects with control subjects trained in another skill, and to contrast the laterally-trained subjects on the basis of nondirective and directive instructional methods.

The basic concepts of lateral thinking are designed to enable subjects to identify problem situations, to consciously break out of fixed patterns of solution response, and to recognize polarities, contradictions and limitations in one's own and others' thinking practices. The techniques devised by deBono (1967, 1971) for generating new ideas, defined in Appendix A, are specific tools for conscious entry into nonrational or nonlogical modes of mind, where judgment is temporarily revoked. In this "boundless" state of mind, thoughts may be generated from mind sources hitherto unexplored. DeBono's aim, and the purpose of the treatment in this study, is to stimulate divergent production, the emergence of many ideas (fluency), some of which may be judged original, clever or remotely possible. Upon the judgment of ideas generated (scoring the responses to the problems in the divergent tests, for example), the essential vertical, logical or hierarchical thinking takes over in the classification of responses and the selection of valuable ideas, some of which may be seen to promise a new view of an old problem, or a solution to the problem under study.

In the past ten years, research in the field of training and instructional effects has given increasing attention to individual differences. Cronbach and Snow (1977) stressed the advantages of using multivariate statistics in the study of aptitude or trait by

treatment interactions of the characteristics of individual learners. Knowledge of aptitude and skill levels, and the personal characteristics of learners, make it possible to adapt treatments and training situations to the requirements, cognitive styles and interests of individual adult learners.

This study investigated the main and the interaction effects of four individual difference variables (field independence, verbal comprehension, age and gender), in relation to the two treatment contrasts, in a multiple regression model, on four dependent variables derived from three Guilford tests of the factors of divergent production, Plot Titles, Consequences II and Alternate Uses.

Questions arising from the research interests in the effects of treatment in lateral thinking content and techniques on the divergent production of ideas, and in the moderating effects of individual difference variables, are specified and transformed into the research problems, variables and hypotheses in the sections that follow.

Research Problems, Variables and Definitions of Key Terms

A set of problems was specified and transformed into four hypotheses and one formalized question for main effects analysis, on the four divergent production dependent variables. In addition to the hypothesized main effects analysis, the second component of the study explored the main effects of individual difference variables, and the interaction of the treatment and moderator variables, on the four dependent variables.

Research problems

The central research problem was to investigate the effects, on the divergent production of ideas, of training continuing educators in deBono's lateral thinking concepts and techniques.

The sub-problems identified were:

1. What are the effects of training continuing educator subjects in lateral thinking concepts and techniques, contrasted with training in a different cognitive skill, on the divergent production of ideas?
2. What are the effects of training continuing educator subjects in lateral thinking on a competency-based method, contrasted with a developmentally-based method, on the divergent production of ideas?
3. What are the relationships of age and gender with divergent production of ideas?
4. What are the relationships of the field independence cognitive style construct with divergent production of ideas?
5. What are the effects of verbal comprehension, as a covariate, on divergent production of ideas, and in relation to the treatment conditions?
6. In terms of age, gender and field independence, what interactions might these variables have with the treatment conditions, in relation to the divergent production of ideas?

Variables

A set of independent, moderator and dependent variables, and a covariate, were selected and defined as factors of interest in the four hypotheses and the formalized question for main effects, and in the interaction analysis. The summary section to Chapter II presents the reasoning for the selection of treatment and moderator variables.

Independent variable:

1. Training in lateral thinking (treatment condition) - classified as a manipulated, categorical variable on two methods:

- (a) Competency-based method - a discrete classification
- (b) Developmentally-based method - a discrete classification

A different set of concepts and skills for vertical thinking were presented in the control group condition. (See following section on "Definition of key terms".) Technically, the training in vertical thinking is a categorical, independent variable; however, the construct was introduced into the study for the sole purpose of presenting an experience different from lateral thinking, but relevant to control group subjects.

For the regression analysis, the training conditions were presented as two independent variable contrasts:

- (a) Contrast 1 - Training in lateral thinking contrasted with training in vertical thinking exercises.
- (b) Contrast 2 - Training in lateral thinking on a competency-based (CB) method contrasted with training in lateral thinking on a developmentally-based (DB) method.

Moderator variables:

Three moderator variables were selected for analysis, field independence, age and gender.

- (a) Scores on Field Independence - a continuous, cognitive style, aptitude variable
- (b) Age - a continuous, organismic variable, used as a linear, and as a discrete or group variable, depending on analysis.
- (c) Gender - a discrete organismic variable, differentiating male and female subjects

Covariate:

Scores on Verbal Comprehension - a continuous, general ability variable correlated with intelligence.

Dependent variables:

In order to generate the dependent variables of interest, a process of transformation was undertaken as presented in Table 1. Four dependent variable components were identified, representing different combinations of factors which comprised the three divergent thinking tests employed in the study.

Table 1

Transformation of Divergent Thinking Test Factors to Component
Dependent Variables

Standardized Tests ³ of Divergent Thinking			Component ¹ Dependent Variables
<u>Plot Titles</u>	<u>Consequences II</u>	<u>Alternate Uses</u>	
2(Clever) + Nonclever	+ Obvious + 2(Remote)	+ Flexible	= TCREATE
		Flexible	= FLEXBL
	Nonclever + Obvious		= FLUENT
Clever	+	Remote	= ORIG
Clever + Nonclever	+ Obvious +	Remote	= FLUENC
		ORIG/FLUENC ²	= ORIGNL

- Notes: 1. The four descriptors represent special combinations of the major factors in Guilford's tests of divergence. They are component dependent variables for experimental analysis.
2. ORIG/FLUENC. These two component dependent variables were not included as dependent variables for the regression analysis. They served as the numerator and denominator of the ORIGNL dependent variable.
3. For information on Plot Titles, Consequences II and Alternate Uses tests see Chapter III, Instrumentation section and Appendix B.

Also see Table 32, Appendix F

As set out in Table 1, the dependent variables in the study were:

1. TCREATE (total creativity) - a "universal" variable consisting of scores on all three Guilford tests, weighted for originality, but not for fluency or flexibility: Plot Titles (clever = 2; nonclever = 1); Consequences II (remote = 2; obvious = 1); and Alternate Uses (flexibility = 1).

2. FLEXBL (flexibility) - a variable comprised of the score from Alternate Uses.
3. FLUENT (fluency) - a variable comprised of the sum of non-clever responses from Plot Titles and obvious responses from Consequences II; that is, non-original but relevant responses.
4. ORIGNL (originality) - a ratio variable, arithmetically controlling for fluency by dividing original (clever plus remote) responses by original (clever plus remote) plus nonoriginal (nonclever plus obvious) responses, as noted in Table 1. The sub-scores from Plot Titles (clever and nonclever) and Consequences II (remote and obvious) were included in the calculation of the ratio for ORIGNL, but not the flexibility score from Alternate Uses.

The selection of the four component dependent variables is discussed in connection with scoring procedures in the Instrumentation Section of Chapter III.

Definitions of Key Terms

Key terms are defined in two sections. The first section is on definitions of important concepts, and the second section presents operationalized definitions.

Definitions of important concepts:

Creative thinking emphasizes the novel, the unusual, the inventive, the ingenious; as distinct from logical thinking, which is

an instrument of verification and not of imagination. Creativity is the emergence of new relational products, growing out of the uniqueness of the individual.

Divergent thinking occurs at the problem formation or predecisional stage of the decision making process. It is a process of going off in various directions, of inductive or broad search and discovery, of fluency, flexibility, originality, and transformation in the generation of ideas.

Lateral thinking, as defined by deBono, is closely aligned with divergent thinking as a system of thought which reserves judgment and seeks to get away from established patterns of thought. The techniques employed are "non-logical" generators of ideas in the predecisional phase of problem solving.

Vertical thinking, as defined by deBono, is logical, iterative, and goal-oriented thinking; representing the traditional problem solving model, based on rules of continuity and linear progression from one state of information to another.

The Competency-based method (Spady, 1978) is a structured, directive, and criterion-referenced approach to learning. The instructor controls the learning environment by means of an ordered or programmed instructional system, directed at enabling the subject to achieve the level of competence specified in the objectives or

learning goals.

The Developmentally-based method (Spady, 1978) is an open ended, non-directive, process-oriented approach to learning. The instructor facilitates the learning process by presenting general goals and guidelines and material, and engaging the learners, interactively, in the developmental learning process.

Operationalized definitions:

Divergent production is divergent thinking operationalized into the fluent, flexible and original generation of ideas. Divergent production is measured by subject scores on the three Guilford tests, the component factors of which were reformed into the four dependent variables, as given in Table 1.

Creativity is identified with the total divergent production score representing a special operation, identified as TCREATE on Table 1, and defined as item (1) in the section following Table 1. TCREATE incorporates the capacity to generate many (fluent), and the ability to generate flexible and original ideas.

Flexibility is the divergent thinking factor related to the ability of a subject to recognize relationships and to move from one classification of concepts or ideas to another. "Flexible" responses on Alternate Uses comprise the FLEXBL score.

Fluency is the divergent thinking factor related to the capacity of a subject to generate numbers of responses, not necessarily original. "Non-clever" responses on Plot Titles and "Obvious" responses on Consequences II comprise the FLUENT score.

Originality is the divergent production factor related to the ability of a subject to generate new or unique ideas. In the present study, originality represents a special ratio operation, identified as ORIGNL in Table 1, and defined as item (4) in the section following Table 1.

Remote responses are scored as "original" on Guilford's Consequences II test.

Clever responses are scored as "original" on Guilford's Plot Titles test.

Obvious responses are scored as "fluent" on Guilford's Consequences II test.

Non-clever responses are scored as "fluent" on Guilford's Plot Titles test.

Flexible responses are scored as "flexible" on Guilford's Alternate Uses test.

Field independence, measured by Witkin's Group Embedded Figures Test (1971), is a cognitive style ability to abstract simple figures from a complex context or background, a space visualization task involving lateralization or multimodal thinking, differentiation,

active restructuring, and speed of closure as the gauge of ability.

Verbal comprehension measured by Guilford-Zimmerman Aptitude Survey - Verbal Comprehension - Part I (1981a) is a particular verbal ability cognitive aptitude, highly correlated with mental ability or intelligence.

Research Hypotheses and Exploratory Analyses

This study investigated two areas of research interest: Research hypotheses for main effects and Exploratory analysis.

Research hypotheses for main effects:

Four research hypotheses for main effects were stated, with four dependent variables being tested for each hypothesis, bringing to sixteen the total number of hypotheses for testing. The generic term "divergent production of ideas" represents the four dependent variables, TCREATE (total creativity); ORIGNL (originality controlled for fluency); FLUENT (nonoriginal responses only); and FLEXBL (flexible responses only).

There were two classes of research hypotheses:

1. Hypotheses for main effects of training

H1 - Subjects trained in lateral thinking will score significantly higher on tests of the divergent production of ideas than subjects trained in vertical thinking.

H2 - Subjects trained in lateral thinking by the competency-based method will score significantly higher on tests of the divergent production of ideas than subjects trained in lateral thinking by the developmentally-based method.

2. Hypotheses for main effects of individual differences:

H3 - There will be a significant and positive correlation between subjects' scores on field independence and their scores on measures of the divergent production of ideas.

H4 - There will be a significant curvilinear relationship between subjects' age and measures of the divergent production of ideas; the form of this relationship will be such that the scores of subjects trained in lateral thinking in the middle career-age group will exceed the scores of subjects trained in lateral thinking in the early and later career-age groups.

Exploratory analysis:

The exploratory analysis is in three parts: Main effects for gender differences; Main effects for linear age and verbal comprehension; and Interaction analysis.

Gender differences. There was one formalized question, on gender differences, of a non-directional nature:

Do male and female subjects differ significantly on the divergent production of ideas?

This question was not set as an hypothesis due to contradictory evidence in the literature. The reason for its inclusion was research interest in exploring for possible main and interaction effects of gender.

Main effects for linear age and verbal comprehension. These two individual difference variables were included in the full regression model, given in Table 10, to explore the effects of linear or chronological age, as distinct from age groups, on main effects and interactions; and the main effects of a covariate, verbal comprehension, on the four dependent variables.

Interaction analysis. In discussing the exploratory nature of aptitude or trait treatment interaction (ATT) research, Cronbach and Snow (1977, 493-4) encouraged searching for variable interactions in hypothesis building as a respectable goal for research. The literature, directly relevant to this research project, was sparse on the subject of interaction analysis. This situation discouraged hypothesis setting for interactions. The purpose of the interaction analysis was to take advantage of the results of the full regression model by analyzing significant ($p < .05$), and interesting ($.05 < p < .15$), interactions for insights into individual difference and treatment relationships for hypothesis building, and to inform the training of adults.

There were three sets of interactions included in the regression model:

- (a) First order interaction effects of individual difference variables (field independence, age, gender)

- (b) First order interaction effects of the two training contrasts and the three individual difference variables
- (c) Second order interaction effects of the two training contrasts and the three individual difference variables

Parameters and Elements of the Study

This section sets out the basic elements on the scope and nature of the study as an introductory perspective.

Subjects. Volunteer subjects ($N = 74$) were members of British Columbia professional adult and continuing education associations, and administrators, and instructional staff of continuing education divisions of post-secondary institutions in the Greater Vancouver area. A total of 25 male and 49 female volunteers participated in the study.

Workshop setting and random assignment. Three, one-day (six hour) training workshops were set in similar facilities and taught by trained teams of two instructors, using guidelines and prepared materials. Subjects were randomly assigned to two treatment workshops, and one control workshop. One treatment group was given training in lateral thinking concepts and techniques on a competency-based (directive) method ($N = 29$). The other was given training in lateral thinking concepts and techniques on a developmentally-based method ($N = 23$). The control group was given training in vertical thinking exercises, on a lecture-discussion basis ($N = 22$).

Workshop content. The six hour workshop session consisted of four and one half hours of intensive instruction and one and one-half hours of testing. Selected (deBono, 1971) lateral thinking concepts and techniques were formulated as instructional materials for presentation in the two treatment workshops. The single control group was presented instructional materials in vertical thinking exercises and case study problem solving, on a lecture-discussion method.

Testing. Two aptitude tests, Witkin's (1971) test of field independence and Guilford's (1981) test of verbal comprehension, were administered to subjects immediately prior to the workshops. Guilford's tests of divergent thinking, Plot Titles (1981), Consequences II (1980a), and Alternate Uses (1978), were employed as the posttest measures of the effects of training conditions and individual difference variables on four dependent variables.

Dependent variables. Four divergent production dependent variables were derived from Guilford's (1979a) Structure of Intellect "product" factors (fluency-units; flexibility-classes; originality-transformations), as given in Table 9 page 109; and in terms of the response classifications in Guilford's three tests of divergent thinking (remote, obvious, clever, nonclever, flexible) as given in Table 1. These four dependent variables were: fluency (FLUENT); flexibility (FLEXBL); originality, controlling for fluency (ORIGNL); and total creativity (TCREATE).

Independent and moderator variables. The independent treatment variable was training in lateral thinking by the two methods, competency-based, and developmentally-based. The control group was

given training in vertical thinking exercises. For the multiple regression model, two contrasts for testing the independent variable components were set: Contrast 1 - training in lateral thinking and training in vertical thinking; Contrast 2 - training in lateral thinking on a competency-based method and training in lateral thinking on a developmentally-based method.

Three individual difference moderator variables were included in the regression model to assess main effects and interactions: field independence scores, age and gender. A fourth individual difference variable, verbal comprehension, was included as a covariate.

Hypotheses and interactions. Four hypotheses for main effects were set, in relation to the four criterion or dependent variables derived from the three Guilford tests: (a) training in lateral thinking was projected over training in vertical thinking; (b) the performance of subjects trained on the competency-based method was projected over the developmentally-based method; (c) the performance of subjects rated higher in field independence was projected over subjects rated lower; and, (d) the performance of laterally-trained subjects in the middle career-age group was projected over early and later career-age groups.

Exploratory analyses were conducted on the gender variable, and first order interaction of individual difference variables, and first and second order aptitude or trait by treatment interaction variables.

Computer program. The Statistical Package for the Social Sciences (SPSSx, 1983) was used to conduct the sequence of multiple regression analyses. The full model (two treatment contrast independent

variables, three moderator variables and one covariate, and the set of fifteen interactions) tested the four hypotheses for main effects and the interactions, on the four dependent variables. Partial models were then computed to obtain residuals to graph and analyze the eleven interactions. Pearson r correlations and univariate ANOVA were run on a preliminary and post hoc basis to provide data of interest in the discussion of principal findings and unanticipated results.

Limitations

The following limitations describe the main restrictions to the study:

1. The voluntary nature of subject participation required that the sample and the population be identified as one and the same. Generalizing the results of the study to the larger population of continuing educators was not possible without random selection. Therefore, the results of the study offered speculative implications only, for continuing educators at large.
2. Volunteers brought an additional control problem by way of their motivation to participate in the study. Willing participants cannot be said to represent the population of continuing educators. Test scores (Halo Effect) could reflect this motivation.

3. The limited number of subjects ($N = 74$), resulting from the problem of obtaining adult volunteers, presented a problem in the multiple regression statistical analysis. The more cases, the more meaningful the analysis. Small sample size limits the power of the statistical test due to inadequate "degrees of freedom", and less chance of proving significance.
4. Female volunteers outnumbered males by approximately 2:1. This imbalance resulted in a compounding of the problem of small sample and cell size in the interaction analyses.
5. The instructors, as variables, placed limitations on the study. The two treatment groups had the same team of two instructors; however, the control group had two different instructors. Consequently, instructors were not crossed over all groups.
6. The validity of Guilford's divergent thinking tests, in measuring the effectiveness of training in deBono's lateral thinking concepts and techniques, has not been well documented in the literature. Few studies have explored deBono's techniques, in experimental settings, as stimulators of the divergent production of ideas; that is, fluency, flexibility and originality (Klawiter, 1976; Rosenthal, 1977, 1977a).

7. The short term nature of the lateral thinking training experience (4 hours) should be considered as a possible limiting factor on the divergent production outcomes of the study. Some research literature supports short time (2 - 15 hours) training (Ridley and Birney, 1967; Hutchins, 1979; Rosenthal, 1977), but few studies were of adult subjects, and only one used deBono's techniques and Guilford's tests (Klawiter, 1976).

Significance of the Study

The significance of this study is derived from two sources. The first is its unique elements as a research experiment with theoretical implications; and the second is its practical value as a study which provides useful information for the development of adult training.

A number of researchers and theorists have presented evidence that direct training in thinking skills can improve performance in the creative production of ideas and in problem solving. It is notable, though, that little creativity training research has been done with adult subjects on divergent thinking; and deBono's lateral thinking techniques seldom have been used by training researchers (Johnson, 1972, 318; Dirkes, 1978; Guilford, 1979b, 41; Sadler and Whimbey, 1979, 3; Martin, 1983, 10; deBono, 1978, 1983, 708).

It was the aim of this study to contribute to the body of research in training for productive thinking, by bringing together Guilford's Structure of Intellect theory and divergent thinking tests, with deBono's lateral thinking concepts and techniques, in what is apparently a new coupling in the field of creativity training. One study (Klawiter, 1976) was found which used deBono content and Guilford tests. Rosenthal's (1977, 1977a) two studies were the only other located which used deBono content and techniques.

The literature on education and psychology contained a sizeable number of empirical and theoretical studies of creativity training, primarily centering on school age children and college and university students (Torrance, 1972; Parnes, 1972; Dirkes, 1977; Durio, 1978). A stream of literature on the relative effectiveness of short term creativity training indicated both positive and negative views and results (Ridley and Birney, 1967; Khatena, 1971; Rosenthal et. al., 1977a; Mansfield, 1978). Some researchers have specialized in the experimental analysis of divergent thinking (Meeker, 1969; Dirkes, 1977, 1980; Hocevar, 1978, 1979a). Cronbach and Snow (1977) reported on many aptitude by trait treatment interaction (ATI) studies, but only a few involving creativity training and cognitive style variables, such as field independence, and adult subjects.

The potential value of the present study, as a contribution to research and theory development, rests in its uniqueness as a training study which introduced aptitude variables (verbal comprehension, field independence), with organismic (age, gender), with experimental treatment contrasts (lateral, vertical; competency, developmental) in

a multiple regression and interaction analysis study of adult performance on divergent production.

On the practical or applied side, this study considered the integration of theory and practice by conducting the research-workshops on a natural or representative design basis, to control for situational variables in instruction, materials and the learning environment. Integrating theory, and the results of research, with skills learning programs is a responsibility of professional development planners and instructors. A practical goal of the workshops was to provide immediate benefits to subjects and their institutions, through the provision of lateral thinking training and materials suitable for use in program planning and institutional settings.

This study was intended to be of value and interest to other creativity training researchers, and to professional continuing educators, by adding information to the body of knowledge on adult cognition and training in divergent thinking. Secondly, and indirectly, through the continuing educator participants, the study was intended to contribute to their professional growth, and to learning situations they may devise for adult subjects.

Summary and Organization of Report

Chapter 1 presented background on the issues and problems which gave rise to this research study and its creativity training purposes. The aim of the treatment in lateral thinking was related to the need for continuing educators to move to new realms of creativity, in the divergent production of clever and remotely possible ideas. Breaking away from traditional patterns of thought and generating new ideas was emphasized as the critically important predecisional phase of the continual process of decision making and problem solving.

Research problems, variables and key terms were defined in operational terms. Hypotheses for main effects were specified, and the exploratory nature of the gender questions and interaction analysis noted. The parameters section set out the scope and basic elements of the study, and the limitations were noted. The significance of the study was discussed in terms of its uniqueness in relation to the existing research and theoretical literature, and its practical value.

Chapter II presents an integrated review of cognitive psychology, creativity training, and other literature consulted in the planning and development of the research study, and includes a summary related to the selection of variables.

Chapter III presents the methodology of the study, including sections on design, workshop settings and content, sample and random assignment, tests and scoring, and the multiple regression procedure for data analysis.

Chapter IV presents the data, analyzes the hypotheses tested in the study, and includes exploratory analysis of interactions.

Chapter V summarizes the research purpose, procedures and hypotheses, and presents principle findings and conclusions, limitations, and recommendations for future research.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of literature starts with observations on the works of Argyris, deBono and Guilford, followed by sections on issues of organizational survival and restraint in education, and the relationship between organizational development and productive thinking. As a context for divergent thinking, the review then investigates open systems theory and decision making, and contingency management. The next sections on cognitive science and problem solving, and on cognitive psychology and creativity, form the main source of theory and techniques for the study. The key section, on experimental research in creativity training, focuses on studies of divergent thinking in reviewing specific design elements and results. The several sections on adult education deal with adult cognition, age and gender factors, and methodology. The concluding section stresses the importance of multiple regression and aptitude by treatment interaction analysis.

Three Major Influences: Argyris, deBono and Guilford

At the summit of an impressive career in the field of organizational theory, Argyris (1974, 1975, 1976, 1982) centered his attention on individual learning, specifically the concept of double-loop learning. Simply put, his thesis is that espoused theory must be

demonstrated by theory-in-use, or the learning that takes place is single-loop, and does not lead to the repatterning of thought, as evidenced by performance. Argyris' goal is to effect change in values and behavior, and to increase the capacity of individuals and organizations to solve difficult and underlying problems.

DeBono (1969, 1971, 1976, 1978), an exponent of creative thinking, has written extensively on the importance of the direct teaching of thinking skills, giving special attention to the development of concepts and techniques in the neglected area of lateral thinking. Problem solving, by means of logical or vertical thinking, is of primary importance; but, identifying the right problem, and generating new options for solution, depends on perception and imagination in the initial stages of thought, on lateral skill in searching the mind, and on the insightful capacity to repattern knowledge (deBono, 1971; 1967, 83).

Guilford (1956, 1967, 1977, 1979a), and associates, working in the field of cognitive psychology and creativity, and applying the statistical techniques of factor analysis to sequences of constructs and factor tests, devised a Structure of Intellect (SI) matrix (Guilford, 1979a, 23). This unified theory of human intellect, is comprised of three multi-faceted dimensions (operations, products, content; 5x6x5 respectively) totalling 150 factor cells. The area of Guilford's work which has attracted most interest is the divergent production plane of the SI model.

Of all the abilities and functions in the SI model,
(abilities in the context of individual differences,
functions in the context of the operating individual)

those in the category of divergent production or fluency of thinking have been generally accepted as features contributing directly to creative thinking (Guilford, 1983, 75).

Systematically related to divergence, and even more important as the key to originality, is the "transformational" (product) category, the ability to repattern information to apply in different and new circumstances, a double-loop learning function (Guilford, 1967, 1979a, 1983).

Argyris' (1982, 159-160) Model II system, double-loop learning, as a theory for change, relates to deBono's lateral thinking and Guilford's divergent thinking, whereby new or opposite ideas and people interact in nonroutine, nonprogramed approaches to difficult issues and problems requiring the reexamination of individual and organizational values and behaviors.

The Issue of Organizational Survival and Restraint in Education

The dilemmas which constrain the economic and social development of nations, and which are evident in the impacts of restraint and contraction in the educational sector, arise from ideological tensions and inadequate social policy and planning, resulting in the disorder of present world conditions (Coombs, 1975; Easton, 1976; Ramphal, 1984).

For the world of tomorrow, the survival of humankind rests, fundamentally, on educational development and the advancement of human learning, on intellectual productivity, creativity, adaptability,

self-reliance and social conscience (Toffler, 1981; Morris, 1982). The importance of the future roles of educators, and educational organizations, in local, national and international networks, will depend on their capacities to anticipate, monitor, and, if necessary, challenge policies and actions or inactions of governments, private interests, and international bodies. Educators, individually and in associations, as experts in learning and training, can become more resourceful sensors for scanning the problematic environment, for advancing the quality of educational decision making and problem solving, and for creating strategies to inform and influence social planning. The future of nations, in no small measure, is contingent upon the performance of educators, in their success at organizing resources, and in teaching people to learn how to learn and to be resourceful in dealing with complex problems and the circumstances of change (Viola, 1977; AUCC Conference Report, 1983).

Impact analysis of the consequences of restraint and contraction sharply clarifies the need to concentrate research and training on the individual educator, and on how to manage educational organizations out of decline toward survival and selective development (Argyris, 1982, 169; Taylor, 1980; Whetten, 1981, 81; Andrews, 1983).

Educational institutions are, as a rule, adopting a passive response to retrenchment, by treating it as a fait accompli. This framework drives out consideration of more aggressive, innovative responses that might enhance the organization's long term adaptive potential (Whetten, 1981, 91).

Evidence points to the conclusion that educators and their institutions appear not to have adapted well to resource limitations resulting from retrenchment. Disbelief, passivity and lack of

preparedness have fueled the problems imposed by reductions in funding and support to the educational sector. Professional and administrative training has been growth-oriented, and not well adapted to survival in the field (Hills, 1980; Andrews, 1983).

DeBono (1978, 10) discriminated between reactive and projective thinking (single-loop vs. double-loop learning) in emphasizing that executives have not been trained to search for unusual ideas or to turn obstacles into opportunities. He espoused direct training in productive thinking, especially in concepts and techniques for lateral or divergent thinking, as the means to acquire skills in repatterning the mind, finding problems and producing new and unusual solutions.

Relationship Between Organizational Development and Productive Thinking

Concern for creativity and innovation in the field of management science arose with the emergence of the human relations movement, based as it was in psychology and interest in the individual and working groups in organizations (Argyris, 1957, 1964, 1982; Katz and Kahn, 1978; Jablin, 1981). Gordon's (1971) work in the area of synectics was a related methodology to engage people of different backgrounds and competencies in special settings for creative problem finding and solving. In the 1970's the success of Japanese management techniques stimulated interest in involving individuals at all levels of the organization in the process of innovation through nonjudgmental brainstorming to generate new and better ideas and ways to improve

production and working life (Ouchi, 1981; Pascale and Athos, 1981; Peters and Waterman, 1982).

Whereas decision making and problem solving have been a primary area of study in the field of management, the theory and research connection between intelligence and productive thinking and problem solving emerged from the fields of cognitive science and cognitive psychology. Among the early researchers in the area of creativity and problem solving were psychologists with strong interests in learning (Torrance, 1964; Guilford, 1967; Parnes, 1972; Getzels, 1975; Resnick and Glaser, 1975; Feldhusen and Guthrie, 1979, Kozmetsky, 1980). Coincident with the creativity work in the fields of psychology and education, researchers and theorists in the field of management fused elements of systems theory and cognitive science and demonstrated increasing interest in learning, creativity and productive thinking (Argyris and Shon, 1974; Kast and Rosenzweig, 1974; Argyris, 1975; Ebert and Mitchell, 1975; Norman, 1980; Simon, 1980, 1983).

By the early 1970's, divergent thinking, hypothesized by Guilford (1956, 1967) and others (Barron, 1969; Bennett, 1973) as the basis for creativity, commanded attention in light of the need to ameliorate the traditional linear approach to decision making and problem solving.

In problem solving and creative thinking we find intellectual abilities working together, if the problem and its solution are at all complex. The two kinds of exercises are intimately related, for the solving of a problem calls for the novel steps in behavior, and this means creative performance (Guilford, 1977, 184).

Lateral thinking, made popular by deBono in the late 1960's, was presented as a set of concepts and techniques to train students, executives and professionals in creative problem solving. DeBono

(1978), and other creativity researchers and theorists, urged direct training in productive thinking as essential for advancing decision making and problem solving skills (Renzulli, 1977; Sadler and Whimbey, 1979; Young, 1979; Martin, 1983).

The implementation of training programs in double-loop learning for change (Argyris), or lateral thinking techniques for ideas (deBono), is premised on an open organizational environment to enable the transformation of learning and thinking skills into processes for decision making and problem solving.

Systems Theory: Context for Productive Thinking, Decision Making and Problem Solving

Churchman (1968) and Laszlo (1972) defined general systems theory as a science of organized complexity, a holistic and dynamic view of the world. Laszlo defined man in the systems view, ideally, as an integral, consciously aware, learning, self-monitoring, reflecting being. Scott (1981, 20), in defining the open systems approach emphasized the "...reciprocal ties that bind and interrelate the organization with those elements that surround and penetrate it."

Van Gigch (1978, xi) called for open systems theory, and its associated broad view thought processes, to be applied to real world problems. And Churchman (1968, 2) noted that the first problem to be solved is the educational problem, to remove the threat of ignorance. Immegart and Pilecki (1973) held that the capacity of open and living systems to survive depended on their contingency abilities to assess changing circumstances, to identify new problems and to generate new

ideas and original solutions. Other observers, in the field of education, have asserted that change (for example, dealing with the impacts of restraint) has been retarded due to inadequate knowledge of open systems principles and techniques (Maxon and Sistrunk, 1973; Hayman, 1974; Zalutino and Sleeman, 1975; Tanner and Williams, 1981).

All open systems share one feature, complexity. The individual human is a complex entity and, in relation to society, is threatened by the complexity of the organizations he creates. Complex systems problems require creative systems solutions. The large systems problems (restraint and contraction) must be attended with options and solutions that satisfy subsystem objectives (individual and organizational), and which consider the survival of the global system (van Gigch, 1978, 2). The principle of interdependence among systems and subsystems implies a contingency view of response options in which alternatives and choices play a vital role (van Gigch, 1978, 81, 573).

Two systems concepts of particular value in productive thinking for problem solving are: (a) cybernetics, the "feedback" science of communications and control (Wiener, 1954); and, (b) negative entropy or "integration", the essential resource intake system balancing process (Laszlo, 1972). This cybernetic-negentropic combination, of interactive systems information processing, relates to adaptability in human thinking and organizational regeneration.

The validity of systems theory as a model for organizational development is exemplified in the works of Kast and Rosenzweig (1974), Cornell (1980), and Ebert and Mitchell (1975). Kast and Rosenzweig (1974, 514) described a systems-contingency view in stressing the need

for openness in organizations:

Systems concepts emphasize that organizations are composed of many subsystems whose interrelationships have to be recognized. Once we accept a systems view it becomes apparent that it is impossible to prescribe principles which are appropriate to all organizations.

In accenting the role of the individual in the organization, Ebert and Mitchell (1975) noted the importance of imagination in cognitive mapping. They described decision making as an intelligent choice process (TOTE - test/operate/test/exit) in problem solving. The success of organizations depends upon human sensitivity to internal and external environment clues and pressures, and imagination or creativity and choice in decision making and problem solving.

Decision making is the number one function of management and underlies the problem solving process (Simon, 1960; Ebert and Mitchell, 1975; Cornell, 1980). Cornell devised a Systems Analysis Approach (SAA) decision making model which gives full attention to predecisional processes. Priority needs to be given to continuous analysis and breadth of analysis, to finding the right problem, and to considering alternatives, before converging on the problem solution. Cornell's SAA model is designed to instruct decision makers in an integrated program of productive thinking, in divergence in exploring alternatives, skill at posing insightful questions, identifying the correct problem, and the application of quantitative techniques in predecisional and decisional and evaluation phases.

Guilford connects productive thinking and problem solving in his Structure of Intellect Problem Solving (SIPS) model, similar in principle to the TOTE decision making choice model demonstrated by Ebert and Mitchell (1975). Guilford's (1979a, 115-116) model displays similarities between episodes of problem solving and productive thinking. If routine specifications are not adequate to obtain the right answer, or if information is lacking, or if a variety of answers are called for, then divergent production is the appropriate component.

Lateral thinking, a close relative to divergent thinking, supports the decisional and problem solving processes with nonjudgmental and nonrational sensing techniques for stimulating thinking in the predecisional phases. The flexible search process is designed to find the problem and produce arrays of solution ideas and possibly conflicting options. Lateral thinking is not a model for decision or for action; it involves open-ended scanning techniques for generating options in the formative phases prior to decision selection, implementation and assessment (deBono, 1971, 13).

The seeds of productive thinking flourish in the flexible context of open systems and contingency approaches to organizational development. It is in interactive, open system settings that the potential for generative thinking becomes impressive, and the significance of the broad search, suspended judgment, and nonlogical nature of lateral thinking can be demonstrated to best advantage.

The Contingency Approach and Creativity in Management and Education

The interdependence phenomenon, in open systems thinking, was stressed by Hellriegel and Slocum (1978), who centered on a contingency factor in the flexible management of the multitude of variables arising from within organizations and imposed upon them from the environment.

General systems theory provides the overall model for the study of social organizations. But it involves a relatively high level of abstraction. Contingency views are based on systems concepts but tend to be more concrete and to emphasize more specific characteristics of social organizations as well as patterns of relationships among the subsystems (Kast and Rosenzweig, 1974, 507).

Contradicting the normative or rational-scientific approach to management, which is based on quantitative techniques and supporting principles and laws about relationships, open systems and contingency approaches project a view of organizations composed of interrelated subsystems for which it is impossible to prescribe a common set of principles. The contingency view is a mid-range concept recognizing complexity in managing organizations, and using patterns of relationships and configurations of subsystems to facilitate improved practice (Kast and Rosenzweig, 1974, 513, 518).

The contingency approach places heavy emphasis on investigation, observation and examination in the determination of management problems (Hellriegel and Slocum, 1978, 92).

Hostrop (1973) asserted that educators had not displayed receptivity to systems and contingency approaches, which offer the framework to build a climate for change on the premise that there is no one best way of organizing or managing teaching and learning.

Hanson (1979) noted that while contingency theory has strongly influenced the field of management, little impact is evident in educational administration. By means of school-based research, Hanson and Brown (1977), stressed the importance of managing environmental turbulence by concentrating on the internal resources of the organization to deal with situational problems. These internal pressures cause tension on the management process and negatively affect the capacity of the organization to deal with environmental disorders. Immegart and Boyd (1979) and Griffiths (1979) characterized the field of educational administration as turbulent, and they, and Getzels (1975, 1979, 1980), urged a creative, problem finding approach to organizational management in education.

In reviewing contemporary theory development in the field of educational administration, Griffiths (1979a) called for a new paradigm in noting the importance of studying administrators as individuals in organizational settings, how they function, and their styles of administration and thought. Griffith's proposed Situation-Environment model is, in effect, a contingency view on internal problems and environmental pressures.

Contingency theory holds that there is no one best way to manage educational problems. Based on that premise, creativity, and divergent and lateral thinking, should play a cardinal investigative role in breaking out of the constraints of boundedness, predicting the unpredictable, generating options and ideas, and taking risks in decision making and problem solving (Hellriegel and Slocum, 1978, 182).

The bridge from organizational theory to cognitive psychology and creativity is maintained by the field of cognitive science, with one of its central purposes being the study of the interrelationships between the human brain and the artificial intelligence of the computer in problem solving.

Cognitive Science, Problem Solving and Problem Finding

The field of cognitive science, a fusion of cognitive psychology, neurophysiology and computer science, has a primary concern for information processing and problem solving (Simon, 1980). One of its major research purposes is to understand intelligent systems and the nature of intelligence, in order to construct nonhuman and human-computer interactive systems for problem solving.

In view of the changes in knowledge that can take place in a professional lifetime, Simon (1980a, 81) emphasized the importance of instruction for acquiring general problem solving (GPS) skills for new learning, and for teaching problem solving explicitly. His heuristic GPS model, based on TOTE looping principles, utilized advances made through computer science and artificial intelligence (AI) in training human thinking processes. Computerized search methods serve to generate alternatives and facilitate the production of strategies for problem finding and solving. To Simon, the computer, a thinking simulator, is indispensable in its AI capacity to TOTE in the creation of new productions.

Intelligence, human or artificial, is the ability to acquire new abilities under less than optimal environmental conditions, where solution routines are not directly taught or programmed. A major aspect of intelligence is the ability to solve problems by inventing new solutions in the absence of complete information or instruction (Resnick and Glaser, 1975, 11, 33). Simon (1980, 45; 1983, 50, 55) reasoned that intelligent behavior is adaptive, that adaptation equals learning, and that the ability to think and learn is the most valuable genetic (genotypic) trait. Rational behavior change (phenotypic) involves conscious search for adaptive responses and the discovery of new possibilities. To Simon (1980, 44-45), organizational evolution does not lead to optimal results. The important thing is the process, of searching, adapting, and satisficing, in emphasizing means equally with ends in a world of unending complexity, an essentially contingency view.

Simon (1983, 40, 87) reasoned that institutional limitations are rooted in individual rationality, and individuals need to bring out their better selves in a selective search for adaptive responses. Norman (1980, 25-6) discussed a new integrative approach to cognitive science, with an emphasis on human learning, including informal, experiential modes of reasoning, and emphasizing learning through novel situations.

Klien and Weitzenfeld (1976) asserted that current theories of problem solving have no explanatory account of the process of problem identification, and that problem solving consists of two simultaneous processes, the generation and the evaluation of alternatives. Their

critique of Newell and Simon (1972), for omitting problem finding in their AI approach, must be revised in view of Simon's (1980, 1980a; 1983) more recent work.

In a direct challenge to fellow cognitive scientists, Getzels (1975, 1979, 167) pressed for research into problem finding, which involved creativity and divergent thinking prior to problem solving:

Very little is known about how problems are found and formulated...whereas...there are dozens of theoretical statements, hundreds of psychometric instruments, and literally thousands of empirical studies of problem solving.

The problems found through creative discovery are the source of questions and hypotheses for research, and the quality of the problem found is the forerunner of the problem solved (Getzels, 1979, 168).

Getzels (1980, 358) quotes Einstein:

The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old questions from a new angle, requires creative imagination and marks real advance in science.

Arlin (1975, 1976) noted that problem finding is not an aberrant variable, but is systematically related to other aspects of human thought. In a Piagetian sense, Arlin described a new operations stage of divergent or creative thought as basic to the highest level of productive thought, and in so doing joined Getzels in setting a new line of inquiry for cognitive science and cognitive psychology.

Cognitive Psychology, Creativity, Divergent and Lateral Thinking

Guilford (1979a, x) defined cognitive psychology as the science which studies the flow of information in the organism, with information qualified as that which the organism discriminates. Blumenthal (1977, 5) presented a complementary definition of the study of cognition as focussing on the nature of human mental processes that enable learning and the use of knowledge. Process, in Blumenthal's view, refers to actions of cognitive performance (perceiving, remembering, thinking, desiring) which depend upon the organism's biological capacities; for example: intelligence, visual acuity, gender, age. Multi-dimensional theories, such as Blumenthal's, are reflected in Guilford's Structure of Intellect model, which, he stated (1979a, xi), "...can provide a taxonomy for cognitive psychology, and is a basis for psychological theory." The SI taxonomy represents individual differences, provides a language for communication, and can be a major source of problems for inquiry, hypotheses to be tested, and a background against which results can be interpreted.

One major outcome of Guilford's twenty year (1950-1970) Aptitude Research Project (1979a, xii), was his work on creativity and divergent thinking. Until Guilford, Torrance, Parnes, Covington, and other proponents of training for creativity, launched their research programs, little formal attention had been given to the identification, training, and testing of the creative search process. In 1950, of 121,000 published articles on the American Psychological Association record, only 186 dealt with creativity. In the

intervening decades this situation was rectified; however, creativity and thinking skills have not received adequate attention in school, college and university, and professional development and organizational settings (Barron, 1969; Rothbart, 1972; Campbell, 1979; Martin, 1983; deBono, 1983).

Koestler (1964, 657, 659) described the creative act as "...the highest form of learning because of the high improbability of the solution...and...the liberation of more primitive, less specialized levels of mentation." Arising from his philosophical views on the creative act, Koestler presented a clear psychological analysis which contrasted originality with habit. Whereas habit is characterized by "associative" thinking, a conservative, matrix-confining process hedged in by guidelines and repetitiveness; originality is characterized by "bisociation" of independent matrices, flexibility, regeneration and novelty. Carl Rogers (1967, ROG, 3M) defined the creative process as:

The emergence in action of a novel relational product, growing out of the uniqueness of the individual on the one hand, and the materials, events, people or circumstances of his life on the other.

The creative individual must be motivated and possess certain cognitive abilities, including: perceptual attitude and ability, conceptual complexity, deductive-analytical ability, (convergence) and inductive-synthetic ability (divergence) (Pearlman, 1983, 296).

Creative thinking, in Guilford's view, involves the output of novel ideas original to the subject, hence, all people can engage in the creative process. Investigators have found low positive correlations between IQ tests and tests of creative aptitude related

to creative performance (Guilford, 1979a, 111).

Of all the abilities or functions of Guilford's SI model, abilities in the context of individual differences, functions in the context of the operating individual, those in the category of divergent production, fluency, flexibility and originality of thinking, generally have been recognized as features contributing directly to creative thinking (Guilford, 1983, 75).

In creative thinking all the SI operations play roles, with divergent production being especially relevant. Any of the kinds of products may be involved, depending on the nature of the task, with transformations being especially important, for they provide a basis for flexibility and originality (Guilford, 1979a, 112).

The essence of creativity is divergent thinking, the kind of thinking in which there is much searching or going off in various directions, and where many alternative ideas are brought to light (Guilford, 1977, 184). The concept of divergence is one interdependent "operation" among five in the SI model: cognition, memory, divergence, convergence and evaluation. The concept of transformation is one interdependent "product" classification among six: units, classes, relations, systems, transformations and implications. Of these six, transformation relates most closely to discovery learning, or the development of new products of information and the revision of old ones. Divergence leads to transformation, and unless both have taken place, creative thinking has not occurred (Guilford, 1977, 162). Of the two concepts, transformation is more important than divergence (Guilford, 1983). With transformation, a change in product is implied, a modification, rearrangement or revision; or how things could be rather than how they are.

Complementing the operation and product categories, is "content", the third dimension, comprised of figural, auditory, symbolic, semantic and behavioral classifications, semantic being the most commonly tested of these content constructs.

Nystrom (1979) identified four stages in an individual's creative process - preparation, incubation, illumination, and verification - with divergent thinking as the key element in the preparation stage in exploring many possibilities, as distinct from the single line reasoning of exclusively convergent thinking. Most tests of creativity, and techniques to promote creativity, are primarily intended to measure or stimulate divergent thinking (Nystrom, 1979, 40).

Building on attentional scanning (Blumenthal, 1977, 197) and divergent thinking, which occur in Nystrom's preparation stage, the problem solver moves to the subsequent (or parallel) incubation stage, where the subconscious thought processes should lead to illumination, insight or discovery of previously unrelated ideas (Bruner et. al. 1967; Nystrom, 1979; Guilford, 1979). The quality of the intuition or the idea, though, is directly related to the quality of the mind, memory and knowledge stored (Simon, 1983, 27). What Nystrom called the final or verification stage is based on deductive logic and cause and effect relationships, the convergent or conclusive stage that has received more than its share of attention in our educational institutions.

Hocevar (1979a, 3), concluded that the creative individual should possess the types of abilities measured by tests of divergent thinking; that is, tests of fluency, flexibility and originality. While the construct of creative aptitude is sufficiently complex to preclude definition by divergent measures alone, Durio (1978) considered the Guilford and Torrance instruments as being acceptable measures of creative aptitude for research purposes. In reporting on their two year program of research on applied creativity, Parnes and Noller (1972; 172-3) noted that their creative problem solving program paralleled Guilford's model very closely, and they employed Guilford's tests, in modified form, to assess elements of creativity drawn from 58 measures of the SI model. Zegas (1976) found Guilford's divergent thinking tests to be valid predictors of creative ability, suitable for use as screening instruments for traits such as flexibility of thought. A more recent use of Guilford's convergent and divergent thinking tests was reported by Horber and Geisinger (1983) in a correlational study of attitudes toward risk taking. Hocevar (1979a, 2), Hocevar and Michael (1979), and Vernon, (1971, 1972, 1979), warned that no psychological concept has proven so difficult to measure as creativity, and the uncritical use of tests is not warranted.

Hocevar's (1979b, 191) research found originality scores to be a function of individual differences in ideational fluency; that is, fluency and originality are correlated or compounded and do not demonstrate discriminant validity. Milgram and Rivka (1981) both supported and questioned Hocevar's view that individual differences are accounted for by overall number of responses, and noted that the

ideational fluency-originality relationship is too complex to be equated simply with fluency or numbers of common responses. For example, Milgram and Rivka reported that variance explained by statistically unusual, but not necessarily high quality, responses, an intermediate classification, far exceeds popular responding or simple fluency.

The speciality of psychometrists is the design, through factor analysis, of tests of factors or variables which comprise cognitive abilities, aptitudes or traits. Guilford's major contribution to cognitive psychology was his factor analytic work, transformed into the SI model and rationalized as a theory base for psychological and educational research, analysis and practice. Other researchers have taken a greater interest in behavioral performance and the design of instruction, materials and techniques for teaching and learning creativity and divergent thinking (Torrance, 1964; Barron, 1969; Maier, 1970; Parnes, 1972; Katsounis et. al., 1975; Rosenthal et. al., 1977; deBono, 1971, 1978; Riley, 1982).

DeBono and lateral thinking. DeBono's extensive work on techniques for improving thinking skills, has been widely used in the field, but seldom has been the subject of experimental research. This situation is due, in part, to his firmly expressed pragmatic views, and his wariness of inappropriate testing (deBono, 1976, 233; Tripp, 1977).

DeBono (1967, 18; 1978, 16) concluded that orthodox education has failed to encourage creative thinking. He joined Torrance, Parnes and others in the view that direct teaching of thinking skills, and the

acquisition and application of tools and techniques, is prerequisite to improving productive thinking and problem solving. Like Guilford, deBono is of the view that creative thinking should not be thought of as a special gift, but as achievable by all and improvable through training.

While deBono's work has demonstrated broad interest in all phases of creativity, productive thinking and the problem solving, he, like Guilford, has given special attention to the concept of lateral or divergent thinking. DeBono contrasts lateral thinking with logical or vertical thinking, while recognizing their unity. Traditional logic, the rational approach to decision making and problem solving, is an intellectual imperative; but, argues deBono, this linear or vertical thinking is not effective without a discovery premise to the overall problem perception-conception-solution pattern. Lateral thinking injects the unusual into the problem solving process to bring about calculated disruption, to find new problems, to raise the probability factor and risk producing new and potentially useful ideas (deBono, 1969, 299; 1971, 3, 13).

The derivation of the constructs "lateral" and "vertical" is given some clarification by Gagné (1962, 70). He defines vertical transfer as a process whereby simpler learned components are incorporated, in hierarchical fashion, into the learning of more complex performance. In contrast, lateral transfer is a process in which a component learned in one task context is recognized as relevant to performance in some other context. This lateral transfer is Guilford's transformation classification, and, no doubt, the source of deBono's

lateral thinking.

The effectiveness of mind in establishing fixed (useful) patterns of thought makes flexibility and creativity difficult. Basically, the mind is poor at updating itself. The incremental-accretion method of processing information may result in overloading, and resistance or blockage may result in obsolescence.

The more specific faults of the system include its divisive tendencies, which create artificial entities and artificial separations between them. This is the phenomenon that has been described as polarization (deBono, 1969, 299).

As did Guilford in the case of divergent thinking, deBono asserted that lateral thinking must be consciously forced because of the mind's naturally conservative information processing system. Rather than rely on flashes of insight, lateral thinking techniques and skills are needed to stimulate connections and patterns which lead to new ideas.

Insight is so haphazard a mechanism that it cannot be expected to reduce the gap between the current arrangement of information and the best possible arrangement with any reliability (deBono, 1969, 299).

The faults of the subconscious mind, its inherent tendency toward rigidity, and the haphazard arranging of information for insight restructuring, inhibit the production of creatively useful ideas. Lateral thinking disrupts sequential processes of mind to bring about insight restructuring, enlarge perception, and generate new patterns and ideas to give direction to vertical or convergent thinking. Purposive restructuring of information, through training in lateral thinking concepts and techniques, serves to improve the fluency and quality of thought patterning and insight, and the production of ideas for problem solving.

In his publication, Lateral Thinking for Management, deBono (1971, 3, 81) stressed the need to protect the accepting concept of lateral thinking from the rejecting function of vertical or convergent thinking. His projective thesis can be set out, analytically, in three parts:

1. Understanding current ideas and ways of doing things: assumptions, tethering factors, polarization tendencies, dominant patterns of mind
2. Learning the principles of discontinuity and change through concepts and techniques for suspended judgment, in order to place the mind in neutral and to break out from rigid patterns; and accepting the contrived, symbolic word PO, a warning not to evaluate as distinct from the vertical YES/NO
3. Learning concepts and techniques for open-ended and even nonrational generation of ideas, to stimulate fluency, flexibility, originality and transformation, for problem finding, decision making and problem solving

Stages 2. and 3. provide an open environment of mind for incoming information to be arranged or rearranged into new configurations.

DeBono's (1971) lateral thinking work can be outlined in five phases of his program to stimulate, discover, connect and focus new ideas by:

1. Demonstrating awareness of the problem or issue by identifying and understanding (verbalizing) current patterns and ideas
2. Changing ideas by avoiding established patterns and applying discontinuity techniques - suspended judgment, PO
3. Changing ideas from within by taking the established pattern, or current view, relaxing the rules of relevance and consciously introducing discontinuity by the application of techniques: intermediate impossible, reversal, distortion
4. Changing ideas from outside by consciously ignoring the established pattern and introducing new information by means of: exposure to objects or people, cross-fertilization in groups, brain storming, problem switching

5. Changing ideas from outside by consciously ignoring the established patterns and deliberately introducing discontinuity by means of seemingly non-logical or irrational techniques: analogy, envelope or random word

Rosenthal (1977, 1977a) one of the few researchers to use deBono's lateral thinking techniques in experimental research settings, underscored deBono's main point on the importance of specific techniques or tools. She concluded that creativity training is more effective when deliberate teaching strategies are used (instruction in specific concepts and techniques, group discussion, independent study), and students have the opportunity to demonstrate techniques learned through practice and transfer by application in real problem settings.

Cognitive Style: Field Independence, Divergence and Intelligence

The complexity of the human mind has been the subject of a century of psychological research, out of which has come the isolation of central psychological processes that help explain many peculiarities of mental functioning (Blumenthal, 1977, 4). Variance in mental functions may be said to be due, in part, to differences in cognitive styles which emphasize: (a) structure rather than the content of thought; (b) transformation of information from objective stimuli into dimensions meaningful to the individual; and, (c) how cognition is organized (Goldstein and Blackman, 1978, 3). Lovell (1980) writing on cognitive style from the adult learning perspective, defined the concept as "...the preferred style of thought reflected in the consistency (and predictability) of individual behavior."

Of the various well researched cognitive styles (authoritarianism, tolerance of ambiguity, dogmatism, cognitive complexity), field dependence-field independence has a substantial theory grounding, and is particularly relevant to the study of creativity and divergent thinking (Goldstein and Blackman, 1978; Witkin, 1978; Guilford, 1979a). In discriminating between field dependence and field independence, Witkin and his associates (1977, 7; 1978, 17-18) described the differentiation as the extent to which one perceives analytically. Individual differences in field perception show up in the problem solving domain where field independence is associated with active structuring or restructuring; whereas field dependence is a tendency to accept the given pattern. A person who is higher on the field independence scale is more autonomous, constant and impersonal, whereas those inclined toward field dependence are more open to external sources of information, and are more changeable and interpersonal (Witkin, 1977, 19; 1978, 20).

Witkin (1978, 29, 44) noted the stability of cognitive styles over time, but also concluded that field independence and field dependence are adaptive, and socialization and training can lead to improved cognitive restructuring and interpersonal relations.

Witkin (1978, 27) hypothesized that the field independent person has greater powers of lateralization in verbal processing (left brain) and configural processing (right brain); in other words is multimodal. This suggests that individuals with higher levels of field independence have greater powers of creativity and divergent thinking, and are generally more efficient and productive in problem

solving. Reynolds and Torrance (1978, 247) concluded that left brain-right brain functioning may be regarded as styles or preferences; and that modifications in hemisphericity are possible by directly training the right, with indirect complementary cerebral development occurring in the left.

Cognitive restructuring is an ability dimension with implications for relationships with measures of intelligence. Andrulis (1977, 177) reported that field independence is positively correlated with intelligence, and Goldstein and Blackman (1978, 185-6) noted a number of studies which reported positive relationships between field independence and intelligence. Controlling for intelligence, Gundlach and Gesell (1979) found field independent persons performed significantly better than field dependent persons on a number of creativity measures, but not on a number of others; however, with intelligence free to vary, field independent persons performed significantly better on all but one measure.

Field independents function more proficiently than more rigid and globally-oriented field dependent persons in the creative area, but may function less effectively on tasks requiring little differentiation (Gundlach and Gesell, 1979, 321).

To the extent that the capacity for divergent production differs among individuals, the construct and its elements (fluency, flexibility, originality) may be termed a cognitive characteristic or style. Divergence is reported as being positively correlated with intelligence, up to what has been labelled the threshold of approximately 120 IQ points, whereupon the relationship becomes increasingly random, and divergence appears to be distinct from intellectual ability and educational achievement (Alpaugh, 1976; Houtz

and Speedie, 1978; Metcalfe, 1978; Lovell, 1980).

Morgan (1976, 8), Gundlach and Gesell (1979), and Cronbach and Snow, (1977, 510), reported that few studies relating cognitive differentiation and creativity exist. Guilford (1980) noted that Witkin's field independence is a tendency to seek or produce transformations, and that a few studies have found field independence positively related to a combination of divergent thinking tests, including Consequences remote (CQ-R), which is a measure of divergent production of semantic transformations (DMT).

Two Brain Hemispheres: Integrating Lateral and Vertical Thinking

Recent literature in education and psychology indicated interest in the implications for learning of brain hemisphere research. Humans possess two different, complementary and highly integrated ways of processing information, a linear mode for analyzing the components of patterns (left brain), and a spatial-relational mode that seeks and builds patterns (right brain) (Hampden-Turner, 1981; McLendon, 1982; Levy, 1983; Williams, 1983). The epilepsy-related exploratory research of neurophysiologists, performing the commissurotomy (split brain) operation by cutting the corpus callosum, has revealed the respective properties and the cortical interconnectedness of the left and right hemispheres. The left brain exhibits verbalizing, counting, analyzing, logical processing, timing and sequencing, whereas the right brain exhibits holistic, metaphorical, intuitive, spatial-relational tendencies (Turner, 1978; McLendon, 1982; Williams,

1983, 26).

As task complexity increases, bilateral hemispheric engagement also increases. Cerebral lateralization occurs with the propositional left lobe relating intermittently with the appositional right (Levy, 1983, 70; Simon, 1983, 24). Finding and solving complex problems requires the interactivity of both cerebral hemispheres.

Young (1979) concluded that unless we interactively use the whole brain we work against ourselves without knowing it. Argyris (1976, 1982) described this phenomenon as single-loop learning, meaning inability to learn, no transformation, and being unaware that learning has not taken place. This ignorance blocks the double-loop learning process, which is evidenced by change in behavior and improved performance.

Economic and educational organizations, and society in general, have tended not to recognize the multimodal properties of the brain, while emphasizing logical, left hemispheric learning and performance at the expense of the relational, intuitive and nonrational right. The evidence strongly disputes the idea that we learn with one side of the brain. The creative processes associated with the right brain are as imperative for learning and problem solving as are logical or convergent thinking (Battista, 1976; Mintzberg, 1976; Levy, 1983; Hart, 1983).

Studies of open-ended mental activity, indicated that the characteristics associated with creativity and divergency (fluency, flexibility, originality, redefinition, transformation, elaboration) are predominantly right hemisphere functions (Turner, 1978; Dirkes,

1978, 816). Training in divergent or lateral thinking should serve to open avenues from hemisphere to hemisphere, right to left, for example, by feeding new stimuli and ideas into the analytic, linear and evaluative functions, thus obtaining the iterative use of both brain modes. To the extent that logical processes interfere with creativity and learning, we should try to design educational settings and methods that are brain compatible and not antagonistic (Hart, 1983, 39).

Until recently, most instructional methods used in training settings, to consciously effect learning and problem solving, have been founded predominantly upon left-brain, linear hemispheric premises and functioning. There is evidence of the need to teach multimodal or interactive strategies for learning, decision making and problem solving (Turner, 1978; Young, 1979; Hart, 1983). Sadler and Whimbey (1979, 2-3), called for innovative teaching and intelligence training in reporting that many college students have been found to rely on rote memory without having gained understanding and the ability to transfer learning.

Training Research in Intelligence, Creativity and Divergent Thinking

The work of a number of researchers (Cronbach and Snow, 1977, 155; Hocevar, 1979a, 1979b; Pellegrino and Glaser, 1979; Sternberg, 1982, 981, 986) has indicated continuing interest in Guilford's factor analysis work and the SI matrix model. Sternberg (1978a, 1978b; 1981, 1181) incorporated elements similar to Guilford's primary abilities

matrix theory into his own research and theory on cognitive correlates and components, in relation to the need to improve intelligence (Detenman and Sternberg, 1982).

Among Sternberg's (1981) four approaches to understanding mental abilities, he included cognitive training as a fundamental area of study and research in the field of cognitive psychology. But, he warned, training should not be undertaken without the theoretical foundations of cognitive correlates and cognitive components research, which serve to validate sub-theories of intelligence (for example, divergence, field independence), and which are tested by the cognitive training approach.

The cognitive correlates phase, according to Pellegrino and Glaser (1979), is the area where Guilford's factor analysis work is concentrated. On the other hand, cognitive components research is task analytic and investigates the complexities, arising from the results of correlational inquiry, in identifying information processing components of performance on tasks generally used for assessing mental abilities, that is, checking on what factor tests measure. In this research context, Guilford's factor-analyzed, primary mental ability constructs (the dimensions of the SI matrix), and his tests for different, but often overlapping thinking attributes, are cognitive correlation procedures which serve to indicate where training and remediation should take place. Simultaneous analysis, to pinpoint specific thinking strengths and deficiencies would occur under diagnostic cognitive components research (Sternberg, 1978a; 1981).

At the cognitive correlation level, training in processes of intelligent activity has been fairly widely researched, and it is generally held that there are complexes of skills which can be acquired to improve creativity and productive thinking (Ridley and Birney, 1967; Khatena, 1971; Rosenburger, 1978; Durio, 1978; Shean, 1977; Hutchins, 1979; Riley, 1982; Haley, 1982; Burr, 1982; Coulson, 1983). Some theorists have concluded that intelligence can be taught, learned and increased (Sadler and Whimbey, 1979, 3; Detterman and Sternberg, 1982; Sternberg, 1982, xii). Whimbey (1975, 14) commented on, "...the neglect of systematic research into the development and training of the mental capacities that are now measurable with fair accuracy by psychometrics."

A number of studies have determined that training in creative thinking strategies, of which lateral and divergent thinking are a subset, can result in significant increases in idea generating skills (Durio, 1978; Shean, 1977; Coll, 1981), and in problem solving skills (Klawiter, 1976; Rosenthal, 1977b; Rosenburger, 1978; Hutchins, 1979; Haley, 1982).

Some researchers have provided evidence supporting the relative effectiveness of short term training episodes, ranging from 20 minutes to 15 hours (Ridley and Birney, 1967; Klawiter, 1976; Rosenthal, 1977, 1977a; Hutchins, 1979; Shean, 1977). Renzulli (1977) and Mansfield et. al. (1978) questioned the effectiveness of short term training workshops, but concluded that if the instructional materials were well designed and presented, the results can be surprising, as in the case of Khatena's (1971), Rosenthal's (1977a) and Hutchins' (1979)

2 hour episodes. In a cognitive trait study, Rokeach (1971, 455-8) concluded that relatively enduring changes in values, attitudes and behavior can be brought about as a result of rather brief experimental treatments.

The majority of the training studies reviewed had small N , ranging from 20 to 90; reflecting, in part the difficulty of obtaining and managing large numbers of subjects in experimental creativity training research, especially where adults are involved. Small sample size can result in problems related to statistical power and reliability or generalizability.

The literature review revealed little use of the multiple regression statistic, which permits the inclusion of several discrete and continuous independent or moderator variables. Approximately half the creativity research studies consulted were correlational and non-experimental, using Pearson r and factor analysis statistics. Most of the experimental studies consulted utilized the t statistic or one-way ANOVA, with a lesser number of multiple factor ANOVA studies.

Two studies (Hutchins, 1979 and Coll, 1981), seriously attended to interaction analysis, and Coll employed a multiple factor analysis of variance (MANOVA) design. In the single nonexperimental study reviewed, Burr (1982) employed one way analysis of variance in the study proper, and multiple regression for post hoc analysis only.

In every case, of twenty research reports directly relevant to the present study, and reviewed in detail, the difficulties of maintaining control and power in creativity training research were etched in the research design, the selection of statistical method, and the results

(Jeroski, 1982, 87-89). Significant effects for training were reported in almost every study consulted, with most setting an .05 level of probability. On the other hand, the effects of different treatment levels (methods, materials, settings...) were, in most cases, declared nonsignificant, and without analysis of possible interactive implications.

Riley's (1982) work, drew attention to the importance of the selection and development of instruments for measuring training and the preparation of instructional formats and materials. The problem of pilot studies not being included in research planning is common, and, hence, tests and materials are not checked as thoroughly as they ideally should be prior to use in formalized research settings (Cronbach and Snow, 1977). Where instructional materials and batteries of tests are derived from prepared packages, there are problems of selection, comparability, and validity and reliability of tests and of training content and method. Most creativity research studies located in the literature review, and those reported here, used combinations of Torrance and Parnes materials and Torrance and Guilford tests.

The following brief reports, on selected experimental studies, explore basic elements pertinent to the present study: training time, numbers and types of subjects, key components of research design, statistical model, type and source of training materials, methods used, tests employed, significant and nonsignificant results, and particular problems and researcher conclusions.

The major proportion of research and theoretical studies in the field of creativity are of school age children, high school students and college students. Few studies have been done of adult learners, mainly school teachers and administrators. Illustrative of the studies involving children, Golub and Hahn (1983) worked with grade three children ($N = 48$), in a 16 hour (four, 30 minute sessions over eight weeks) training program on teaching creativity in open versus closed classrooms, in experimental and control conditions. A collection of exercises selected from the works of Parnes, Osborn, Torrance and Myers were presented to the experimental group. A battery of Torrance tests for fluency, flexibility, originality and elaboration was employed on a pre and post test basis. Using a series of t tests, the researchers found significant ($p < .01$) differences for the experimentally treated traditional and open groups, over control groups, on all measures. They concluded that creativity training facilitates growth and expression, and the open experimental condition offered achievement advantages over the traditional experimental condition.

Another example of research set in the school environment, and the single reference located which employed deBono concepts and techniques and Guilford tests, Klawiter, (1976) studied high school students to assess the effects of training in lateral thinking concepts and techniques. He distilled deBono (1970) materials into a sequence of 8 one hour lesson plans which he presented to the treatment group, while instructing the control group in the normal program of studies. The three dependent variables, problem solving, flexibility and dogmatism,

were measured by a battery comprised of three Guilford tests (Alternate Uses, Plot Titles, Match Problems), the Rokeach Dogmatism Scale and the California Psychological Flexibility Inventory.

Klawiter employed random assignment, a posttest only design, and the t statistic and canonical correlation, in obtaining significant results ($p < .05$) for the experimental ($N = 20$) over the control ($N = 20$) group in problem solving, but not for either flexibility or dogmatism. He concluded that, while training in lateral thinking served to reject the null hypothesis on problem solving, it would appear easier to teach a subject a particular way of performing a task than to modify the way a subject habitually approaches a task.

In a study of college students ($N = 90$; 53 male/37 female), Rosenthal et. al. (1977) used deBono's (1976) Cognitive Research Trust (CORT) techniques in lesson (skill centered) vs. lecture (topic centered) settings. Rosenthal and associates employed Torrance Tests of Creative Thinking in finding that short time (40 minute) creativity training is more effective when deliberate teaching strategies are used and students have the opportunity to practice the principles taught. The pretest-posttest 2x2 ANOVA design, with random assignment of subjects, found a main effect for lesson over lecture in both high and low divergent subjects, but no significant difference ($p < .05$) in the sex variable. Rosenthal, in this and a subsequent study (1977a) claimed the results gave evidence to the effectiveness of deBono's lateral thinking concepts and techniques.

Moving more in the direction of adult training, Rosenberger (1978) conducted a study ($N = 141$) of preservice student teachers randomly assigned to training (12 hours over 6 weeks), of self versus directed versus no instruction, in which she exposed the two levels of the experimental group (self and directed) to a researcher-developed module of creative thinking and problem solving. By means of Torrance Tests of Creative Thinking, Rosenberger used a (3×2) analysis of variance statistic (ANOVA) in establishing a significant main effect for training ($p < .10$) for instruction on verbal, figural and total creativity of subjects. Of the levels of the experimental group, there was no significant difference between instructor taught and self taught, leading the researcher to conclude that the training module was appropriate in both situations, and that specific training programs can develop competence in creative thinking and facilitate the creative process.

Hutchins (1979) conducted a 2×2 ANOVA study of prospective teachers trained in creative problem solving skills on two levels, structured and unstructured, and two different types of materials, common problems and instructional problems, versus those trained in another skill. Employing a 5 hour Parnes-Osborn brain storming training program, condensed into a 2 hour episode, Hutchins reported significant main effects for training, with the four groups significantly superior ($p < .01$) to the control group on both fluency and originality outcome variables. Interaction effects among the four experimental groups indicated that no one group performed

significantly better than the other. Unstructured groups produced greater fluency, but not originality, than structured groups.

In a study of thinking styles among an intact group of volunteer, randomly assigned, college students ($N = 133$; 71 male/63 female), Coll (1981) compared four conceptual levels (concrete to abstract, 1-4) with two environment factors, (structured versus unstructured task instructions) and two levels of task administrator (low and high status) on fluency, flexibility and originality factors derived from Torrance tests of consequences. By means of multivariate analysis (MANOVA 4x2x2) Coll reported no significant main or interaction relationships of scores on the three dependent variable measures with conceptual level, status or structure. The classification of thinking styles failed to discriminate in terms of the manipulated treatment variable environment-status factors. Ex post facto, univariate ANOVA did reveal some main effects on levels by treatment. Coll's use of MANOVA points out the risk of employing multivariate analysis and eliminating main effects claimed by one-way ANOVA.

Of the relatively small number of studies located on creativity or divergent thinking with adult subjects (Jenkins, 1967; Khatena, 1971; McGruder, 1972; Bowers, 1972; Grimsley, 1973; McCuistan, 1974; Coulson and Strickland, 1983), three (Shean, 1977; Burr, 1982 and Riley, 1982) merit comment in relation to the purposes of the present study.

Shean (1977), working with adult professionals in an educational administration graduate program ($N = 51$; 32 experimental, 19 control) employed a 15 hour Parnes Creative Problem Solving Institute (CPSI) sequence to gauge the effect of treatment on creative production as

measured by Torrance Tests of Creative Thinking (fluency, flexibility and originality), and Likert Scales of Organizational Perception. Shean reported highly significant results for the experimentally trained group on the Torrance tests, given six months after training, indicating a high level of retention. Shean's study, a quasi-experimental design (pretest, posttest, nonequivalent control group design) was statistically treated with one way ANOVA on the three (fluency, flexibility and originality) dependent variables, and a Pearson r on the organizational perception test. Given a probability level of .05, Shean's results indicated a main effect for training ($p < .001$) on all three dependent variables, with the null hypotheses accepted in the case of organizing perceptions. The research design reflected some problems, particularly small numbers and time lapse from training to testing. The researcher obtained data on gender, age and major studies, but did not submit these factors to statistical analysis.

In one of only two studies located on creativity training and competency-based (CB) methodology, Riley (1982) described a teacher education program for creative problem solving, and critiqued the Rosenberger (1978) and Hutchins (1979) studies for failing to demonstrate a connection between creative thinking abilities and classroom teaching performance, and for not undertaking a pilot study to test the reliability and validity of the methods materials and measures. In an earlier study, Riley (1980) reported that his competency-based Creativity Teaching Dilemma instrument gauged specific problem solving performance in observable behaviors; and that

the abilities measured can be enhanced through creativity training.

In a study of the effectiveness of SI training on divergent production, Burr (1982) employed Meeker's Structure of Intellect Learning Abilities Test to gauge performance on 24 variables related to Guilford's SI model. This ex post facto design involved an intact sample of graduate teachers ($N = 134$), in three pre-study conditions: SI trained, training in working with gifted children, and no similar training. Employing one way ANOVA for subject differences, on divergent dependent variable scores, Burr found that the cognitively taught SI group was significantly better ($p < .01$) than the other two groups on quality (originality), but that there was no significant difference among the three groups on quantity of production or fluency. Burr employed multiple regression for post hoc analysis of relationships among creativity rating scores, demographic data and inter-rater reliability.

Adult Education, Learning and Cognitive Styles

Peters (1980) emphasized the importance of introducing organizational models, particularly open systems thinking, into the field of continuing and adult education. Complex problems, including the impacts of restraint, professional obsolescence and an aging population, demand imaginative response from continuing educators. While the acquisition of information is important in managing both restraint and obsolescence, the greater professional development need

is for behavioral change, effected by the diagnosis of individual differences, self-directed learning, and access to a range of learning opportunities (Grabowski, 1981, 91-2).

Long (1980, 2) reported that there is a substantial body of knowledge on the intellectual abilities of adults; however, the literature of adult education and psychology provides little insight into questions concerning adult cognition. McCrary and Long (1980, 41) held that training should be shown to affect operational structures instead of involving only independently learned skills. For example, if adult subjects classified as concrete thinkers demonstrated abstract thinking on post-training transfer tasks, a case for environmental stimulation (training) will have been made.

In a review of the literature on the effectiveness of creativity training with adults, Mansfield et. al. (1978, 532) concluded that existing research with adult professionals failed to produce evidence for the criterion-related validity of most divergent thinking tests. Among design problems noted were short term training, small samples, inadequate controls on instructors, and the complexity of the research task.

Long's (1980, 1980a, 1983; McCrary and Long, 1980) interest in a theory of adult cognitive development, related to environmental stimulation (training) in adult learning, identified a role for research in cognitive psychology, adult intelligence and creativity. Sargent (1979) reasoned that the curriculum of adult education needs to include systematic options in areas untouched by years of schooling and socializing: psychological education and personality development,

skills of interpersonal competence, communications skills and idea generating, problem finding, decision making and problem solving skills. Lovell (1980, 105-8) stressed the need to expand the psychology of adult learning to investigate the intellectual development of adults at all ages, and to incorporate the study of productive thinking and cognitive styles. Cognitive styles influence the way people approach learning and working tasks, and a particular style or method of organizing, administering or teaching will not suit all people equally. Training in productive thinking insures that the individual adult learner will approach the self-education ideal, to learn how to learn, and to improve his or her capacity to adapt to change.

Little (1979, 17) noted that the characteristics of the learner (individual differences), and the types of learning outcomes expected, influenced the independence-dependence dimension of the training process; that is, the amount of guidance required, and the appropriate methodology, techniques and materials. In some learning situations, and for some individuals, close guidance (competency-based) of individual learners is appropriate; whereas, in other situations more experiential (developmentally-based) methods are appropriate. In the first instance the predominant view is directive, in the second exploratory.

With Mansfield's warning in mind, the concern, expressed in the ideas of Long, Lovell, Sargent and Little, to further the development of the psychology of adult learning, supports the projection of adult education and training research into the area of aptitude or trait by

treatment interaction studies. The planning process for adult education and training is aided by knowledge of the cognitive variability of adult learners, and appropriate methodologies for different individuals and different learning tasks.

Age and gender factors. Psychologists, gerontologists and adult educators are exploring the effects of aging on many facets of life and adult learning. New questions on creativity and problem solving have been introduced. Riegel (1973) and Arlin (1975, 1976) projected a fifth or dialectic stage as an extension of the Piaget's developmental theory (Flavell, 1963; Azima and Henry, 1980). Their concern was that the final, formal stage of cognitive development appeared to deny continuous growth into adulthood. Piaget's formal stage, based mainly on problem solving ability, peaks during late adolescence, and is linked more with fluid (natural) ability as distinct from crystallized (socially learned) intelligence (Flavell, 1963). It has been recognized that cognitive growth and creativity continue throughout the phases of adulthood (Kogan, 1973; Gruber and Barrett, 1973; Lovell, 1980; Long 1980a). Arlin (1976) described the post-formal stage in adult intellectual development in terms of creative or divergent thinking:

This fifth stage, the problem-finding stage may best be characterized as creative thought, the envisaging of new questions, and the discovery of new heuristics in adult thought.

On the subject of the developmental phases of intelligence and adulthood Guilford (1967, 468), stated:

Whereas formerly it was believed that (intellectual) maturity is reached in the teens, with the use of tests of other kinds of abilities, such as those in the divergent production

category, it is now apparent that mature maxima might not be reached until the age of thirty and beyond.

Environmental stimulation and educational initiatives, with multiple approaches, offer the promise of stimulating changes in adult cognition for advancing decision making and problem solving for individual and organizational ends (Birren and Woodruff, 1973; Guilford, 1979, 37; McCrary and Long (1980, 33).

Andrulis' (1977) work found that subjects (ages 25-58) responded more slowly to test items with increasing age, and that this tendency is related to several phenomena, loss of physiological capacities and becoming more conservative and reflective. He reported that research on life stages is opening up questions of the relationships between, for example, the reflection-impulsivity and other trait or aptitude variables, as well as instructional variables. Alpaugh (1976) concluded that the peak years of creative performance are ages 40-45, when subjects are more secure in their professions as distinct from younger and older groups. And Jaquish and Ripple (1981, 117) found middle-aged adults performed better on all measures of divergent thinking, concurring with Levinson's (1978) theory that creative abilities may be optimally realized as individuals resolve the great polarities of mid-life development.

Alpaugh and Birren (1977, 242) found that divergent thinking in older subjects, as evidenced by a battery of Guilford's tests, and preference for complexity, declined with age, but that these decrements were not due to diminished intelligence. They noted that entering the age variable into a regression equation is a significant factor when IQ is statistically controlled. Jaquish and Ripple (1981,

81) found that age did not differentiate the ability to be original in a clever way, and divergent thinking abilities did not follow a linear age decrement model.

The literature of psychology and education has been profoundly influenced by the matter of gender-related differentials. Gender, along with race and socio-economic class, may be one of the most studied variables in psychology and education.

From experience and research we know that...men and women have grown up in two different cultures in which certain behaviors are more prevalent and acceptable when expressed by men and others are allowed and rewarded for women (Sargent, 1979, 73).

In males this socialized gender differential values competitiveness, power and coolness, and relates to the left brain, logical, rational approach to problem solving. Women are characterized as predominantly right brain, expressive, considerate and compromising. Men are stereotyped as task-oriented, women as affect-oriented (Sargent, 1979, 73-4).

In the field independence - field dependence cognitive style dimension, male characteristics are related more to independence (more constant) and female to dependence (more changeable) (Witkin, 1971, 1978, 18-19). To the degree that left brain phenomena are associated with field independence and right brain with field dependence, it might be inferred that men tend to be analytical, vertical thinkers, whereas women tend to be intuitive, lateral thinkers (McLendon, 1982). Levy (1983, 70) reported that solving problems in changing circumstances requires the cerebral lateralization activities of both hemispheres. In this connection, Sargent (1979) pointed out the adult

education interest in the learning phenomenon identified as "androgynous behavior", in which both genders are encouraged to express "masculine" independence and "feminine" nurturance and spontaneity. The model of androgynous behavior suggests the values to both females and males, of integrated skills for being a whole person, the full range of which are essential to the problem solving demands of both instrumental and expressive behavior.

Methods in adult learning. In developing his theory of method, Verner (1962, 1975, 180) declared that the demands for behavioral change on individuals is too important to be left to chance. An institution (or an individual) that fails to adapt its methods to existing patterns and new demands will be superceded by more open institutions able to adjust to the changed patterns of association in society (Verner, 1975, 191).

Methods, according to Verner's (1975, 187) typology, are the ways or strategies by which institutions serve their clientele, the administrative processes for devising formalized instructional settings for individuals. His model identified two group methods related, respectively, to the competency-based and the developmentally-based approaches to instruction:

1. Group method - class (competency-based) - sequence of learning experiences arranged in systematic order, with the agent charged specifically to direct and control the learning experience, and which focuses on individual learning in a class setting for content mastery
2. Group method - discussion group (developmentally-based) - sequence of learning experiences in which the predominant technique is small group discussion, with the responsibility for learning shared by the learner, the group and the agent.

A workshop, in Verner's definition is a concentrated, limited time activity in which varied techniques may be employed. Techniques comprise an array of tactical elements to vary communication between agent and learner, for example: lecture, programed instruction, group discussion, and simulation.

Competency-based and Developmentally-Based Learning

Mitchell and Spady (1978) identified four broad themes characterizing the role of education in society:

- 1) Social responsibility - concern for consequences of actions and welfare of others and society as a whole.
- 2) Social integration - concern for interaction among individuals from varying social and cultural groups through collective activities.
- 3) Competency - concern for promoting and certifying achievement.
- 4) Development - concern for the fullest expression of an individual's physical, affective and mental capacities.

The four constructs are not mutually exclusive, but they are identifiably different. The competency-based (CB) and developmentally-based (DB) conceptual models for organizing training, Mitchell and Spady's third and fourth classifications, represent essentially different methods for training research on learning style preferences.

Competency-based education (CB) requires a set of administrative structures and practices geared to treat the framing and attainment of outcomes or certification as the primary basis of intellectual planning and objectives. Major procedural operations, decisions and

opportunities for instructor and learner are based on explicitly stated goals, objectives, tasks and tests. This shift, from a traditional norm-referenced system to one based on criterion-referenced standards, programed material, and directive instruction, emphasizes the importance of insuring competency in individual skill development (McGregor and Little, 1983).

Goals and objectives take on a new importance as they are made more explicit and are operationally defined in terms of actual competencies and capacities which learners are expected to develop and demonstrate (Spady, 1978, 19).

The concern for standards, skill development and outcome in the CB mode is different from the DB emphasis on process, potential and individual experience in flexible learning environments and small group settings. The main thrust of the developmentally-based approach to learning and training involves concentrating upon student learning and capacities for self-fulfillment, (Mitchell and Spady, 1978, 13-14). The goal is the quality of engagement in the learning experience, with instruction and supervision of a guiding and facilitative nature. Two modes of DB education may be identified: cognitive development and humanistic development. On the intellectual or cognitive side, the focus is on advancing unique personal excellence. The humanistic character of the developmental approach, and the factor which strikes the contrast with the CB approach, is seen in the affective concern for linking instruction and acculturation in expanding the experiential and social capacities of learners.

The competency-based and the developmentally-based approaches are both essential in the empowerment of individuals, and they are different concepts for learning.

Multiple Regression (MR) and Interaction Analysis

For multiple regression analysis, Kerlinger and Pedhazur (1973, 441-2) noted that variables should be as few as possible, and entered into the equation on the basis of theory because partial correlations vary with different ordering. Ideally, a regression equation should have 100 or more subjects per treatment. With large samples and few independent variables the regression weights are fairly reliable, and MR can be a good predictor of performance on outcome variables in the testing of research hypotheses (Kerlinger and Pedhazur, 1973, 442, 446, 363).

Pedhazur (1983, 7) summarized the flexibility and comprehensiveness of the multiple regression for interaction analysis:

Combinations of continuous and categorical variables may be used in various designs for different purposes. For example, in an experiment with several treatments (a categorical variable) aptitudes of subjects (a continuous variable) may be used in order to study the interaction between these variables in their effect on a dependent variable. This is an example of an aptitude by treatment (ATI) interaction design ... or, aptitudes may be used to control for individual differences as in analysis of covariance.

Multiple regression is fundamentally similar to ANOVA and MANOVA, but the regression technique also has certain advantages for statistical analysis. One important capability of MR is in the handling of unequal cell numbers by means of adjusting for the effects

on the correlation coefficients, a process of weighting. Whereas ANOVA and MANOVA treatment by levels designs result in the categorization of continuous variables, and the accordant loss of data which discards variance, MR is able to retain the variance. In addition, MR can handle more independent variables, both discrete and continuous (Kerlinger and Pedhazur, 1973, 7-8; Pedhazur, 1983, 7-8).

Interaction analysis. The volume of research on learning, instruction and individual differences is enormous, but limited progress has been made toward an integrated understanding of the nature of individual differences in ability to learn. Adjusting to individual differences implies: (a) adaptation of educational practices, which, at present, has not been well documented by studies of the relationships between cognitive or learning styles; and, (b) the need to enhance or to change these styles through the provision of optional settings, methods, content and techniques (Kerlinger and Pedhazur, 1973, 240; Cronbach and Snow, 1978, 85; Guilford, 1979a; Pedhazur, 1983).

An aptitude treatment interaction is considered to be demonstrated wherever the regression of outcome from one treatment differs in slope from the regression of outcome from another upon a measure of some pretreatment characteristic of the learner (Jeroski, 1982, 85).

Kerlinger and Pedhazur (1973, 240) and Pedhazur (1983, 7) urged researchers to look for interactions among independent variables, in order to explore what works best under various circumstances, otherwise certain relations might go unnoticed. They stressed the need to search for optimal learning conditions for different types of people, for subjects with different levels of intelligence, different

cognitive strategies and different ages. Where competing methods of instruction exist in a field, an investigator may accept the treatment as fixed, and select organismic or aptitude variables on the basis of theory, and in terms of learner skills, styles or characteristics (Cronbach and Snow, 1977).

Jeroski (1982, 91) warned that all too often treatments suffer from brevity and artificiality. Cronbach and Snow (1977, 44) noted that aptitude treatment interaction research to improve education should be of considerable duration; however, when testing hypotheses derived from theory, short, sharp treatments are in order.

Jeroski (1982, 92) reported that when Cronbach and Snow examined ATI research by content area, they found little on productive kinds of thought. Their interest in creativity research was demonstrated by their review of Guilford's work (Cronbach and Snow, 1977, 160).

It is a task for research to inform the design of instruction, so that cognitive style and other variables can be identified, matched with learning or training conditions and developed or changed. To become more skilled at memory tasks, divergent thinking, or field independence, to the extent possible in every individual, is a vital aim for quality education, or as Cronbach and Snow (1977, vii) put it, "...probable losers must be converted to winners."

Summary

The main pattern of thought, pursued throughout the literature review, was characterized by continual reference to training in productive thinking skills to improve the decision making and problem solving abilities of individuals in organizational settings.

A fundamental component of productive thinking, the divergent operation, was projected as essential to creativity training for productive thinking to stimulate organizational redevelopment through the generation of new ideas.

The review dealt with three levels of research and theory on developing intellectual skills:

1. That which has evolved into established theory, and which formed the foundation for the present study, as exemplified by the works of Argyris, Cornell, van Gich, Simon, Guilford, Witkin, Sternberg and Cronbach and Snow.
2. That which has emerged as important developmental and transitional work, and which was selectively incorporated: (a) to illustrate new directions and possibilities for creativity training; and, (b) to support the selection of variables for study, as exemplified by the works of deBono, Long, Mitchell and Spady, Reigel and Arlin, Getzels, and Hocevar.
3. That which represented specific experimental interests in cognitive training, instructional techniques and methods, and research designs and statistical models, as represented in the

research reports of Rosenthal, Riley, Dirkes, Alpaugh, Gundlach and Gesell, Klawiter, Rosenberger and Coll.

The analysis of research reports revealed the emergent nature of creativity training research. Few studies have been done on divergent thinking, and very few with adult subjects. Existing research in training for creative thinking provides useful information for the design of multiple regression studies incorporating treatment and individual difference variables for both main effects and interaction analysis.

In addition to providing a background of issues and organizational theory, the literature review concentrated on cognitive psychology and creativity training and presented an information base for the selection of variables for the present study.

Treatment variables. The research results reported in the literature generally supported the effectiveness of training in divergent and lateral thinking, in treatment over control groups, on tests comprised of divergent thinking problems. The present study aimed at supplementing this research by hypothesizing a significant effect ($p < .05$) for training in lateral thinking on divergent production, over training in vertical thinking. Further, it was hypothesized that training continuing educators in lateral thinking on a competency-based method would result in significantly better performance than training in lateral thinking on a developmentally-based method. This reasoning was based on the expectation that a directive approach, in a short training session, would impart concepts and techniques more efficiently than a nondirective approach.

Moderator variables. The moderator variables were selected to represent aptitude and organismic factors for inclusion as individual difference variables in the regression equation, to test for possible main effects and to explore interactions. Field independence was identified as a well-researched aptitude, with limited indication of positive correlation with intelligence and divergence thinking. This study supported and tested that claim. A limited amount of information indicated subjects of middle career-age were more productive in their thinking than younger or older subjects. Using age as a proxy for years in career, this study tested the mid-career thesis. The lack of research comparing male and female adult professionals on divergent production resulted in a decision to include the gender variable as a question, but not as a directional hypothesis.

Dependent variables. Four dependent variables were revised from the factor components of three Guilford tests of divergent thinking. (See Table 1). In relation to Hocevar's (1979b) finding on the compounding of fluency with originality, and to secure discriminant validity in assessing originality, two of the component dependent variables were modified, one by means of weighting (creativity) and one by ratio (originality). Two other component dependent variables were selected as unweighted straight counts of fluency and flexibility.

The methodology employed in this study is presented in Chapter III.

CHAPTER III

METHODOLOGY OF STUDY

There are three sections to Chapter III, the first section is on the design of the study, the second section is on procedures for analyzing data and the third section is on instrumentation.

Design of Study

This section is comprised of information on the population and sampling methods, the nature of the research design, the experimental setting and training programs for the three research-workshop groups, and the preliminary study.

Population and Sample

The population for the study was comprised of professional continuing educators in the Province of British Columbia. All but five volunteer participants came from the Greater Vancouver area. Subjects were members of professional associations for continuing education and/or faculty members of institutional divisions for continuing and adult education.

Survey and announcements

A career development survey was designed and conducted to obtain the interest of continuing educators in the research study-workshop on "Decision Making". The invitation-surveys were mailed to 600 members of six British Columbia associations for adult and continuing education: Pacific Association for Continuing Education, B.C.; Society for Training and Development; B.C. Vocational Association, Adult Special Education Association of B.C.; Adult Basic Education Association of B.C.; B.C. Association of Continuing Education Administrators.

Following the approximate breakdown of the mailing lists, 66% went to members in the Greater Vancouver area, and 33% to members in centers throughout the province.

The aim of the combined workshop invitation and survey was to:

1. Interest potential volunteers to participate in a professional development workshop-research study on the subject of "Decision Making"
2. Collect demographic data on sex, age, major studies, professional classification, degrees and specialized training
3. Obtain views and case studies on issues and problems in the field of continuing education
4. Obtain information on familiarity with the field of cognitive psychology and with deBono's works

Completed responses from the mailing of the 600 surveys numbered 97, with 22 returned as undelivered, a 97/578 or 16% return. A reminder letter brought little additional response. Of the 97 survey returns, 51 volunteers were obtained. Of these, 12 were randomly assigned to the preliminary study group, and the other 39 included in

the pool of subjects for the treatment and control groups.

In order to increase the number of subjects, a second effort was required. The researcher contacted senior administrators in eight institutions of higher education, in the Greater Vancouver area, containing divisions of continuing education. Upon clearance, letters of invitation and announcements of the research workshops were distributed to faculty members. This appeal resulted in 61 volunteers, added to the group of 39 to form a pool of 100.

Random assignment process

The 100 volunteer subjects were randomly assigned, by age group and gender, to three groups, and the three groups randomly assigned to the two treatment and one control workshop conditions. Of the 100 potential subjects, eight cancelled in the week prior to the workshop, two left the developmentally-based workshop before the posttests, and sixteen failed to attend on the day, totalling a 26% dropout rate.

Numbers for each workshop are summarized in Table 2.

Table 2

Total Number of Subjects and Breakdown of Workshops by Group and Gender

		Female	Male
1. Experimental Treatment Group (ETCB)	29	17	12
2. Experimental Treatment Group (ETDB)	23	18	5
3. Control Group (C)	22	14	8
Total subjects	<u>74</u>	<u>49</u>	<u>25</u>

As can be seen in Table 2, of the 74 subjects, 29 were in the competency-based treatment group, 23 in the developmentally-based treatment group and 22 in the control group. Forty-nine of the subjects were female (66.2%) and 25 were male (33.8%).

Additional demographic data on the nature of the sample was gathered. Ages ranged from 26 to 66 years. By academic concentration, 25 subjects had social science backgrounds, 15 humanities and 25 science and applied science, with 9 subjects classified as "other". Thirty subjects were classified as administrators, 28 subjects as instructors, and 16 subjects were either private consultants, technicians or part time instructors. All but three subjects possessed a university degree. Sixty-seven subjects were regularly employed in institutions of higher education. Six subjects were independent consultants, and one was a part time instructor.

The random assignment plan for the original 100 potential subjects divided them into four age groups, approximately equivalent in numbers by gender. Table 3 reports the four age group classification, which was originally designed to divide the larger, middle career-age group into two groups, equivalent in size to younger and older groups, and considering the age spread of the fewer male subjects. This four part classification was used for the stratified random assignment and in the regression interaction analysis.

Table 3

Four Age Group Classification for Random Assignment of Subjects

Group	Classification	N	Female	Male
Group #1	- less than or equal to 35	20	15	5
Group #2	- greater than 35; less than 40*	18	11	7
Group #3	- greater than 40; less than 45*	19	15	4
Group #4	- greater than 45	17	8	9
		<u>74</u>	= <u>49</u>	+ <u>25</u>

* or equal to

As can be seen from Tables 2 and 3, the 74 subjects attending the three workshops were nearly equally distributed across the four age groups, with the ratio of females to males greater for Groups 1 and 3 than for Groups 2 and 4.

Research Design Elements

In the traditional research design classification, this study is a "quasi-experimental, posttest only, control group design" (Campbell and Stanley, 1966; Tuckman, 1978). The designation "quasi" was considered necessary due to the voluntary participation, the limited number of subjects, and the modified nature of the random assignment. A schematic of the study design is presented in Table 4.

Table 4

Basic Research Design of Study

Assign	Treat	Test	
R	ET(CB)	O ₁	- Lateral thinking (CB)
R	ET(DB)	O ₂	- Lateral thinking (DB)
R	C	O ₃	- Vertical thinking

Note: CB = Competency-based method
 DB = Developmentally-based method
 C = Control group
 ET = Experimental treatment group
 R = Random assignment
 O = Battery of three divergent thinking tests

As can be seen in Table 4, there were two experimental treatment groups ET(CB) and ET(DB), and one control group (C). One strength of a posttest only model is control over the influence of the pretest on the posttest. In a short training experience, involving 4 hours of lateral thinking training in a total 6 hour workshop, the experience gained on a pretest of divergent thinking abilities could influence subject performance on the dependent variables. Table 9 gives details on the two cognitive ability tests, administered to all subjects prior to the workshop, and the three posttests.

Representative design. The environment within which a treatment takes place merits special consideration in training research studies. As a method of environmental control for validity and reliability, the present study was based on representative design (RD) theory. The RD concept involves planning an experiment to reflect, as

accurately as possible, the real life environments in which learning occurs, and the natural characteristics of the learners (Snow, 1974; Borg and Gall, 1983, 643). This natural approach to research planning was appropriate for attracting and retaining volunteer adult subjects, who came to the research setting with expectations and reservations, and who were free to leave.

Experimental Workshop Setting and Training Programs

In keeping with the principles of representative design, the setting and training programs were given special consideration as a natural basis for conducting the learning program and the testing. The sections that follow give details on the research-workshop context, deBono concepts and techniques and treatment and control group content and methods.

Research-workshop context. The three research settings were announced and presented as professional development workshops. The publicized "Decision Making" theme was addressed in the workshops through the introduction of the Systems Analysis Approach (SAA) model (Cornell, 1980), during the first hour of the presentation. For the two groups given training in lateral thinking, the emphasis was on the predecisional search and problem finding phases. For the control group the introduction emphasized the decisional, problem solving and evaluation phases.

The workshops were one-day, six hour, intensive learning experiences, located in a training institution with good standard instructional facilities. Routine workshop procedures were followed and the social context was considered in the provision of refreshments and lunch in settings adjacent to the classrooms.

The three workshops were held on two consecutive Saturdays, selected after a random sampling of potential subject preferences. The two workshops on the second Saturday were held in the same institutional setting, in similar classrooms, but in separate buildings to preclude contact between groups at breaks and during lunch.

Particular attention was given to test administration procedures, because of the importance of the testing to the research study, and the fact that testing would be the main event which differentiated the research component from the workshop.

Workshop framework. All three workshops were conducted on the basis of a similar outline of components:

1. Schedule - similar time frame, logistics, format
2. Prior and posttesting - identical tests, timing and administrative routines
3. Facilities - similar workshop meeting room settings
4. Materials and resources - similar in the sense that each group received sets of instructions, exercises, case studies and

readings, and experienced a learning program involving the use of chalkboard and/or flipcharts and overhead transparencies.

5. Evaluation and debriefing - all three groups participated in workshop evaluation and debriefing sessions.

Appendix D presents details on the three workshop programs - materials, timing and content, and samples of the instructor and facilitator guides.

Stages for training. The organization of the three workshops reflected five stages for training as outlined by deBono (1971, 156): (a) Interest (motivation); (b) Understanding (comprehension); (c) Practice (experimentation); (d) Skill (formulation); (e) Use (application).

Interest and motivation was cultivated in the pre-workshop contacts between researcher and volunteer, and by instructors in introducing concepts and techniques for lateral thinking. Understanding was enabled by means of the presentations, exercises and assessments of concepts and techniques. Practice opportunities were provided through problem exercises and case studies, and use was reflected in performance on the problems which comprised the battery of divergent thinking tests.

DeBono concepts and techniques. The content for the ET(CB) and ET(DB) workshops was derived from deBono's (1971) Lateral Thinking for Management: A Handbook of Creativity. The researcher selected the concepts and techniques listed in Table 5, and developed workshop

materials and instructors guides for the two treatment groups. The nature of deBono's lateral thinking work was explained in Chapter II, and Appendix A presents examples of instructional materials used in the two treatment workshops and definitions of the concepts.

Table 5

Selected deBono Concepts and Techniques

Concepts	Techniques/Skills
1. Vertical thinking	
2. Lateral thinking	
3. Dominant ideas	
4. Tethering factors	
5. Polarizing tendencies	
6. Breaking out of set patterns	1. Delaying judgment
	2. PO (Do not evaluate)
7. Initiating ideas	3. Reversal
	4. Intermediate Impossible
	5. Envelope/Random Word
	6. Cross-fertilization
	7. Brainstorming

As can be seen in Table 5, there were seven primary concepts and seven techniques, selected from deBono's (1971) handbook. Appendix D contains the Workshop Programs, indicating sections II and III of both the laterally-treated (CB and DB) workshops as the 4 hour period of intensive instruction.

Competency and developmentally-based methods. Both competency-based and developmentally-based approaches have been well established as distinct methods of instruction, equally important in

training. They are different methods and may appeal more or less to individuals whose learning styles vary, or as one or the other fits the circumstances of the learning tasks. The contrasting lists of concepts which guided the planning of the respective CB and DB workshop methods are presented as Table 6.

Table 6

Differentiating Competency-Based and Developmentally-Based Methods

Competency-based (CB)	Developmentally-based (DB)
1. higher structured	1. lower structured
2. more formalized	2. less formalized
3. less open	3. more open
4. instructional objectives	4. goal statement
5. outcome-oriented	5. process oriented
6. explicitly stated outcomes	6. implicit outcomes
7. criterion-referenced	7. norm-referenced
8. directive instructor	8. facilitative instructor
9. instructor-centered	9. client-centered
10. class method	10. group method
11. lecture-discussion technique	11. buzz group technique
12. systematic presentation	12. optional presentation
13. skill development	13. intellectual development
14. specific content/order	14. optional content/order
15. individualized	15. socialized

From Table 6 it is clear that the competency-based approach is characterized as highly-structured, formalized and instructor-directed. In contrast, the developmentally-based approach is characterized by low structure, less formality and client centered.

To maintain controlled differentiation between the competency and developmental methods, several steps were taken. One purpose of the Preliminary Study, reported in Chapter III, was to test the

competency-based guidelines. Observations by the researcher and an unobtrusive observer, resulted in the revision of competency-based guidelines to adhere closely to the provisions and routines of the CB method as set out in Table 6.

Based on the principles of the competency method, the researcher designed the workshop environment and program to adhere to the structured approach to learning. Appendix D contains comparative examples of extracts from the Instructor (CB) and Facilitator (DB) guidelines used in the conduct of the two workshops.

The researcher completed a course on the "Design of Competency-Based Instruction" prior to planning the research-workshops. The senior instructor for the competency-based workshop was a specialist in the field of instructional design. The researcher served as associate instructor. In the developmentally-based workshop the roles were reversed, the researcher served as the senior instructor, with the senior instructor for the CB group as associate. See Appendix E for complete research team roles.

Treatments

The two experimental treatment groups, ET(CB) and ET(DB), received training in lateral thinking concepts and techniques on two different methodological bases, on a competency-based (CB) method, and on a developmentally-based (DB) method. While the lateral thinking content and techniques presented were the same for both groups, as outlined in

Table 5, the method of presentation and practice differed, as given in the Table 6 contrast. ET(CB) was conducted on an individualized basis in class settings with directive instruction; ET(DB) was conducted on a facilitative learning basis, in small group settings.

In the following sections the experimental and control group treatments are discussed in terms of the workshop program and content.

Workshop program and content: ET(CB) Experimental treatment group - competency-based method. The CB instructor was guided by an instructional design "template", a sample page of which is given in Appendix D, consisting of specified instructional objectives, learning tasks for each concept and technique, and supportive materials. Presentation was based on an MGP model: Motivation - explain and inform; Guidance - lecture, demonstrate, question; Practice - problems, exercises and quizzes. Instruction was presented to the group as a class, with subjects working independently, as a class, or under the direct guidance of the instructors. There were no small group sessions.

The package of deBono materials distributed to subjects did not contain the instructor templates and related instructor materials. Samples of the lateral thinking materials given to the subjects in the two treatment groups (CB and DB) are included in Appendix A. The (CB) workshop schedule, material items and content is included in Appendix D.

Workshop program and content: ET(DB) Experimental treatment group - developmentally-based method. The ET(DB) material items were similar to the ET(CB) workshop materials given in Appendix A. In the DB method the instructors employed a flexible lesson plan, as presented in Appendix D, with students involved in the organization of the learning process. General goals were set, small groups formed and assignments shared. Instructors, as facilitators, initiated discussion on deBono concepts, presented visual demonstrations of lateral thinking techniques, answered questions and consulted with the small groups. Four groups of 5-6 participants engaged in discussions, readings and lateral thinking exercises. Within group exercises were shared with the whole group. Appendices A and D present samples of DB group materials and the workshop program.

Workshop program and content: C - Control Group - lecture and small group discussion methods. Adherence to the representative design principle called for control subjects to receive a satisfactory "Decision Making" professional development experience. A summary of the control group workshop program is included in Appendix D. In place of the lateral thinking concepts and techniques, the C group participated in a workshop on vertical thinking, emphasizing convergent problem solving through the analysis of actual case studies of problems in higher education in British Columbia.

Research team roles

The composition of the research team and the roles of members were important considerations in planning and implementing the training research. The team consisted of the researcher and five professional associates: three instructors, one marker and one observation specialist. The roles are reviewed in Appendix E.

Preliminary Study Report

Attention to the process of developing content, methods, and instructional and testing procedures, in a study of training effects, is beneficial to the research process (Cronbach and Snow, 1977; Mansfield, 1978; Riley, 1982; Borg and Gall, 1983, 100). A preliminary study, with a total of 12 subjects randomly selected on the basis of age and gender from a group of 51 volunteers, was conducted as a field test for the procedures and materials. Four purposes were identified to:

1. Check workshop administrative routines and facilities
2. Monitor instructor performance on the competency-based method
3. Observe subject reactions to deBono materials
4. Assess effectiveness of the instructional program and materials

The preliminary study, classified as a "one-shot case study", was not a full pilot study, there being no control group involved. A specialist in unobtrusive interaction analysis observed and reported on the pre-experiment study. As a result of this preliminary

experience, the following adjustments were made in the experimental research study-workshop plans:

1. The roles of the instructors were adjusted to suit their strengths.
2. Indications of subject test anxiety and fatigue resulted in the decision to eliminate a fluency pretest and one originality posttest.
3. The competency-based method, for presentation of content, was made more directive and more specifically criterion-based.
4. Indications of subject difficulty with deBono techniques resulted by the introduction of the Systems Analysis Approach model (Cornell, 1980) as a framework for the introduction of lateral thinking, and by developing a sequence of overhead transparencies, examples of which are given in Appendix A.

Procedures for Analyzing Data

This section presents information on the computer program used in the regression analysis, and parameters in the development and application of the regression model.

Statistical Package for the Social Sciences

Data derived from the five tests, and the survey (age, sex), were analyzed by the Statistical Package for the Social Sciences (SPSSx, 1983) computer program. The multiple regression statistical technique was used to test the main effects hypotheses and the interactions. The REGRESSION command, and DESCRIPTIVES and STATISTICS subcommands, computed stepwise regression and produced statistical data, including: Pearson r correlations, R , R^2 , Significance of F and Significance of

F Change, R² Change, and partial correlations.

The regression techniques for "unpacking" interactions is reported in conjunction with Chapter IV, Table 15. The RESIDUALS subcommand residualized data for use in the construction of the interaction graphs, as given in Tables 16 to 26 in Chapter IV. Pearson r correlations and univariate ANOVAS, conducted for preview and post hoc analysis, are reported in Appendix F.

Multiple Regression Analysis

The regression model for this study was designed after the a priori Model 3 technique for stepwise regression, specifying order of entry of variables (Overall and Spiegel, 1969). Multiple regression achieves the equivalent of ANOVA for analysis of the main effects hypotheses, and goes beyond the basic analysis of main effects, to the interaction analysis of the "predictor" variables on the dependent variable.

Multiple regression allowed the inclusion of two continuous aptitude variables, the moderator variable field independence and the covariate verbal comprehension, with one continuous or grouped organismic variable, age, one discrete organismic variable, sex, and two sets of independent variable categories: Contrast 1, lateral training and vertical training; Contrast 2, lateral-developmental method and lateral-competency method. The main and interactive effects of this model, or set of "predictor" variables, was analyzed on the four component dependent variables, TCREATE, ORIGNL, FLUENT and

FLEXBL. Table 1, in Chapter I, describes the composition of the dependent variables. Table 10, in Chapter IV presents the results of the full regression model analysis.

The multiple regression, least squares technique for data analysis was selected because of its certain advantages: (a) a capacity to handle the unequal n through weighted regression coefficients; (b) to allow the inclusion of several a priori ordered variables in the mixed discrete-continuous model; and, (c) to minimize the possibility that correlated variables or significant effects will cancel one another (Overall and Spiegel, 1969, 319; Kerlinger and Pedhazur, 1973).

Phases of the multiple regression procedure. The full regression model, given in Table 7, was conducted on each of the four dependent variables, noted in the column heads for Table 10 in Chapter IV: TCREATE, FLUENT, ORIGNL, FLEXBL. The full model was also employed for the curvilinear analyses of the three group comparison of middle career-age subjects with early and late career-age subjects, on each of the four dependent variables; as explained in conjunction with Table 11, Chapter IV and in Appendix G. Pearson r and partial correlations interpreted main effects sources as given in Table 13, Chapter IV. Special regression models were designed for each interaction analyses, on the appropriate dependent variables, as discussed in conjunction with Table 15, Chapter IV.

Basic regression model. The basic regression model (condensed)

for the study was given as:

$$Y_i^1 = a + b_{TXT} + b_{MXM} + b_{IXI} + b_{CXC} + e$$

Where:

Y_i^1 = predicted or expected scores on the four dependent variables
ORIGNL, FLUENT, FLEXBL, TCREATE

X = scores, ranks (or coding) on the independent, moderator, and interaction variables and the covariate

a = intercept constant

b = regression coefficient

e = error term

T = Treatment variable(s)

M = Moderator variable(s)

I = Interaction variable(s)

C = Covariate

bTXT - indicates two treatment contrasts for testing:

Contrast 1 = (ET(CB) + ET(DB)) and C

Contrast 2 = ET(CB) and ET(DB)

bMXM - indicates three individual difference moderator variables for testing: field independence, a continuous aptitude variable; age, continuous or grouped organismic variable; gender, a discrete organismic variable

bIXI - interactions for testing between T and M on Y

bCXC - covariate: verbal comprehension, a continuous aptitude variable

Degrees of freedom. The number of degrees of freedom (df) for any statistic is the number of components free to vary, a particularly important concept in research such as the present study which involves relatively small samples (McCall, 1970; Guilford and Fruchter, 1978). Table 7 lists the variable source and degrees of freedom for the full regression model.

Table 7

Degrees of Freedom for the Full Model of Four Regression Equations

<u>Source</u>	<u>df</u>	<u>variable levels</u>
Grand mean	1	
Main effects:		
C1	1	Contrast 1 (lateral and vertical training)
C2	1	Contrast 2 (competency and developmental method)
F	1	Field Independence
A	1	Age
S	1	Sex
VC	1	Verbal Comprehension
Interactions:		
AXS	1	Age X Sex
AXF	1	Age X Field Independence
SXF	1	Sex X Field Independence
C1XA	1	Contrast 1 X Age
C2XA	1	Contrast 2 X Age
C1XS	1	Contrast 1 X Sex
C2XS	1	Contrast 2 X Sex
C1XF	1	Contrast 1 X Field Independence
C2XF	1	Contrast 2 X Field Independence
C1XAS	1	Contrast 1 X Age X Sex
C2XAS	1	Contrast 2 X Age X Sex
C1XAF	1	Contrast 1 X Age X Field Independence
C2XAF	1	Contrast 2 X Age X Field Independence
C1XSF	1	Contrast 1 X Sex X Field Independence
C2XSF	1	Contrast 2 X Sex X Field Independence

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Note: Variables being tested for main effects are not listed here in the order of entry.

The degrees of freedom for calculating the F scores totalled 52 (N = 74-22 = 52 df), a sample size smaller than desirable for multiple regression and interaction analysis, but adequate if treatment and other variables form a set of good predictors.

Level of significance. Given the relatively small sample size ($N = 74$) and the use of 22 df for testing variables, the .05 standard ($p < .05$) was selected as the probability level for significance (Borg and Gall, 1983, 380). Winer (1962) noted the restrictions on research imposed by the working conditions and stated that levels of significance may be more appropriate at .20 or .30, than the .01 or .05 levels. For exploratory purpose, interesting main effects in the .05 to .15 level of probability are discussed.

For the exploratory interaction component of the study, in addition to interactions within the .05 level of probability, variables within the .05 and .15 levels were analyzed, reported and discussed. Cronbach and Snow (1977, 86) urged greater attention to the description of effects, and less to decisions about the null hypotheses.

Partialling technique. The regression procedure produced data to assess the effects of statistical control by analysis of partial correlations, to account for intercorrelational effects of multiple independent and moderator variables. Preliminary correlational analysis for this study, given in Table 33, Appendix F, supported the expectation that independent and moderator variables were correlated to some degree, some substantially. To clarify variable relationships the regression analysis gives: (a) the R^2 Change; that is, the amount of variance accounted for on the dependent variable by each ordered factor, and the Significance of F Change, or probability

level; and, (b) the partial correlation data of the residuals in the dependent variable.

The R^2 Change and Sig F Change data enable the identification of the significant and interesting main effects and interactions for analysis, as given in Table 10, Chapter IV (Kerlinger and Pedhazur, 1973, 93-94). The Pearson r and partial correlations give the degree of relationship and the source of the variance in main effects analysis, as given in Table 13.

Order of entry of variables

In a structured regression analysis, the order of entry of variables is determined by convention and by the specific interests and objectives of the researcher. Kerlinger and Pedhazur (1973, 95), explained the order of entry:

As far as the calculation of R^2 is concerned, it makes no difference in what order the independent variables enter the equation and the calculations. But the order in which the independent variables are entered into the equation makes a great deal of difference in the amount of variance accounted for by each variable. A variable, if entered first, almost invariably will account for a much larger proportion of the variance than if it is entered second or third. In general, when the independent variables are correlated, the more they are correlated and the later they are entered in the regression equation, the less the variance accounted for (Kerlinger and Pedhazur, 1973, 95).

The order of entry of variables is important and should be based on theory and the logic of the study. The order of entry for the regression model is presented in Table 8, followed by an explanation.

Table 8

Order of Entry of Variables for the Regression Analysis

-
- First - enter Verbal Comprehension - a continuous, aptitude variable
 - Second - enter Age, a continuous, organismic variable
 - Third - enter Sex, a discrete, organismic variable
 - Fourth - enter Field Independence, a continuous cognitive style, aptitude variable
 - Fifth to Seventh - enter first order individual difference interaction variables
 - Eighth - enter Contrast 1, training in lateral thinking and training in vertical thinking, representing two discrete classifications
 - Ninth - enter Contrast 2, training in lateral thinking on a competency-based method and training in lateral thinking on a developmentally-based method, representing two discrete classifications
 - Tenth to Fifteenth - enter first order aptitude by treatment interaction variables
 - Sixteenth to Twenty-first - enter second order aptitude by treatment interaction variables
-

Note: See Table 7 for the list of main effect and interactive variables

A priori ordering adds a specifically ordered term to the model after each effect tested (Overall and Spiegel, 1969). Individual difference variables, and their first order interactions, as noted in steps one to seven in Table 8, were entered into the regression equation prior to the manipulated treatment contrasts, in order to estimate the effects, on the dependent variable, of factors other than the treatment. If the selected individual difference variables

(effects brought by subjects to the study) had been entered after the treatment variables, the results would have inflated the importance of treatment by assigning higher Sig F Change and R^2 Change values. The a priori ordering decision gave a clearer indication of the real value of treatment, and, through interaction analysis, provided data on the effects of individual differences on each other, on the treatment contrasts, and on the dependent variables.

Subject scores on verbal comprehension, the covariate, were entered first, according to convention, in order to assess the impact of verbal ability on the four dependent variables, and as an indirect test of the treatment contrasts (Overall and Spiegel, 1969; Pedhazur, 1983). If treatment effects are significant, when verbal ability (and other preceding variables) is included in the model, then the experimental treatment is well-tested in conjunction with a verbal ability variable which is moderately to highly correlated with intelligence.

It may be seen from Table 7 that the verbal comprehension factor was not included in the combinations of effects for interaction analysis. Once the main effects were determined, a decision was made not to include verbal comprehension as an interaction variable, and to focus on age, sex, field independence and treatment. Furthermore, had verbal comprehension been included in the interactions, the df would have been reduced to 41. With limits on what was possible to include in the regression model, field independence, over verbal comprehension, was the cognitive variable of interest in the interaction analysis.

Following the entry of the verbal comprehension covariate, or control variable, the effects of organismic variables were assessed by entering the continuous variable, age, and the discrete variable, gender (coded as male = 1; female = -1), fundamentally important characteristics each subject brings to the study.

Next, subject scores on field independence, a pretreatment characteristic classified as a continuous, cognitive style, individual difference variable, was entered into the equation.

Next were entered first order individual difference variable interactions for age, sex and field independence (AXS; AXF; SXF) as combinations of individual difference moderator variables.

According to the a priori logic for the study, following the entry of all individual difference variables, and their interactions, the two treatment contrasts (C1, C2) were entered in order to assess treatment effects on each of the four dependent variables, after accounting for individual difference variables.

Next were entered the first order aptitude (or trait) treatment interactions (ATI), to assess the joint impacts of C1 and C2 with age and sex and field independence (C1XA; C2XA; C1XS; C2XS; C1XF; C2XF).

Last were entered the second order ATI, to assess possible multiple impacts of C1 and C2 with age and sex and field independence (C1XAS; C2XAS; C1XAF; C2XAF; C1XSF; C2XSF).

Controlling variability

Variables entered into a regression equation are subject to statistical control through the process of being included in the model. The overall coefficient of influence is calculated by R^2 , or total variance accounted for, with the balance attributed to error variance, or the effects of unknown or uncontrolled influences.

The credibility of a research design rests on its attention to test validity and reliability, and to control measures taken in the research environment. The Design of Study section in this chapter was concerned with controls in the research-workshop setting and program. Test validity and reliability are discussed in the following Instrumentation section and in Appendix B.

Instrumentation

This section describes test selection and purpose, scoring procedures and testing arrangements.

Test selection

A total of five tests were selected for the research study, based on reports in the review of literature (Buros, 1974, 1978; Mitchell, 1983), and on usage reported in the test manuals.

Two aptitude tests were given immediately prior to each workshop, and a battery of three divergent thinking tests was given immediately after each workshop. Table 9 sets out information on the types of tests, order employed and timing. Appendix B contains reports on validity and reliability for all five tests employed in the study.

Table 9

Experimental Testing: Type of Test, Order and TimingTests administered prior to the workshop:

<u>Timing</u>	<u>Tests</u>	<u>SI cell[*] identity</u>	<u>Testing for</u>
5/25	G-Z Verbal Comprehension (GZVC)	CMU	verbal comprehension
3/12	Group Embedded Figures (GEFT)	NVT	field independence

8/37 = 8 minutes administration, 37 minutes testing for prior tests

Tests administered after the workshop:

<u>Timing</u>	<u>Tests</u>	<u>SI cell[*] identity</u>	<u>Testing for</u>
3/6	Plot Titles (PT)	DMT/DMU	fluency/ originality
2/10	Consequences A-II (CON)	DMT/DMU	fluency/ originality
2/15	Alternate Uses (AU)	DMC/DMT/DMU	flexibility

7/31 = 7 minutes administration, 31 minutes for posttests

* Structure of Intellect, cell identity (Guilford, 1967, 1979a)
 Note: NVT = coNvergent visual transformation; CFR = cognitive figural relations; CMU = cognitive seMantic units; DMU - divergent seMantic units; DMC = divergent seMantic classes; DMT = divergent seMantic transformations.

As can be seen in Table 9, a total of nearly 1 1/2 hours of test administration took place. The two aptitude tests given prior to the workshops totalled 37 minutes testing time, and the three divergent thinking posttests totalled 31 minutes testing, not including administration time.

The Group Embedded Figures Test and the Verbal Comprehension Survey were given prior to the workshops to determine cognitive aptitude levels for field independence and verbal comprehension.

The Group Embedded Figures Test (Witkin, et al., 1971) is a much used measure of field independence cognitive aptitude, and an effective determiner of individual differences in the visual abstraction or "disembedding" skill. Its inclusion, as a test of the effects of field independence on divergent production, was based on limited evidence, in the literature of the positive correlation of the two variables. Guilford's (1978, 136) view is that field independence is a flexibility trait of the NVT order (coNvergent/visual/transformation); he reports that field independence is moderately positively correlated with the original production of ideas.

The Guilford-Zimmerman Aptitude Survey: Part II - Verbal Comprehension, Form A (1981a), a well-used aptitude measure, gives a score on comprehension of word meanings, and is classified in the SI model as CMU (Cognition of seMantic Units). Verbal comprehension, one of two dominant factors (with general reasoning) in predicting academic success, is a key primary ability, moderately to highly correlated with other forms of verbal ability and with intelligence (Guilford, 1981, Sternberg and Powell, 1982, 979, 981; Sternberg and Salter, 1985, 5);

and expected to be low to moderately positively correlated with divergent production.

The tests administered after the workshop were three of Guilford's factor-analyzed tests of divergent production: Plot Titles, Consequences II and Alternate Uses. These tests were selected as the measures of divergent production to match the fluency, flexibility and originality interests of the research study, and because of evidence of their effectiveness in creativity research, as reported in Appendix B. Research reports and standard references indicated that the three tests are satisfactory measures for use in experimental research, and the test manuals provided evidence of their validity and reliability in gauging divergent production, and the factor components of fluency, flexibility and originality.

For a brief explanation of the Structure of Intellect model cell identity system and the factors being tested (fluency, flexibility and originality) see Table 9 and the "Definitions of key terms" in Chapter I. The section in Chapter II on Cognitive Psychology contains a review of the components of the Structure of Intellect model. Details may be obtained by consulting Guilford references (1967, 1979a).

Plot Titles, (1981) is a factor test to gauge DMU and DMT. Units are identified as "nonclever" responses; transformations as "clever" responses.

Consequences II, Form A, (1980) is a factor test to gauge the same DMU/T contingencies as Plot Titles, but identified as "obvious" and "remote".

Alternate Uses, (1978) is a factor test said to gauge DMU/DMC and secondarily DMT. In the present study it is regarded as a measure of DMC, or of flexibility of thinking skill.

Method of scoring tests

Scoring the battery of divergent thinking tests, by subjective judgment, required a marking system to insure consistency. The researcher and a co-marker studied the three divergent thinking test manuals and the scoring instructions provided with the tests. A scoring routine was established:

1. Each set of tests was scored for all subjects at one time, before proceeding to the next test; and within each test, each section was scored entirely before proceeding to the next section.
2. All tests were scored independently by both markers.
3. Both markers, together, reviewed every response, and, where differences occurred, brought a jointly agreed upon judgment. Disagreements in scoring were resolved on the basis of the scoring guides. In the case of the Consequences II test, the co-markers developed a list of border-line considerations, because of disagreement with certain of Guilford's "remote" examples.

Formula for scoring divergent thinking. Hocevar (1979b) warned of the problems of measuring creativity. His research on the confounding of originality and fluency resulted in the conclusion that summing scores is inflationary and favors the more fluent subject. Controlling fluency, by arithmetical or statistical means, provides a different gauge for discriminating creativity, an originality-dominated view. Originality factors, (remoteness, cleverness) the essence of creativity

are given priority over sheer fluency or numbers of low level ideas.

Jaquish and Ripple (1981) assessed originality on a percentage basis, and in defining originality identified two criteria, rareness and cleverness. To Jaquish and Ripple, a rare response is one that occurs in fewer than 5% of the total responses. A clever response is determined by inter-scorer judgment as to its appropriateness and imaginativeness.

In the present study, the 5% guideline for rare responses was not feasible with the volume of items, and the concept goes against the grain of Guilford's system of set criteria and examples for original responses. Jaquish's inter-scorer "cleverness" judgment, and modifications of Guilford's scoring classifications and examples, were used for determining original (clever and remote) responses. Where a particular original response was judged to have appeared too frequently in the first round of independent scoring, the markers noted the point and compiled an "originality baseline." Borderline responses were judged and either maintained as original or changed to the fluency classification.

Scoring and transforming divergent production test factors
(fluency, flexibility, originality) into dependent variables.

Fluency, or the number of responses, is important, however, a central concern for this study was to gauge creativity and originality. In order to control for fluency, two arithmetical techniques were used for the TCREATE and ORIGNL variables, as noted in Table 1, Chapter I.

On TCREATE, originality is the more valued phenomenon, therefore, remote or clever ideas were awarded 2 points, and nonoriginal, but relevant ideas, (obvious and nonclever) were awarded 1 point, as was flexibility of thought. The weighting of the original scores was to control for fluency and flexibility. The 2:1 scoring decision was an arbitrary method of discriminating in favor of the original production of ideas, over fluent and flexible production, in the "universal" or total creativity variable, TCREATE.

On ORIGNL, original (remote and clever) ideas comprised the numerator in a ratio with total fluency (remote and clever and obvious and nonclever) as the denominator. This ratio variable, in effect, gives an originality reading while controlling straight fluency of production, or numbers of responses. There are problems with this "batting average" variable, but all methods of creativity scoring present problems. The aim was to paritial out fluency and reward originality. The most obvious problem ($5/10 = .50$; $3/3 = 1.00$; $9/30 = .30$) is tempered by the random assignment, by the reality of time limits and the expectation of productivity, and by the fact that subjects did not know their response would be subjected to ratio treatment (ORIGNL), or weighting (TCREATE).

Fluency (FLUENT) is a straight count of nonoriginal, (nonclever and obvious) but relevant responses. Flexibility (FLEXBL) is a skill to be valued more than fluency; however, questions arose, from a preliminary ANOVA study, given in Appendix F as Table 28 as to the discriminant validity of Alternate Uses (testing flexibility) on the lateral thinking treatment factor. The suitability of the test for

adult subjects, and the relationship of flexibility to originality, may be questioned. It was decided not to weigh flexible as an original response, to score the factor on the same single point basis as fluent responses, and to include a separate FLEXBL dependent variable, the regression analysis.

Testing Arrangements

Special attention was given to testing conditions, to make test administration as orderly and as non-threatening as possible. A balance between control and informality was maintained with the knowledge that too close monitoring of the test environment has been known to inhibit response. In the test administration, no instructions to be "creative" or "flexible" or "fluent" were given, since some studies present evidence that encouragement stimulates performance (Guilford, 1980, 8-9).

The researcher trained a second test administrator, in the procedures for testing as set forth in each of the five test manuals. In the course of test administration, both examiners followed prepared guidelines.

Summary

Chapter III reported on research design, procedures for analyzing the data, and instrumentation. The basic research model was identified as a "posttest only control group design", and the representative design (RD) concept was explained as the logic of the research-workshop setting. Details on the treatment and control workshops explained their differentiation in terms of methods and content. Information was presented on the population and sample of subjects, on the random assignment procedure, and on the composition of the two treatment and control group workshops. A preliminary workshop study influenced the experimental design procedures and instructional materials.

The "Procedures for Data Analysis" section explained the use of SPSSx in processing the regression analysis model for analysis of main effects and interactions. A priori order of entry of variables was stressed as a critical factor in the regression analysis.

The "Instrumentation" section explained the prior and posttesting arrangements, and noted the Structure of Intellect basis of the Guilford tests of divergent thinking. Details on the judgmental scoring procedures, and the nature of the four divergent production dependent variables were reviewed.

The data gathered in the study and the results and analysis are presented in Chapter IV, with further analysis and implications for training presented in Appendix C.

CHAPTER IV

PRESENTATION OF RESULTS AND ANALYSIS OF DATA

Chapter IV includes four sections. The first section is on the presentation of data for the regression models. The second section is on the analysis of research hypotheses tested in the study. The third section is on the exploratory analysis of data for main effects. The fourth section is on the exploratory analysis of data for interactions.

Using the Statistical Package for the Social Sciences (SPSSx), data were analyzed by multiple regression to test the hypothesized main effects and to explore the effects of individual difference variables and interactions. The four regression analyses, given in Table 10, were based on the same model of multiple discrete and continuous variables: the two independent variable contrasts, the three moderator variables, the covariate, and a set of fifteen interactions, on the four dependent variables.

Presentation of Data for the Full Regression Model

Three sets of regression analyses were conducted on each of the four dependent variables in order to obtain the data for main effects and interaction analyses.

Full regression model and analyses

The overall regression analyses, testing for main effects and interactions, is displayed as Table 10, specifying Sig F Change (p value) and R² Change (variance accounted for), as a summary of the

Table 10

Regression Analyses: Four Dependent Variables (Sig F Change (SFC)) and R^2 Change (R^2C)

INDEPENDENT VARIABLES	DEPENDENT VARIABLES			
	TCREATE SFC/ R^2C	FLUENT SFC/ R^2C	ORIGNL SFC/ R^2C	FLEXBL SFC/ R^2C
VCOMP	.025*, .068	.66	.036**, .06	.005**, .10
AGE	.84	.27	.015*, .075	.96
SEX	.82	.79	.80	.45
F/IND (H3)	.49	.45	.70	.018*, .07
AXS	.29	.29	.84	.72
AXF	.057+, .048	.88	.116+, .033	.002**, .11
SXF	.19	.043*, .058	.63	.48
C1 (H1)	.10+, .035	.59	.047*, .049	.85
C2 (H2)	.39	.105+, .036	.50	.60
C1XA	.90	.73	.67	.43
C2XA	.56	.044*, .055	.145+, .0275	.57
C1XS	.31	.33	.98	.86
C2XS	.96	.30	.22	.40
C1XF	.60	.78	.98	.28
C2XF	.68	.15+, .025	.38	.79
C1XAXS	.058+, .047	.34	.32	.25
C2XAXS	.91	.18	.42	.34
C1XAXF	.40	.30	.83	.56
C2XAXF	.97	.96	.67	.74
C1XSXF	.78	.59	.32	.23
C2XSXF	.59	.29	.068*, .042	.54
MR =	.54	MR = .60	MR = .57	MR = .62
R^2 =	.29	R^2 = .37	R^2 = .33	R^2 = .39
F =	.32	F = .19	F = .09	F = .05

Notes: N = 74; df = 74-22 = 52; ** $p < .01$; * $p < .05$; + .05 < $p < .15$

R^2 Change is given only in the case of variables under study

R^2C stands for multiple correlation squared change, or the amount of variance accounted for by each variable

SFC stands for Significance of F Change

Sig F Change (probability value) is listed for all main effects and interactions

V Comp = verbal comprehension; F/Ind = field independence;

C1 = Contrast 1; C2 = Contrast 2

H1, 2, 3 = Hypothesis sets 1, 2, 3; See Table 13 for H4, Hypothesis Set 4

results of the four linear equations. To qualify for analysis, the results were based on two sets of significance criteria. For the hypothesized main effects, the .05 level of probability was established. For review purposes and for indications of interaction, a second exploratory level of probability was set for the .05 to .15 range.

As can be seen in Table 10, of the four individual difference variables in the model, the covariate, verbal comprehension is significant ($p < .05$) on three of the four dependent variables, accounting for 7% of the total variance on TCREATE, 6% on ORIGNL and 10% on FLEXBL; but not on FLUENT. The age variable is reported as significant on ORIGNL, accounting for 8% of the total variance. Field independence is reported as significant on FLEXBL, accounting for 7% of the total variance.

The individual difference interaction variable, age by field independence, is significant ($p < .05$) on FLEXBL, accounting for more than 11% of the total variance or one quarter of the R^2 . The sex by field independence variable is significant ($p < .05$) on FLUENT accounting for 6% of the variance. Age by field independence is in the direction of significance on TCREATE ($p = .057$) and on ORIGNL ($p = .12$).

The treatment contrasts, C1 (contrasting training in lateral thinking and training in vertical thinking) is significant ($p < .05$) on ORIGNL accounting for 5% of the total variance. Contrast 1 is in the direction of significance ($p = .10$) on TCREATE. Contrast 2 (contrasting competency and developmental methods) is in the direction of significance ($p = .11$) on FLUENT.

Of the first order treatment by individual difference interactions, there is one measure of significance ($p < .05$) with C2 by age on FLUENT, accounting for 6% of the total variance. There are two first order treatment by individual difference interactions in the ($.05 < p < .15$) exploratory range: C2 by age on ORIGNL ($p = .145$), and C2 by field independence on FLUENT ($p = .15$).

For the second order treatment by individual difference interactions there are no significant differences noted. Two variables come within the exploratory probability range, C1 by age by sex on TCREATE ($p = .06$), and C2 by sex by field independence on ORIGNL ($p = .07$).

Regression model and analyses for curvilinear interaction

Table 11 presents a caption of the results of a separate set of four multiple regression analyses for testing the curvilinear interaction effects of the three age groups (middle, early and later) trained in lateral and vertical thinking. Contrast 1, subjects trained in lateral thinking contrasted with subjects trained in vertical thinking, was tested in an interaction format with contrast G1, middle career-age group contrasted with early and late career-age groups; and contrast G2, early career-age group contrasted with later career-age group. Contrast 2, subjects trained in lateral thinking on the competency-based method contrasted with subjects trained in lateral thinking on the developmentally-based method, was also tested for interaction analysis with G1 and G2 contrasts (See Tables 37, 38 in Appendix G).

Table 11

Curvilinear Regression Analysis Test for Interactions on Treatment
Contrasts 1 and 2 by Career-Age Group Contrast 1 and 2

Independent Variables	Dependent Variables			
	TCREATE	FLUENT	ORIGNL	FLEXBL
	SFC/R ² C	SFC/R ² C	SFC/R ² C	SFC/R ² C
C1 X G1	.057 ⁺ , .045	.068 ⁺ , .0445	.99	.35
C1 X G2	.50	.51	.88	.39
C2 X G1	.31	.74	.54	.31
C2 X G2	.81	.24	.39	.88

⁺ .05 < p < .10

Notes: These data were extracted from the full regression model.

C1 = Training in lateral thinking (CB + DB) contrasted with training in vertical thinking

C2 = Competency-based contrasted with developmentally-based method

G1 = Middle career-age contrasted with early career-age and later career-age

G2 = Early career-age contrasted with later career-age

SFC = Significance of F Change (p value)

R² C = Squared multiple regression change; accounting for variability

The only difference between the full regression model reported in Table 10 and the full model from which the data in Table 11 was extracted was an adjustment to test the curvilinear, three career-age group interaction. The two interaction variables, contrast 1 by linear age (C1XA), and contrast 2 by linear age (C2XA), were replaced with four interaction variables (C1XG1, C1XG2, C2XG1, C2XG2), as given in Table 11, reducing the error degrees of freedom from 52 to 50, $N = 74 - 24 = 50$.

As presented in Table 11, two interaction results in the exploratory ($.05 < p < .15$) range were reported for CIXG1 on TCREATE ($p = .057$) and FLUENT ($p = .068$). The interaction analysis of these two results were subjected to the "unpacking" procedure by conducting a regression analysis on the model given in Table 15 (d), and the results are reported in Tables 25 and 26, and graphed in Figures 10 and 11.

Regression model and analyses for hypothesis four

In order to test the curvilinear hypothesis on the contrast predicting that the laterally-trained middle career-age group will score significantly higher on divergent production than the laterally-trained early and later career-age groups, a separate regression model was designed. For this analysis the middle career-age group was contrasted with the early and later career-age groups combined, as given in Contrast 1, Table 38, Appendix G. In the regression model given in Table 12, the G1 contrast has been renamed "curvilinear age", a contrast of the scores of the 52 laterally-trained subjects only, on each of the four dependent variables, 23 in the middle career-age group, and 29 in the early and later career-age groups combined, as given in Tables 37 and 38, in

Appendix G. The regression analysis is, in effect, a simple ANOVA, contrasting the scores of the two groups to assess main effects and individual difference interactions on each of the dependent variables. Table 12 sets out the results of the regression analyses on each of the four dependent variables: TCREATE, ORIGNL, FLUENT and FLEXBL.

Table 12

Regression Model and Analyses for Testing the Relationship of Laterally Trained Subjects Only in the Middle Career-Age Group with Early and Late Career-Age Groups Combined (Significance of F Change)

<u>Model</u>	<u>Dependent Variables (Sig F Change)</u>			
	TCREATE	ORIGNL	FLUENT	FLEXBL
Verbal Comprehension	.02*	.139	.92	.006*
Age (Linear)	.64	.09	.57	.70
Sex	.96	.98	.90	.64
Field Independence	.61	.54	.48	.14
Age by Sex	.17	.80	.27	.95
Age by Field Independence	.25	.35	.58	.01*
Sex by Field Independence	.13	.93	.07	.81
Curvilinear Age	.57	.53	.49	.50

*
p<.05

From Table 12 it can be seen that the probability, or Sig F Change, results for the independent variable "curvilinear age", contrasting the laterally-trained middle career-age group with laterally-trained early and later career-age groups combined, are not significant on any of the four dependent variables. Verbal comprehension demonstrated its importance on three of the four outcome measures similar to the Table 10 results, and age by field independence indicated a significant interaction on FLEXBL, as was the case given in Table 10.

Determining the source of main effects

Determination of the nature or source of main effects is explained by reference to the Pearson r correlation for the first entered variable. For subsequent variables, the source of the effect is explained by the partial correlation between residuals in the dependent variable, given at the particular step at which the variable entered the model. Table 13 gives Pearson r and partial correlations for the significant independent and moderator variables for main effects on the dependent variables. The Sig F Change data is from Table 10. Table 13 reports hypothesized results within the .05 probability standard, and exploratory results in the .05<p<.15 range.

Table 13

Pearson r and Partial Correlations for Significant ($p < .05$) and Interesting Independent and Moderator Variables

<u>Independent Variable</u>	<u>Dependent Variable</u>	<u>Pearson r Correlation</u>	<u>Sig F Change</u>
Verbal Comprehension (-) (+) Lower to Higher	FLEXBL	.32	.005**
(-) (+) Lower to Higher	TCREATE	.26	.025*
(-) (+) Lower to Higher	ORIGNL	.24	.036*
		<u>Partial Correlation</u>	
(-) (+) Age - Younger to Older	ORIGNL	-.28	.015*
Field Independence (-) (+) Lower to Higher	FLEXBL	.28	.018*
(+) (-) C1 Lateral and Vertical	ORIGNL	.24	.047*
(+) (-) C1 Lateral and Vertical	TCREATE	.20	.10
(+) (-) C2 Competency and Developmental	FLUENT	-.20	.105

** $p < .01$; * $p < .05$

Note: The (+) and (-) refer to contrast coding of discrete or continuous variables

As given in Table 13, there are six (of a possible twenty-four) significant ($p < .05$) main effects results, two of which were hypothesized: Contrast 1 - laterally-trained subjects contrasted with vertically-trained subjects on ORIGNL; and field independence on FLEXBL. These two significant results are discussed in the following section on the Analysis of Research Hypotheses Tested in the Study. The two hypothesized results reported as being in the direction of significance (C1 on TCREATE; C2 on FLUENT) are also discussed in the next section. Four of the results, one for age and three for verbal comprehension, reported in Table 13, indicated significant main effects for individual difference variables in the equation. These four results, which were not hypothesized, are discussed in the subsequent section on Exploratory Analysis of Main Effects and Interaction Results.

Analysis of Research Hypotheses Tested in the Study

There were four sets of research hypotheses stated for main effects. With the four dependent variables, TCREATE, ORIGNL, FLUENT, FLEXBL, the total number of hypothesized main effects, was sixteen, as noted in connection with the specifications of research hypotheses in Chapter I.

Hypothesis 1 - Subjects trained in lateral thinking will score significantly higher on tests of the divergent production of ideas, given as the four dependent variables, than subjects trained in vertical thinking.

Results - The regression analyses reported in Table 10 indicate that Contrast 1 (laterally-trained subjects contrasted with vertically-trained subjects) is significant ($p < .05$) on ORIGNL. The laterally-trained treatment group (ET(CB) and ET(DB)) scored significantly ($M = 31.0$; $SD = 13.7$) higher than the vertically-trained control group (C) ($M = 23.8$; $SD = 9.07$) on the ORIGNL dependent variable (See Table 39, Appendix H). There are no significant differences between the treatment group trained in lateral thinking and the control group trained in vertical thinking on TCREATE, FLUENT or FLEXBL. The research hypothesis is accepted for ORIGNL, but rejected for TCREATE, FLUENT and FLEXBL.

The most important result in the regression analysis, given in Table 10, is the evidence of significance ($p < .05$) for Contrast 1 on ORIGNL, with the Sig F Change or p value given as .047, and the R^2 Change indicating that the variable accounted for 5% of the total ORIGNL variance. The direction of significance is given by the partial correlation (.24), noted in Table 13, of Contrast 1 and ORIGNL, at the point at which C1 entered the equation. This positive partial correlation value indicates that the positive or plus group in Contrast 1 goes with high scores on ORIGNL.

Under conditions of control for the individual difference variables which precede Contrast 1 in the regression equation, the laterally-trained treatment subjects (competency-based and developmentally-based) together outperformed the vertically-trained control group. The results confirmed that subjects trained in deBono's lateral thinking concepts and techniques are significantly more productive on the originality ratio dependent variable, controlled for fluency, than subjects who are trained by the more conventional vertical thinking.

The significant results reported for Contrast 1 on ORIGNL were not realized for the other three dependent variables. TCREATE, FLUENT and FLEXBL are not significantly related to Contrast 1; training in lateral thinking produced results no different than training in vertical thinking.

One interesting result in the exploratory range was indicated by Contrast 1 on TCREATE with a Sig F Change, or p value of .10. The nature of the association is given by the .20 partial correlation given in Table 13. The positive or plus group on Contrast 1 goes with higher scores on TCREATE. The laterally-trained subjects are more productive on the total creativity dependent variable than the vertically-trained subjects. This result should be considered with caution.

Hypothesis 2 - Subjects trained in lateral thinking by the competency-based method will score significantly higher on tests of the divergent production of ideas, given as the four dependent

variables, than subjects trained in lateral thinking by the developmentally-based method.

Results - The regression analyses reported in Table 10 indicate that the results for Contrast 2 (laterally-trained subjects on competency-based method contrasted with laterally-trained subjects on developmentally-based method) are nonsignificant for all four dependent variables, TCREATE, ORIGNL, FLUENT, FLEXBL. The research hypothesis were rejected for TCREATE, ORIGNL, FLUENT and FLEXBL.

One interesting result in the exploratory range was indicated by Contrast 2 on FLUENT with a Sig F Change or p value of .11. This result offers limited evidence that subjects trained on the developmentally-based (DB) method exceeded the performance of subjects trained on the competency-based (CB) method, in the production of FLUENT, or low level but relevant responses. The direction of the decision is given by the negative partial correlation (-.20) in Table 13, indicating that the subjects trained on a DB method and coded (-) in contrast 2, the developmentally-based method subjects are associated with the higher FLUENT scores.

Hypothesis 3 - There will be a significant and positive correlation between subjects' scores on field independence and their scores on measures of the divergent production of ideas given as the four dependent variables.

Results - The regression analyses reported in Table 10 indicate that field independence is significantly ($p < .05$) related to the FLEXBL dependent variable. This is not the case for the other three dependent variables, TCREATE, FLUENT and ORIGNL. Therefore the research hypothesis for FLEXBL is accepted, but rejected in the case of TCREATE, FLUENT and ORIGNL.

The field independence variable registered as significant ($p < .05$) on FLEXBL, with the Sig F Change given as $p = .018$, and the R^2 Change indicating that the variable accounted for 7% of the total FLEXBL variance. The direction of significance for field independence on FLEXBL is indicated by the partial correlation (.28) noted in Table 13, meaning that subjects who score more highly on field independence tended to score more highly on FLEXBL, demonstrating relatively more flexibility of thought than subjects lower on field independence.

Under the condition of statistical control for the three preceding variables, verbal comprehension, age and sex, the field independence variable achieved significance on FLEXBL. This was not the case for the other three dependent variables, TCREATE, ORIGNL and FLUENT.

Hypothesis 4 - There will be a significant curvilinear relationship between the subjects' age and measures of the divergent production of ideas given as scored performance on the four dependent variables; the form of this relationship will be such that the scores of subjects trained in lateral thinking in the middle career-age group will

significantly exceed the scores of subjects trained in lateral thinking in the combined early and later career-age groups.

Results - The results of the regression analyses given in Table 12 indicate that the curvilinear, three age-group contrasts are nonsignificant for all four dependent variables, TCREATE, ORIGNL, FLUENT, FLEXBL. The research hypotheses are rejected for TCREATE, ORIGNL, FLUENT and FLEXBL.

The contrast between the 23 subjects in the middle career-age group, and the combined total of 29 in the early and later career-age groups, fell far short of significance, as given by the Sig F Change results reported for Curvilinear Age in Table 12. Age grouping resulted in no differences among the 52 laterally-trained subjects. The evidence in the literature of higher productivity in mid-career was not supported by these results.

Exploratory Analysis of Data for Main Effects

The exploratory nature of the second phase of this research study was noted in Chapter I. This section analyzes the results for the question on possible gender differentials, and the main effects results for two individual difference variables, linear age and verbal comprehension.

The question of main effects of gender differentials

On the question of gender differentials, there were no significant main effects between males and females on any of the four dependent variables. While gender did not appear to be a factor of much importance in the main effects component of this study, male/female differences did enter into two of the second order treatment by individual difference interactions.

Individual difference variables ($p < .05$)

Two individual difference main effect variables resulted in measures of significance.

Linear age. The regression analyses results given in Table 10 indicate the age variable significant ($p < .05$) on ORIGNL, with a Sig F Change or p value of .015, accounting for 8% of the total variance. The partial correlation of $-.28$ given in Table 13 indicated that younger subjects significantly outperformed older subjects on ORIGNL, when verbal comprehension is statistically controlled. Given its order of entry, age made no difference on the other three dependent variables, TCREATE, FLUENT and FLEXBL.

Verbal comprehension. As expected of a covariate, the most significant ($p < .05$) results reported in Table 10 were the effects of the verbal comprehension general ability measure, on three of the four dependent variables. On FLEXBL, verbal comprehension registered a Sig F Change or p value of .005, and accounted for 10% of the total

variance. On TCREATE, the verbal ability score registered a Sig F Change or p value of .025, and accounted for 7% of the total variance. On ORIGNL, the verbal ability score registered a Sig F Change or p value of .036, accounting for 6% of the total variance. This evidence indicates the strength of the influence of verbal ability on three of the four dependent variables. The direction of significance for the first entered variable is given as the Pearson r correlation, as indicated in Table 13. For verbal comprehension, these are r = .26 on TCREATE; r = .24 on ORIGNL; and r = .32 on FLEXBL, with the positive relationship indicating higher verbal higher divergent production factor. The results for verbal comprehension on FLUENT are different, with virtually no correlation at r = -.05.

This evidence permits the conclusion that, with this sample of subjects, those who score higher on this particular form of verbal ability score higher on those divergent production dependent variables involving originality (TCREATE, ORIGNL), and flexibility (FLEXBL), but not on a straight count of fluency responses (FLUENT).

Exploratory Analysis of Data for Interactions

The aim of the interaction analyses was to explore significant and interesting interactions for possible insights on variable relationships, to pose questions for hypothesis building, and to derive implications for training adult professionals.

From Table 10, it can be seen that there were two first order individual difference interactions, and one first order interaction variable, within the .05 level of probability. Heeding the warning, by Cronbach and Snow (1977), that interactions are difficult to predict and not easy to find, it was decided in the proposal for this study, and noted in Chapter I, that interactions in the .05 to .15 probability range would be explored. Of these, there was one first order individual difference interaction, and two first order and two second order aptitude or trait treatment interactions. In addition, the curvilinear contrast for treatments by three age groups produced two interactions just beyond the .05 level.

Eleven interactions were subjected to regression analysis to obtain the residualized data necessary for graphing results for visual and logical analysis. Each separate analysis includes a table of data, a graphed figure, and a summary description of the nature and meaning of the interaction. In Appendix C, further analysis is presented on implications of the interactions to inform the development of training.

Of the five independent and moderator variables implicated in the interactions (C1, C2, age, sex, field independence), linear age or age groupings were involved in 8 interactions; field independence in 6 and sex in 2. C1 was involved in 3, and C2 in 4 interactions. The list and order of interaction analyses is presented in Table 14.

Table 14

Summary Table of Interaction Analyses on Dependent Variables

<u>First order individual difference interactions</u>	<u>Dependent variables</u>	
A X F - Age by Field Independence on	TCREATE	ORIGNL FLEXBL
S X F - Sex by Field Independence on		FLUENT
<u>First order aptitude by treatment interactions</u>		
C2 X A - Contrast 2 by Age on	ORIGNL	FLUENT
C2 X F - Contrast 2 by Field Independence on		FLUENT
C1 X G1 - Contrast 1 by Age Group on	TCREATE	FLUENT
<u>Second order aptitude by treatment interactions</u>		
C1 X A X S - Contrast 1 by Age by Sex on	TCREATE	
C2 X S X F - Contrast 2 by Sex by Field Ind.	ORIGNL	
Total interactions 11 = 3 + 3 + 1 + 4		

Note: Two probability criteria were set for interaction analysis:

(a) $p < .05$ and (b) $.05 < p < .15$

Unpacking the interactions

The system for structuring the models for the interaction regression equations was consistent over all analyses. All the ordered variables in the full regression model, as set out in Table 10, were eligible for inclusion. The formula for arriving at the "predictor"

variables, to be contained in each of the interaction models, included any variable appearing prior to the interaction variable under study, except those factors which interacted with the variable under study. For example, the A X F interaction on FLEXBL included verbal comprehension and sex as independent or predictor variables in the model. Age and field independence and AXS were related to the variable under study, therefore they were excluded from the "predictor" model.

In processing the interaction regression equations, the SPSSx program for Regression and Residuals provided standardized residuals data and scattergrams for analysis. Based on the linear regression equation, ($Y^1 = bX_i + a$), minimum and maximum calculations were made for locating extreme points of the regression lines in order to plot the graphs.

Models for interaction analyses

In order to "unpack" the interaction effects, and obtain the residuals data needed for constructing graph figures, the following models were derived, as set out in Table 15.

Table 15

Regression Models for Determining Interactions

(a)	(a)	(b)	(b)	(c)	(c)	(d)
AXF on FLEXBL ORIGNL TCREATE for V Comp Sex	SXF on FLUENT for V Comp Age	C2XA on FLUENT for V Comp Sex Find AXS AXF AXF	C2XF on FLUENT for AGE Sex AXS AXF C1 C1XA C1XS	C1XAXS on TCREATE for V Comp Find C2XA C2XS C2XF	C2XSXF on ORIGNL for V Comp Sex C1 C1XA C1XS C1XAS C1XAF	C1XG1 on TCREATE FLUENT for V Comp Sex Find SXF C2

Notes: Find = Field Independence

For interpretations of abbreviations see Table 7 Chapter III

(a) first order individual difference interactions

(b) first order aptitude or trait by treatment interactions

(c) second order aptitude or trait by treatment interactions

(d) curvilinear contrast, first order or trait (age) by treatment interactions

The order of the interaction analyses follows Table 15, from left to right, with: (a) first order individual difference interactions (A X F on FLEXBL, ORIGNL and TCREATE, S X F on FLUENT); (b) first order aptitude by treatment interactions (C2 X A on FLUENT, ORIGNL; C2 X F on FLUENT); and (c) second order interaction variables (C1 X A X S on TCREATE; C2 X S X F on ORIGNL); and, (d) the curvilinear three career-age group by treatment contrast, a first order aptitude by treatment interaction (C1 X G1 on TCREATE and FLUENT).

Each set of (a) to (d) classifications, and each interaction followed the same pattern of analysis. First the interaction is noted, with the Sig F Change and R^2 Change values from Table 10. Next a table of standardized residuals data is given, which presents essential statistical results for designing the graph figures. The figures were followed by discussion on the nature of the interaction.

First order individual difference interactions

The interaction influence of the individual difference variables, registering within the probability parameters ($p < .05$; $.05 < p < .15$), were analyzed to assess the relative importance of the interacting of aptitude (field independence) and organismic (age, sex) factors, in terms of the relevant dependent variables, and with treatment contrasts excluded. The graphed Figures 1, 2 and 3 reveal the contrasting effects of the individual difference variables.

Age X Field Independence on FLEXBL (Sig F Change .002; R^2 Change 11%)

Age by field independence, a significant interaction ($p < .05$), accounted for a substantial (11%) amount of variance on FLEXBL in the full regression model. Table 16 presents the residualized and other statistical data for graphing and interpreting Figure 1.

Table 16

Standardized Residuals Regression Data (A X F on FLEXBL)

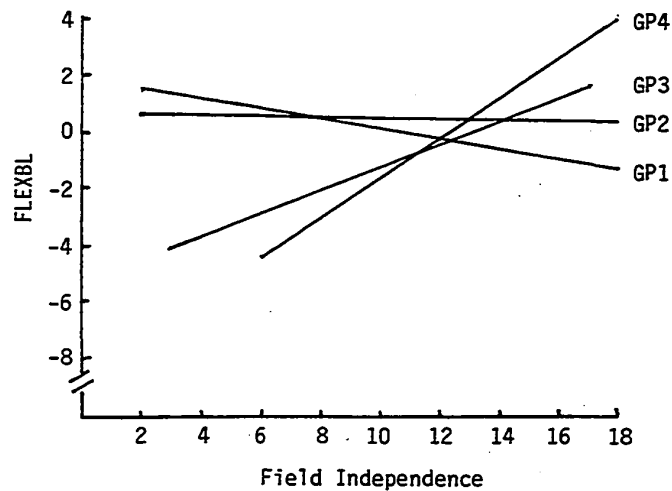
Age Group	Grp	N	(b) Slope	(a) Intercept	Xi Min	Xi Max	Y ¹ Min	Y ¹ Max	r	sig
24-35	1	20	-.17	1.70	2	18	1.36	-1.32	-.21	.18
36-40	2	18	-.01	.75	2	18	.73	.59	-.01	.48
41-45	3	19	.48	-5.60	3	17	-4.10	2.53	.52	.01*
46	4	17	.71	-8.70	6	18	-4.45	4.07	.59	.006*

*

p < .05

Min = low score on field independence

Max = high score on field independence

Y¹ Min = residualized FLEXBL score for low field independenceY¹ Max = residualized FLEXBL score for high field independenceFigure 1 Age Groups and Field Independence
Interaction Effects on FLEXBL

Interpretation

The interaction of age with field independence on FLEXBL (Alternate Uses) is apparent in the divergent relationships of older from younger subjects on higher and lower levels of flexibility. The field independent ability of younger (GP1, 2) subjects appears to have little effect on their flexibility of thought. There is a tendency for younger people who are lower on field independence to perform somewhat better than younger people who are higher on field independence. In contrast to the two younger groups, the positive and significant ($p < .05$) regression lines for the two older groups (GP4, $r = .59$; GP3, $p = .50$) indicate that older subjects who are higher on field independence are correspondingly higher in flexibility; whereas older subjects who are lower in field independence are lower in flexibility.

Age X field independence on ORIGNL (Sig F Change .11; R^2 Change 3%)

Age by field independence indicated a modest relationship with the ORIGNL dependent variable. Table 17 presents the residualized and other statistical data for graphing and interpreting Figure 2.

Table 17

Standardized Residuals Regression Data (A X F on ORIGNL)

Age Group	Grp	N	(b) Slope	(a) Intercept	Xi Min	Xi Max	Y ¹ Min	Y ¹ Max	r	sig
24-35	1	20	.09	4.22	2	18	4.41	5.91	.03	.45
36-40	2	18	.34	-6.94	2	18	-6.26	-.85	.23	.17
41-45	3	19	-.38	3.07	3	17	1.89	-3.43	-.13	.29
46	4	17	1.81	-24.67	6	18	-13.81	7.91	.52	.015*

* p<.05

Min = low score on field independence

Max = high score on field independence

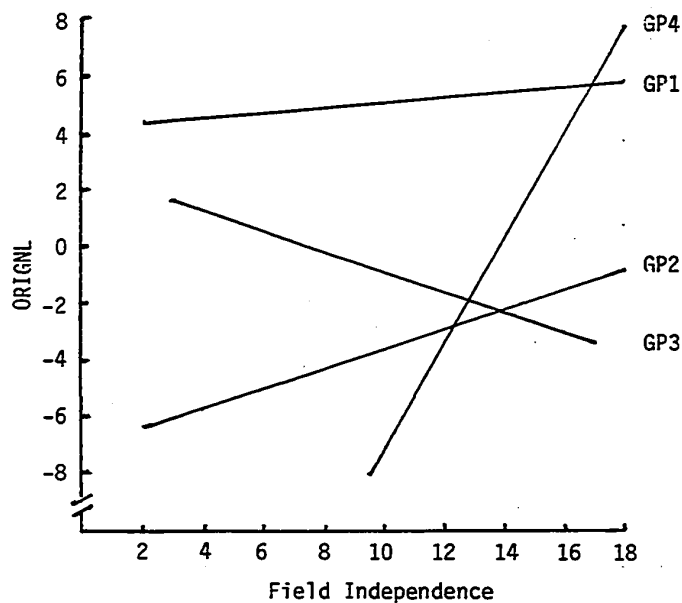
Y¹ Min = residualized ORIGNL score for low field independenceY¹ Max = residualized ORIGNL score for high field independence

Figure 2 Age Groups and Field Independence Interaction Effects on ORIGNL

Interpretation

The interaction of age and field independence is indicated by the regression line for the older group (GP4; $r = .52$; Sig $F = .015$), in contrast to the lower and negative correlations for the other three younger groups. Older adults are clearly more extreme, with higher field independents scoring higher on ORIGNL, and lower field independents scoring lower. The youngest (GP1) members are similar on ORIGNL at all levels of field independence, and higher, on average, than the other three groups. The two middle groups (GP2, 3) are lower on ORIGNL scores on average, than GP1, and less extreme than the older GP4.

Age X Field Independence on TCREATE (Sig F Change = .06; R^2 Change 5%)

The age by field independence interaction was close to the .05 level of significance on the TCREATE dependent variable, accounting for 5% of the variance in the full model. Table 18 presents the residualized and other statistical data for graphing and interpreting Figure 3.

Table 18

Standardized Residuals Regression Data (A X F on TCREATE)

Age Group	Grp	N	(b) Slope	(a) Intercept	X_i Min	X_i Max	Y^1 Min	Y^1 Max	r	sig
24-35	1	20	-.45	4.91	2	18	4.00	-3.20	-.23	.16
36-40	2	18	.29	-4.77	2	18	-4.20	.39	.11	.33
41-45	3	19	.11	-.91	3	17	-.57	.10	.05	.41*
46-66	4	17	1.17	-13.60	6	18	-6.57	7.47	.43	.04*

*
p < .05

Min = low score on field independence

Max = high score on field independence

Y^1 Min = residualized TCREATE score for low field independence

Y^1 Max = residualized TCREATE score for high field independence

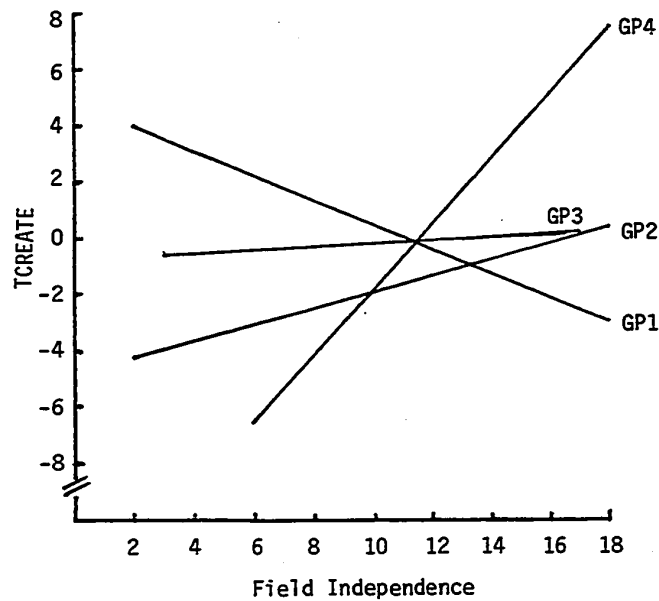


Figure 3 Age Groups and Field Independence
Interaction Effects on TCREATE

Interpretation

The most prominent indication of interaction is in the crossing of the regression lines for GP4 ($\bar{r} = .43$) and GP1 ($\bar{r} = -.23$). The pattern here is comparable to AXF on ORIGNL. Notably, the older group (GP4) is again more extreme in performance, with low field independence related to low creativity and high to high; contrasted with the opposite effect for the youngest group (GP1). Higher field scorers in GP1 tend to do less well than lower field scorers on TCREATE. Again, the middle groups (GP2, 3) are less variable or less

extreme in performance, with a low positive correlation between field independence and TCREATE; and, as on A X F on ORIGNL, younger subjects lower on field independence did as well on TCREATE as younger subjects higher on field independence.

Sex X Field Independence on FLUENT (Sig F Change .04; R^2 Change 6%)

The interaction of sex by field independence on FLUENT was significant ($p < .05$) and accounted for 6% of the variance on the full model. Table 19 and Figure 4 provide the data and graphic representation.

Table 19

Standardized Residuals Regression Data (S X F on FLUENT)

Group	N	(b) Slope	(a) Intercept	Xi Min	Xi Max	Y ¹ Min	Y ¹ Max	r	sig
Males	25	.72	-9.39	2	18	-7.95	3.57	.22	.15
Females	49	-.57	6.59	2	18	5.45	-3.65	-.28	.026*

*

$p < .05$

Min = low score on field independence

Max = high score on field independence

Y¹ Min = residualized FLUENT score for low field independence

Y¹ Max = residualized FLUENT score for high field independence

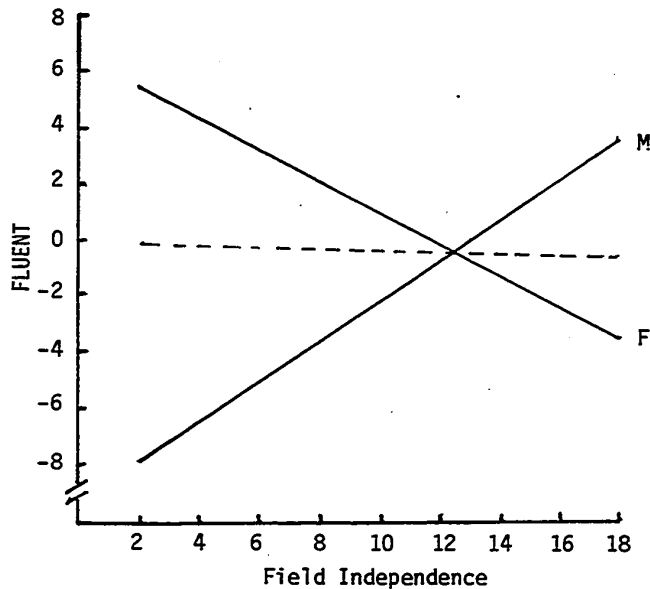


Figure 4 Sex and Field Independence
Interaction Effects on FLUENT

Interpretation

Whereas, in the main regression equation, there was no effect for field independence on FLUENT, (Sig F Change = .45) the factor did interact with sex on fluency. Males higher on field independence demonstrate (Sig F = .15; r = .22) more "fluency" than males who are lower on field independence. The reverse is true for females at Sig F = .026, r = -.28. Females lower on field independence generate low level but relevant ideas at a greater rate than those higher on the field independence scale. Over all subjects, a rough averaging of the

regression lines, as given by the dashed line, indicates near zero correlation between field independence and FLUENT; however, the interaction reveals an inverse relationship between male and female subjects in this study.

First order aptitude by treatment interaction

Of the six first order aptitude by treatment interaction variables, tested on each of the four dependent variables in the full regression model, three were eligible for analysis, with one (C2XA on FLUENT) significant at the .05 level of probability.

Contrast 2 X Age on FLUENT (Sig F Change .04; R^2 Change .06)

While there were no C2 main effects given on Table 10, C2 is an interesting variable in interaction analysis. Table 20 and Figure 5 are the first of four data representations indicating C2 interaction with individual difference variables. (Contrast 2 - lateral training with competency-based (CB) method contrasted with developmentally-based method (DB)).

Table 20

Standardized Residuals Regression Data (C2 X A on FLUENT)

Group	N	Slope	Intercept	Min	Max	Y^1_{Min}	Y^1_{Max}	r	sig
CB	29	-.20	6.36	29	66	.07	-6.64	-.16	.198
DB	23	.51	-17.54	26	52	-4.16	9.23	.38	.03*

* $p < .05$

Min = minimum age

Max = maximum age

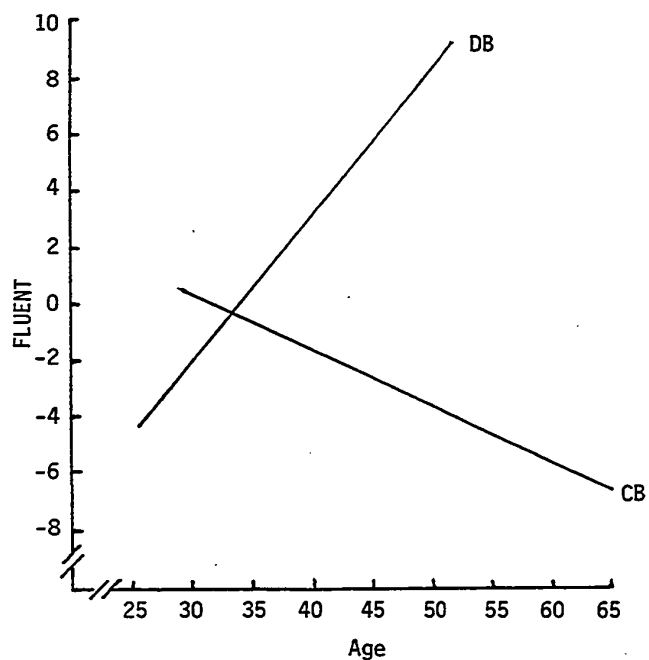
 Y^1_{Min} = residualized FLUENT score for low age Y^1_{Max} = residualized FLUENT score for high age

Figure 5 Contrast 2 and Age Interaction Effects on FLUENT

Interpretation

The interaction is indicated by the divergence on age by the two training methods. Older subjects trained by the CB method ($r = -.16$) do less well, on average, than younger subjects trained in the same method, on the FLUENT dependent variable. The more open DB method appears to better serve the needs of older subjects ($r = .38$), while younger subjects on DB do less well, on average, though not so low as older people trained under the CB method. CB trained subjects, of all ages, are more contained and perform at a much lower rate than DB trained subjects. As on C2XA on ORIGNL, and several other interactions noted, the more extreme performance of older individuals is again demonstrated, with 14 compared to 4.5 residual points for younger subjects at each extreme. The cross-over of regression lines at age 33 indicates an early start to the differential tendency on fluency performance.

Contrast 2 X Age on ORIGNL (Sig F Change .14; R^2 Change 3%)

Table 21 data and Figure 6 indicated that, as in C2XA on FLUENT, linear age was found to be interactive with Contrast 2, reinforcing the importance of age as a variable effect on treatment and the interaction of Age and C2 on ORIGNL.

Table 21

Standardized Residuals Regression Data (C2 X A on ORIGNL)

Group	N	Slope	Intercept	Min	Max	Y ¹ Min	Y ¹ Max	r	sig
CB	29	.21	-8.25	29	66	-2.05	5.80	.15	.22
DB	23	-.42	15.50	26	52	4.63	-6.29	-.26	.11

Min = minimum age

Max = maximum age

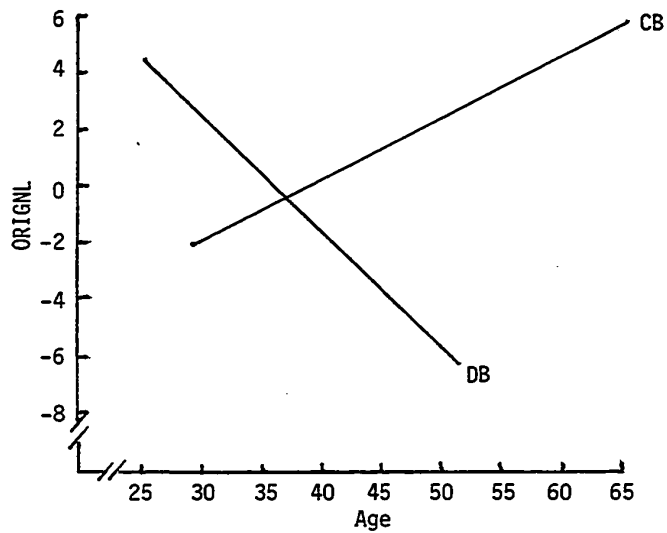
Y¹Min = residualized ORIGNL score for low ageY¹Max = residualized ORIGNL score for high age

Figure 6 Contrast 2 and Age Interaction Effects on ORIGNL

Interpretation

Older subjects trained on the competency-based (CB) method ($r = .15$), exceeded the performance, on average, of younger subjects trained by the same method on the ORIGNL dependent variable, which controls for fluency. The opposite is the case for the developmentally-based (DB) method, with younger subjects scoring at a higher rate than older subjects ($r = -.26$). The more extreme performance of older individuals is demonstrated again with a comparative (extreme) range of 12 residual points to 6.5 for younger subjects.

On the originality ratio variable, when instruction is more directive (CB), the older subjects are more productive than when instruction is open-ended (DB), whereas the reverse was the case for younger subjects, who tend to demonstrate better performance on DB than on CB.

Contrast 2 X Field Independence on FLUENT (Sig F Change .15 R^2 ; Change 3%)

The modest relationship (Sig F Change = .15) of C2XF on FLUENT, revealed a significant F ($p < .05$) negative correlation for subjects trained on the developmental (DB) method on FLUENT, when field independence is taken into account as given in Table 22 data and Figure 7.

Table 22

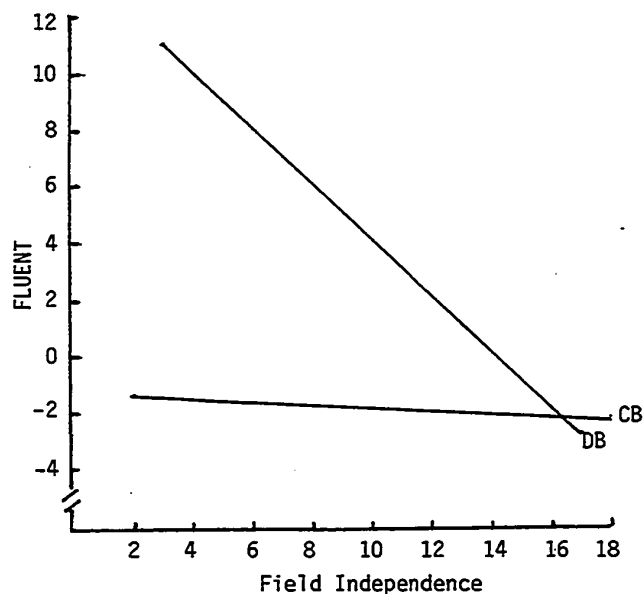
Standardized Residuals Regression Data (C2 X F on FLUENT)

Group	N	(b) Slope	(a) Intercept	Xi Min	Xi Max	Y ¹ Min	Y ¹ Max	r	sig
CB	29	-.05	-1.19	2	18	-1.28	-2.02	-.02	.46
DB	23	-1.07	15.29	3	17	11.03	-2.82	-.36	.046*

*
p<.05

Min = low score on field independence

Max = high score on field independence

Y¹Min = residualized FLUENT score for low field independenceY¹Max = residualized FLUENT score for high field independenceFigure 7 Contrast 2 and Field Independence
Interaction Effects on FLUENT

Interpretation

The interaction is based on the tendency for lower field independent subjects toward higher fluency in the DB case, and lower fluency in the CB case, with both CB and DB high field independent subjects performing close to the mean on FLUENT, at a level similar to low field independent CB subjects. In the CB case, the correlation of field independence and fluency is near zero ($r = -.02$), with subjects dispersed over all cells. In contrast, the DB subjects form a negative regression line ($r = -.36$; Sig $F = .046$). Competency-based training did not appear to have much influence on fluency, over subjects at all levels of field independence.

Second order aptitude treatment interactions

Of the six second order aptitude by treatment interactions, on the four dependent variables, two (C1XAS on TCREATE and C2XSF on ORIGNL) registered as near significant. Contrast 1 (treatment contrasted with control), by linear age by sex, interacted on TCREATE. This was the single interaction involving C1. The C2XSF interaction on ORIGNL, numbered the fourth interaction in which C2 was involved. These results indicate the importance of reviewing the C2 interaction effects, in contrast to the limited main effect impact of C2, as given in Table 10.

Contrast 1 X Age X Sex on TCREATE (Sig F Change .06; R^2 Change 5%)

Age effects, in relation to Contrast 1 and to gender effects, on TCREATE, are indicated in the Table 23 data and Figure 8.

Table 23

Standardized Residuals Regression Data (C1 X A X S on TCREATE)

Group	N	Slope	Intercept	Min	Max	Y^1_{Min}	Y^1_{Max}	r	sig
ET(M)	17	-.19	10.21	34	66	3.41	-2.99	-.20	.22
ET(F)	35	.18	-5.88	26	56	-1.20	4.20	.16	.18
C(M)	8	.15	-11.00	31	58	-6.35	-2.30	.12	.38
C(F)	14	-.33	9.65	29	45	-.08	-5.20	-.20	.24

Min = minimum age

Max = maximum age

Y^1_{Min} = residualized TCREATE score for low age

Y^1_{Max} = residualized TCREATE score for high age

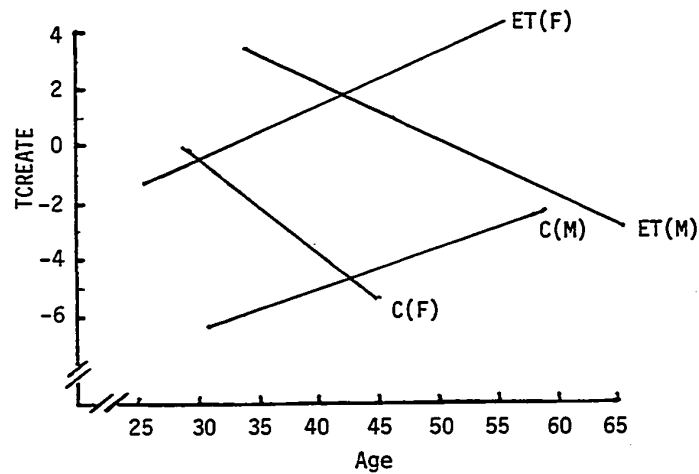


Figure 8 Contrast 1 and Age and Sex Interaction Effects on TCREATE

Interpretation

Contrast 1 (lateral treatment group contrasted with vertical control group) interacts with two organismic variables, sex and age, on TCREATE. The fairly low level of differentiation among the regression lines advises caution in attributing relationships. The two more prominent results are the negative regression lines for treatment group males (ET(M), $r = -.20$) and control group females (C(F), $r = -.20$). Both regression lines are inverted in relation to their male and female treatment and control counterparts. Detailed analysis of the four nonsignificant regression lines is not appropriate. However, it is interesting to note that if a line is drawn at the zero or mean residual point, parallel to the abscissa, it is visibly apparent that the larger percentage of treatment subjects (ET(M) and ET(F)), trained in lateral thinking, scored above the mean point on TCREATE; whereas the control (C(M) and C(F)) subjects trained in vertical thinking were all below the residual mean.

Contrast 2 X Sex X Field Independence on ORIGNL (Sig F Change .07; R² Change 4%)

The interaction of C2 (competency-based method contrasted with developmentally-based method) by sex and field independence on ORIGNL, as given in Table 24 data and Figure 9, is a complex interaction confounded by small n . However, selective analysis of the regression lines revealed several potentially useful insights.

Table 24

Standardized Residuals Regression Data (C2 X S X F on ORIGNL)

Group	N	Slope	Intercept	Min	Max	Y ¹ Min	Y ¹ Max	r	sig
ET1(CB)M	12	.81	-7.00	2	18	-5.38	7.58	.28	.18
ET1(CB)F	17	-.29	2.54	2	18	1.96	-7.78	-.11	.34
ET2(DB)M	5	-4.90	56.13	10	16	7.13	-22.27	-.79	.05*
ET2(DB)F	18	1.04	-12.31	3	17	-9.19	5.37	.39	.05*

* p<.05

Min = low score on field independence

Max = high score on field independence

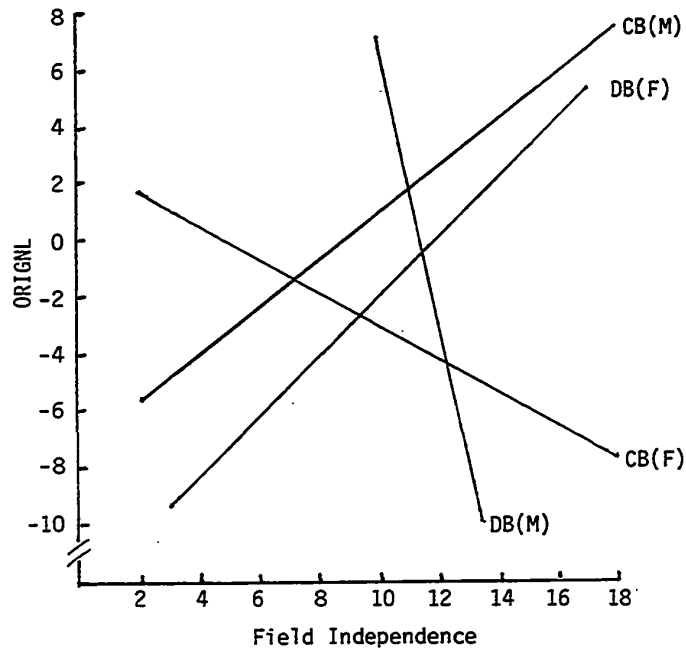
Y¹Min = residualized ORIGNL score for low field independenceY¹Max = residualized ORIGNL score for high field independence

Figure 9 Contrast 2 and Sex and Field Independence Interaction Effects on ORIGNL

Interpretation

The interaction is demonstrated most clearly by the double crossing regression lines of CB males ($\bar{r} = .28$) and CB females ($\bar{r} = -.11$), and, more erratically, by the cross-over of the DB males ($\bar{r} = -.79$) and DB females ($\bar{r} = .39$). CB trained females, low on field independence, outperform CB females higher on field independence on the "original" ratio variable controlling for fluency; whereas the reverse is true for CB men. The opposite effect is the case in comparing DB male and DB female performance. High field independent DB females outperform the lower field independent females, with DB men narrowly confined on a field independence range of 10 to 16 points, an artifact of small n .

Curvilinear analysis - First order trait (age) treatment interaction

The results of the interactions of C1 X G1 on TCREATE and FLUENT, were generally similar in function, and are interpreted together following Tables 25 and 26 and Figures 10 and 11. As graphically demonstrated, the regression patterns for the laterally-trained subjects are in the hypothesized direction, whereas the vertically-trained subjects are in the opposite direction. The curvilinear hypothesis, testing for main effects of the middle group over the older and younger groups, trained on lateral thinking, was discussed in the analysis of the research hypotheses section. Tables 37 and 38, in Appendix G, give the career-age group breakdown contrast coding to control for n .

Treatment Contrast 1 X Age Group Contrast 1 on TCREATE
(Sig F Change .06; R^2 Change 5%)

Table 25

Standardized Residuals Regression Data (C1 X G1 on TCREATE)

A Contrast 1 - Training in Lateral Thinking (CB + DB)

Age Group	Valid N	Mean	Standard Dev	Min	Max
Young	12	1.39	7.75	-9.80	14.70
Middle	23	2.13	9.70	-13.07	22.90
Older	17	.39	8.90	-15.00	15.60

B Contrast 1 - Training in Vertical Thinking (Control)

Age Group	Valid N	Mean	Standard Dev	Min	Max
Young	6	-1.2	7.3	-8.76	12.4
Middle	12	-6.0	10.1	-27.90	10.5
Older	4	1.7	8.2	-8.80	10.4

Min = lowest standardized residual for TCREATE scores on group

Max = highest standardized residual for TCREATE scores on group

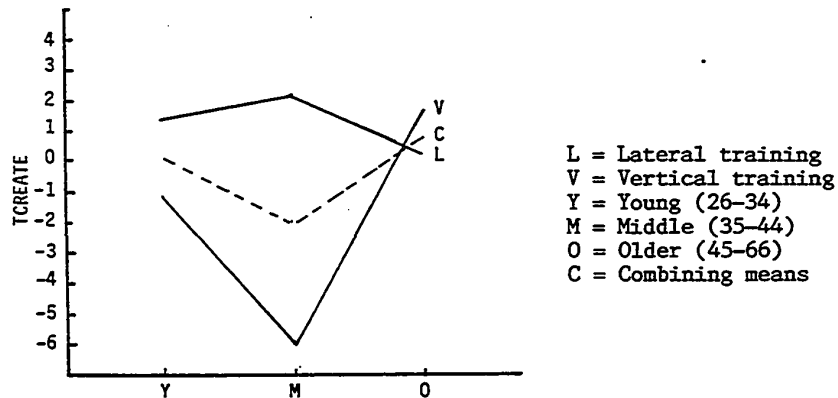


Figure 10 Treatment Contrast 1 and Curvilinear Age Group Contrast 1 Interaction Effects on TCREATE

Treatment Contrast 1 X Age Group Contrast 1 on FLUENT
 (Sig F Change .07; R^2 Change 4%)

Table 26

Standardized Residuals Regression Data (C1 X G1 on FLUENT)

A Contrast 1 - Training in Lateral Thinking (CB + DB)

Age Group	Valid N	Mean	Standard Dev	Min	Max
Younger	12	-2.70	10.9	-19.1	16.9
Middle	23	1.76	11.4	-19.7	30.0
Older	17	1.50	10.4	-14.1	26.6

B Contrast 1 - Training in Vertical Thinking (Control)

Age Group	Valid N	Mean	Standard Dev	Min	Max
Younger	6	-1.9	6.0	-8.7	6.3
Middle	12	-4.2	7.5	-21.2	7.6
Older	4	7.0	9.0	-2.9	17.0

Min = lowest standardized residual for FLUENT scores on group
 Max = highest standardized residual for FLUENT scores on group

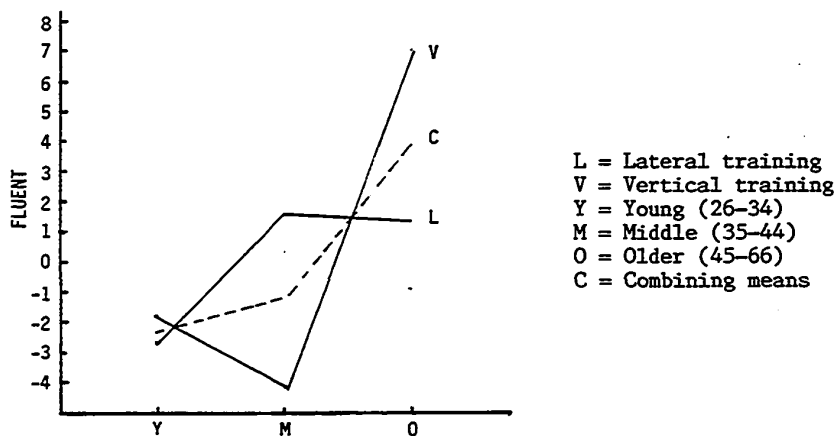


Figure 11 Treatment Contrast 1 and Curvilinear Age Group Contrast 1 Interaction Effects on FLUENT

Interpretation

For C1 X G1 on TCREATE and FLUENT, the Sig F Change results given in Table 12, indicated interactions and not main effects. Combining the results (dashed line C on Figures 10 and 11), of both laterally and vertically trained subjects, gave a graphic impression of little difference in achievement among all three age groups on TCREATE, and a positive "linear" relationship on FLUENT.

The interaction is occasioned by the opposite shapes of the curves, on both dependent variables. The difference between lateral and vertical middle groups on FLUENT is paralleled by a larger difference on TCREATE. Relating to several other interactions involving age, younger subjects tend to cluster at the mean, on both FLUENT and TCREATE. The two middle groups are divergent on both variables, and the older groups are divergent on FLUENT. The extreme performance of the older, vertically trained subjects should be considered in the light of small cell n. The extreme performance of older subjects on the production of low level (FLUENT) responses is in some contrast to the results on overall creativity (TCREATE).

Figures 10 and 11 reveal a clear differential between the residualized means of the middle career-age groups, who comprised the larger cell numbers. The laterally trained subjects are clearly superior to the vertically trained subjects. This middle career-age group differential warrants further inquiry.

Effectiveness of the Regression Analysis: Four Dependent Variables

The overall R^2 for the four multiple regression equations given in Table 10 accounted for a modest amount of variability; however, the "predictor" variables could not be said to have represented a strong model. The most variance accounted for was on FLEXBL, with an R^2 of .39, leaving 61% of the variance to the error term. Of the 39% of the variance accounted for, 72% of that was attributed to verbal comprehension, field independence and a first order individual difference variable (A X F) indicating the strength of the two aptitude variables in relation to FLEXBL, the flexible production of ideas as gauged by Alternate Uses. Thirty-seven percent of the variability was accounted for on ORIGNL, 33% on FLUENT and 29% on TCREATE. These summary results indicated that the model worked best with FLEXBL, and that the "universal" outcome variable TCREATE was the most difficult to account for, with this particular model.

Summary of Regression Results

Of the four hypotheses for main effects tested on the four dependent variables, two of the sixteen possibilities were significant at the .05 level of probability. Verbal comprehension and gender are not included in the estimate of sixteen, since they were not hypothesized.

The hypothesized Contrast 1 on ORIGNL (originality controlled for fluency) gave evidence that subjects trained in lateral thinking significantly ($p < .05$) outperformed subjects trained in vertical thinking. The hypothesized C1 on TCREATE (total test scores, weighted for originality) failed to achieve the .05 level of significance. The Sig F Change value ($p = .10$) indicated potential for analysis and future inquiry.

The hypothesized field independence on FLEXBL (Alternate Uses) indicated that subjects higher in field independence ability attained results which were significantly ($p < .05$) higher than subjects lower in field independence.

The hypothesized curvilinear age contrast failed to achieve significant main effects for the laterally-trained, middle career-age group over early and later groups on any of the four dependent variables, although two interactions between laterally and vertically trained subjects were noted, C1XG1 on TCREATE and FLUENT.

There were no hypotheses set for the linear age variable; however, in the exploratory dimension age was significant ($p < .05$) on ORIGNL, with younger subjects tending to outperform older subjects, when fluency is controlled by ratio means, and verbal comprehension is statistically controlled. Gender differences were nonsignificant on the four divergent production dependent variables.

The covariate was, as anticipated, a strong test of the independent and moderator variables, in accounting for significant differences on three of the four dependent variables TCREATE, ORIGNL and FLEXBL, but not on FLUENT.

Of the nine significant and interesting interactions noted in Table 10, and the two interesting interactions in Table 11, three were significant at the .05 level of probability. Two were individual difference interactions (AXF on FLEXBL and SXF on FLUENT), and one was a second order aptitude by treatment interaction (C2XA on FLUENT). The eight other interactions explored were in the .05 to .15 probability range. Of the total of eleven interactions analyzed, Contrast 1 was implicated in three and Contrast 2 in four. Age appeared prominent, with linear age in three interactions, the four discrete age group model in three, and the three discrete age group model in the two curvilinear interactions. Field independence was involved in six interactions. Of the "predictor" variables in the model, gender was involved in the fewest interactions with two.

The following summary statements provide a review of both significant and interesting results derived from the exploratory interaction analyses of the tabular and graphic data for the Figures 1 to 9. These tentative observations are presented in the interest of future problems for research and for suggesting the value of interaction analysis for informing professional development and training.

1. Training in lateral thinking tended to be a more effective stimulator of creativity for older females and younger males than for older males and younger females (Figure 8).

2. Older subjects performed better on the developmentally-based (DB) method than on the competency-based (CB) method on fluent production (Figure 5); but better on the CB method than the DB method on the production of original ideas, with fluency controlled (Figure 6).
3. Older subjects, higher on field independence, tended to perform better on flexibility of thinking than older subjects with lower field independence scores, and better than younger subjects at all levels of field independence (Figure 1).
4. Level of field independence ability, in relation to the production of flexible and original ideas, does not appear to influence younger (group 1) subjects to the extent that the cognitive style variable influences older (group 4) subjects. Group 4 subjects form positive and significant regression lines for field independence on FLEXBL and ORIGNL (Figures 1, 2). The older subjects in this study tended to be more variable than younger subjects in divergent production performance.
5. Averaging the interacting regression lines over all subjects, level of field independence ability has no clear influence on the fluent production of low level responses, as indicated by the dashed "zero" regression line on Figure 4.

6. Male performance on field independence ($r = .22$) is inversely related to female performance ($r = -.28$) on fluency (Figure 4).
7. Group 4 older subjects, lower on field independence, performed at lower rates of divergent production on FLEXBL, ORIGNL and TCREATE, as noted in Figures 1, 2, and 3.
8. Under the competency-based method, males, higher on field independence, perform better on the production of original ideas (controlling for fluency), than high field independent females, who demonstrate more success under the developmentally-based method (Figure 9).

The analysis of main effects and interactions were tempered by an awareness of the limitations of the study. The interaction results were complex and to some extent contradictory; however, these problems are not unusual in research, and were not taken as a deterrent to selective analysis, exploration and discussion.

Further analysis of results

The results for main effects and interactions reported in Chapter IV, and discussed in Chapter V, are reviewed in Appendix C, with additional speculations and implications for training. Chapter V presents a summary of the research study purpose, procedures, hypotheses, limitations to the study, major findings and conclusions, and recommendations for future study.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

Chapter V includes a summary of the purpose and methodological procedures and hypotheses, a review of limitations, principle findings and conclusions, unanticipated results, and recommendations for future research.

Summary

Creativity training for professionals has been recognized as important in dealing with the complex problems and pressures facing society and organizations. Research and evaluation on training in divergent thinking, a predecisional phase in problem solving, has provided evidence of success in advancing subject skills in the flexible production of many (fluent) and original ideas.

The main research purpose of this study was to investigate the treatment effects of training continuing educators in deBono's lateral thinking concepts and techniques on their skill at solving sets of problems requiring the divergent production of ideas. These problems were the components of the factor-analyzed tests of fluency, flexibility, and originality, from the Operations plane of Guilford's Structure of Intellect model.

The overall research goal, of this quasi-experimental study, was to contribute information to the small body of research on creativity training concerned with adult cognitive development; specifically, on lateral or divergent thinking, and in relation to both treatment and individual difference variables. In the interest of field development, this research, particularly the exploration of interaction analysis, was an exercise to obtain information for planning professional development for continuing educators. The workshops were intended to encourage subjects to acquire deBono's imaginative and nonlogical lateral thinking techniques, as a means of more readily dealing with decision making and problem solving responsibilities, and as a resource base for the instruction of associates, students and adult clientele.

Four sets of hypotheses were designed to test the key research problems and interests. The first set of four hypotheses anticipated that subjects trained in lateral thinking would significantly ($p < .05$) outperform subjects trained in more traditional vertical or logical thinking exercises, on the divergent production of ideas represented by the dependent variables TCREATE, ORIGNL, FLUENT and FLEXBL (See Table 1, Chapter I). The second set of four hypotheses projected that the group trained in lateral thinking on the competency-based method (directive) would perform at a significantly higher level on the divergent production dependent variables than the group trained in lateral thinking on the developmentally-based method (non-directive). The third set of four hypotheses projected that subjects who score

higher on field independence would perform at a significantly higher level on divergent production dependent variables than subjects who score lower on that cognitive aptitude scale, and who might be described as more field dependent. The fourth set of four hypotheses projected that laterally trained subjects in middle career-age group would significantly outperform the early and later career-age groups on the divergent production dependent variables.

Exploratory analysis was undertaken on the question of male/female differentiation on divergent production, and on a set of first and second order interactions to study the effects of individual differences, with treatment variables, on the divergent production dependent variables.

Three professional development research-workshops, on the subject of "Decision Making" were announced to continuing educators in professional associations and institutions of higher education in British Columbia. Prospective participants completed a career development survey, were sent information on the research-workshops and signed an agreement form for eligibility to attend.

One hundred volunteer subjects (90% from the Greater Vancouver area) were randomly assigned, by age and gender, to three groups, and the groups to three one-day workshops. A total of 74 adult continuing educators, 25 males, 49 females, participated in the study. The two treatment workshop groups, and the one control group, were taught by trained instructors. Instructional guidelines and specially-designed participant materials were developed by the researcher in order to insure effective presentations, and to control for sources of

variability in the workshop settings.

Two aptitude tests were given in a forty minute session immediately prior to the start of the workshop, Witkin's Group Embedded Figures Test (1971) of field independence, and Guilford's Verbal Comprehension (1981) test. The five hours of instruction included a one-hour orientation to decision making and, in the case of the two training (CB and DB) groups, four hours of training in lateral thinking concepts and techniques. The control group received a different one-hour orientation on decision making, followed by three hours of training in vertical thinking exercises and case study problem solving. The competency-based treatment group was instructed according to specific guidelines of a directive nature; the developmentally-based treatment group experienced a facilitative, less directive workshop program. The control group was instructed on a lecture-discussion method.

Three of Guilford's divergent thinking tests, comprised of problems requiring divergent production of ideas, Plot Titles, Consequences II, Alternate Uses, collected performance data on fluency, flexibility and originality of thinking, from the three groups, in a similarly administered thirty minute session at the end of the workshops. The divergent thinking tests were scored by two markers on the basis of test manual guidelines and negotiated judgment.

Dependent variables on the four multiple regression equations were derived from the three components of Guilford's tests of divergent production, fluency, flexibility and originality: FLUENT, a straight count of nonoriginal, but relevant responses; FLEXBL, a straight count

of eligible responses on Alternate Uses, described as a test of flexibility of thought; ORIGNL, a ratio variable controlling for fluency by dividing original responses by total original and nonoriginal responses; and TCREATE, or total creativity, summing all original and nonoriginal and flexible responses, and controlling for nonoriginal and fluent responses by multiplying original responses by a factor of 2.

Data were analyzed by means of the Statistical Package for the Social Sciences (SPSSx, 1983) computer program for multiple regression. Hypotheses for main effects were tested, and interactions explored, by the regression analysis. The full regression model, based on a priori order of entry, included: (a) a set of individual difference variables: the covariate, verbal comprehension, and three moderator variables, field independence, age and gender, and their first order interactions; (b) the two sets of treatment contrasts; and, (c) a set of first and a set of second order aptitude by treatment interaction variables. Error degrees of freedom were established at $N = 74 - 22 = 52$; and significance levels were set at $p < .05$ for hypothesized main effects, and $.05 < p < .15$ for exploring treatment contrasts and interactions. For each of nine interactions noted in the full regression model, a special regression model was devised to "unpack" the interactions and produce residualized data for graphic analysis. A separate full regression model was run to test the curvilinear age hypothesis, contrasting laterally-trained middle career-age subjects with early and late career-age subjects, and to analyze two additional interactions. Post hoc correlational and

one-way ANOVA results were calculated, using SPSSx, to support the analysis of results.

As a result of the procedures the following results were found for the four research hypotheses on each of the four dependent variables: TCREATE, ORIGNL, FLUENT, FLEXBL.

On the first set of hypotheses, training in lateral thinking was projected as a means for stimulating subjects to significantly improve their divergent production of ideas, in contrast with subjects trained in a more traditional, vertical thinking content. The results were significant ($p < .05$) on one of the four dependent variables, ORIGNL. Laterally-trained subjects outperformed vertically-trained subjects on ORIGNL, the production of original ideas controlling for fluency, but not on TCREATE, FLUENT or FLEXBL.

On the second set of hypotheses, the more structured competency-based method was projected as a significantly superior method for training subjects in lateral thinking for divergent production, in contrast to the less structured developmentally-based method. The results were nonsignificant on all four versions of the divergent production dependent variables.

On the third set of hypotheses, it was projected that there will be a significant and positive correlation between subjects' field independence ability and performance on the divergent production

dependent variables. The results indicated significance ($p < .05$) on one of the four dependent variables, FLEXBL, or flexibility of thought, but not on overall creativity (TCREATE), fluency (FLUENT) or originality (ORIGNL).

On the fourth set of hypotheses, it was projected that middle career-age subjects would be significantly related to the measures of divergent production, in contrast to the performance of older and younger subjects. The results of the "curvilinear" contrast were nonsignificant for main effects on all four dependent variables.

Limitations To the Study

Previously identified limitations to this study were noted in Chapter I. The limitations reported here relate to those stated at the onset of the study, and introduce additional factors arising from the experimental research experience.

1. In an multiple regression study, the order of entry of variables is a limitation. If ordered differently, the effects of independent, moderator and interactive variables would result in changes to the R^2 Change. The incremental accounting for variance, by stepwise regression, varies from one order of variables to another, and can mean shifts in significance or nonsignificance in the effects of a

particular variable, or interactive combination on the dependent variable.

2. The sample size ($N = 74$), and the imbalance between males (25) and females (49), resulted in small cell n problems in the interaction analysis.

3. The relatively small numbers for a multiple regression analysis, the volunteer nature of subject involvement, the random assignment only, and the influence of the drop-outs on the random assignment procedure, precluded the generalization of results to the larger population of continuing educators.

4. Instructors, as variables, place limitations on a study. Instructors were provided training and guidelines in an effort to control performance. But having a different team of instructor and associate for the control group introduced a problem, in that instructors were not crossed over all groups. It is important to note that all instructors were male. In terms of social interaction, and gender considerations, that situation will have had a variable impact on the subjects and the learning environment.

5. The degree of discriminant validity of the problems comprising the Guilford tests, in assessing treatment by testing divergent production, was a cause for some concern. The effectiveness of the deBono content and techniques has not been well documented, nor is

there evidence of correlation of test and treatment (r_{tt}), with Guilford's tests of divergence assessing deBono's treatments.

6. Reconceptualizing dependent variables, from the divergent thinking tests and their constructs of fluency, flexibility and originality, is common practice in training research. But little research material exists which examines the processes and effects of selective transformation of test factors or responses (clever, non-clever from Plot Titles, remote, obvious from Consequences II, and flexible from Alternate Uses) into combinations of specialized dependent variables. There were three such dependent variables in this study, derived by the weighting on TCREATE, by ratio means on ORIGNL, and by including nonoriginal responses only, excluding original responses, on FLUENT.

7. Alternate Uses was third, out of the three tests employed to gauge the effectiveness of training in lateral thinking, correlating lowest with Plot Titles and Consequences II on an intercorrelation matrix, as given in Table 35, Appendix F. The DMT (divergent, seMantic, transformation) originality-transformational (DMT) element, claimed by Guilford as a secondary but important factor for Alternate Uses (DMC - divergent seMantic classes) was clearly secondary in this study. A univariate ANOVA result, given as Table 28 in Appendix F, comparing control groups and treatment on Alternate Uses, and confirmed by the multiple regression analyses, resulted in a question as to the test's validity as a measure of divergent production; at least on this sample of adult subjects.

8. The limitation imposed by the four hours of instruction in lateral thinking must be considered as a factor in recognizing the modest results obtained in this study for hypothesized treatment effects. Although a number of creativity researchers have provided evidence of the effectiveness of short time training in divergent thinking on problem solving, a longer or periodic and equally intensive training session may be necessary for adult learners to demonstrate significantly improved ability in the application of deBono's lateral thinking content and techniques for the divergent production of ideas.

Principle Findings and Conclusions

The findings and conclusions relate to the present sample of subjects only. Generalization to the larger population of continuing educators is not appropriate in a study based on volunteer participation and without the random selection of subjects.

The principle findings and conclusion section is set out in five parts to reflect the hypothesized and exploratory research interests of the study: hypothesized and significant ($p < .05$) main effects findings; hypothesized main effects findings in the exploratory ($.05 < p < .15$) range; exploratory findings for significant ($p < .05$) main effects of individual difference variables; exploratory ($.05 < p < .15$) findings for main and interactive effects of gender; and, exploratory findings for interaction analysis.

Hypothesized and significant main effects findings:

1. Controlling for the previously entered variables (See Table 10), training in deBono's lateral thinking concepts and techniques resulted in significantly ($p < .05$) better performance on the ORIGNL dependent variable, the production of original ideas when fluency, or numbers of responses, is controlled by a ratio method. This finding provides evidence that the continuing educator subjects, randomly assigned to the lateral thinking treatment group, significantly outscored the continuing educator subjects randomly assigned to the control group given training in vertical thinking exercises. The laterally-trained group produced a significantly higher ratio of clever and remote responses, when fluency was controlled by dividing original responses by total number of original and nonoriginal responses. This ORIGNL measure is based on an economy principle to value original ideas over sheer fluency of nonoriginal ideas.

2. The regression results indicated that the cognitive style variable, field independence, did not have an overall strong main effect relationship with divergent production, as evidenced by low partial correlations on three out of the four dependent variables. Field independence is significantly ($p < .05$) related to flexibility (Alternate Uses), statistically controlling for verbal comprehension, age and sex, but not to two measures of originality (TCREATE and ORIGNL) nor on fluency (FLUENT).

It may be concluded that low field independent (or field dependent) subjects are not significantly different from high field independent subjects, on the fluent production of ideas, and on originality;

however, the field independence cognitive style is positively and significantly correlated with flexibility of thought, as represented by the Alternate Uses test.

Hypothesized main effects findings in the exploratory (.05 < p < .15) range:

3. On the total creativity (TCREATE) variable, arrived at by summing scores on fluency, flexibility and originality, with originality weighted by a factor of 2, training in deBono's lateral thinking concepts and techniques resulted in continuing educator subject performance in the direction of significance, at a probability level of .10, in contrast to the performance of vertically-trained subjects. Although this result must be treated with caution, it is apparent that training in deBono's lateral thinking concepts and techniques had a considerably more of an impact on "total creativity" than training in vertical thinking.

4. Training in lateral thinking on the competency-based (CB) method is not significantly different from training in lateral thinking on the developmentally-based (DB) method on ORIGNL, TCREATE, FLEXBL or FLUENT. However, the multiple regression data gave evidence that the DB method did encouraged the fluent (FLUENT) production of low level responses in the direction of significance, with a probability level of .105.

This result, although not within the .05 level of significance, suggests that training in lateral thinking techniques on the less directive, developmentally-based method, was more effective for stimulating the fluent production of nonoriginal but relevant ideas than the more directive competency-based method.

5. The regression model, contrasting the three part age group classification (middle career-age contrasted with early and later), resulted in no indications of significant main effects on the four dependent variables.

Exploratory findings for significant ($p < .05$) main effects of individual difference variables

6. The regression analysis of the main effects of linear age revealed that younger subjects significantly ($p < .05$) outperformed older subjects on the (ORIGNL) original production of ideas controlling for fluency, when verbal comprehension is statistically controlled. There were no significant differences for linear age on the other three dependent variables, FLUENT, TCREATE or FLEXBL.

7. The strength of the verbal comprehension covariate made an important impression on the results of this study. Its inclusion in the regression equation was premised on the need to have a measure of general intelligence as a test of the effectiveness of treatment and the moderator variable in the main effects analysis. Level of verbal comprehension accounted for significant differences in variance on creativity (TCREATE), originality (ORIGNL) and flexibility (FLEXBL), but not fluency (FLUENT).

From this evidence it may be concluded that, for subjects in this study, the higher the verbal comprehension ability the higher the originality and flexibility scores. Verbal comprehension served as an effective covariate on all but fluency, and was the strongest "predictor" variable in the model.

Exploratory findings for main and interaction effects of gender:

8. There were no main effects differences on divergent production between male and female subjects. Gender differences were not an important factor in the main effects analysis. However, one interaction (Figure 4 - sex by field independence on FLUENT) indicated that low field females and high field males are more productive on fluency than low field males and high field females.

Exploratory findings for interaction analysis:

The following findings are supported by evidence presented in the exploratory interaction analyses. They were selected and are presented here as interesting, speculative results, and as possible questions for hypothesis building and future multivariate and interaction research.

9. One interesting interactive pattern to emerge is the contrasting performance of younger and older subjects. Four interactions involving age as a component (one on each of the four dependent variables) indicated that younger subjects tended to group more closely than older subjects, on the divergent production of ideas. (See Figures 1,3,5,6,) The regression lines give evidence that the scores of younger subjects tend to be less variable than older subjects. Older subjects demonstrate a tendency to greater variance than younger subjects, scoring both higher and lower. This differential pattern suggests the possibility of a changing ability profile accompanying age.

10. The level of field independence ability of younger subjects (A X F on FLEXBL, ORIGNL, TCREATE; Figures 1, 2, 3) appeared not to be positively correlated with the divergent production of original ideas. The opposite was the case for older subjects in groups 3 and 4 on Figure 1 and group 4 on Figure 2 and 3, with higher field independence related to higher production of original ideas and low field independence to lower production.

11. On the production of low level, but relevant ideas, or straight fluency, (C2 X A on FLUENT, Figure 5, $p < .05$), older subjects benefited significantly more from the developmentally-based (DB) method than the competency-based (CB) method. However, when fluency is controlled by a ratio method, as in ORIGNL (C2 X A on ORIGNL; Figure 6), older subjects performed better (not significantly so) on the CB method. Viewing the interaction results on Figures 5 and 6, it is apparent that directive settings (CB) worked for older subjects on ORIGNL, whereas nondirective settings (DB) worked for older subjects on the FLUENT production of fluent or low level ideas.

Observations on Findings and Conclusions

The results of testing the first set of treatment hypotheses presented modest evidence that training in deBono's lateral thinking techniques resulted in superior performance by the continuing educator subjects on the originality-related dependent variables, with a significant result ($p < .05$) on ORIGNL, and a probability level of .10 on

TCREATE. This was not the case on the FLUENT and FLEXBL dependent variables, where the vertically-trained control group scored at a rate similar to the laterally-trained treatment group. Post hoc analysis, by means of univariate ANOVA, indicated that the deBono techniques were most effective on the Consequences II test, which contained the "remote" (original) component. A Scheffe analysis gave evidence that the two treatment groups were significantly ($p < .05$) superior to the control group (See Tables 29, 30, Appendix F). On the other hand, the ANOVA results indicated that deBono treatment had no significant impact on Alternate Uses (the equivalent of FLEXBL). In fact a comparison of means and standard deviations revealed very similar results for treatment and control groups (See Table 28, Appendix F).

The ANOVA analyses suggest that deBono's lateral thinking techniques, based as they are on reservation of judgment and nonlogical premises, have significant impact on "remote" (which, with "clever", comprises the numerator for ORIGNL) or implausible problem situations, where free-flowing imagination is all important (See Table 34, Appendix F). The factor which Guilford calls "flexibility" (flexible production of ideas) represented by Alternate Uses, did not respond to the deBono techniques employed in this study; nor did the deBono techniques have any more effect than training in vertical thinking on stimulating fluency; that is, production of nonoriginal but relevant responses.

The nonsignificant results for the second set of treatment hypothesis, on the projected superiority of the competency (CB) over the developmentally-based (DB) method, may indicate that both deBono techniques and the divergent production of ideas, may be incompatible

with directive and structured learning environments. Perhaps the tools for creativity cannot be effectively learned in programed settings where the emphasis is on individual performance rather than interactive participation. In the regression analysis of the CB:DB contrast, the single result of note indicated that subjects trained on the DB method performed at a higher rate ($p = .10$) than subjects trained on the CB method in the FLUENT production of nonoriginal ideas. The open environment may have encouraged the generation of numbers of ideas. The expected efficiency of the CB method, given the short four hour training time, failed to match the level of divergent production of the DB method. Post hoc ANOVA revealed higher means for the DB group than the CB group on Plot Titles and Consequences II tests, as given in Table 28, Appendix F.

Whereas the main effects of Contrast 2 (CB:DB) were nonsignificant and of limited informational value, a number of interactions revealed interesting insights into the two methods. For example, Figure 9 reveals that CB-trained males, who are higher on field independence, performed better ($r = .28$) on ORIGNL than CB-trained high field independent women ($r = -.11$). High field independent women demonstrated more success under the DB conditions ($r = .39$).

The anticipated strength of field independence, on the four divergent production dependent variables, resulted in significance ($p < .05$) on FLEXBL only. The regression model indicated that this visual abstraction skill did not correlate significantly with the originality-related dependent variables ORIGNL and TCREATE. The moderately strong correlation of field independence and FLEXBL ($r = .32$), and the minimal

relationship between field independence and both ORIGNL ($r = .09$), and TCREATE ($r = .12$), point up an interesting result for future analysis (See Appendix F, Table 34).

The value of conducting interaction analyses with cognitive aptitude variables, such as field independence, is indicated in considering item 4 in the Chapter IV summary. The level of field independence ability, in relation to the production of original ideas, appears to be a less important factor for younger subjects than for older subjects, who are more variable. This result relates to the suggested general differential on age, with younger subjects tending to cluster closer to the mean on the dependent variables, and older subjects more differentiated.

In addition to modest confirmation that training in lateral thinking skills had a positive main effect impact on the original (particularly the "remote") production of ideas, the importance of individual difference variables, in main effects analysis, was indicated by: (a) the relationship of field independence to FLEXBL (See Table 34, Appendix F); (b) the significant results for linear age on ORIGNL reported in the Principle Findings and Conclusions section; and (c) the strong effects of verbal comprehension on ORIGNL, TCREATE and FLEXBL. Furthermore, the interaction analysis gave support to the importance of individual difference variables; that is, to the interrelationships of field independence, age and sex, with treatment contrasts, on the four dependent variables, as reported in the Summary of Regression Results in Chapter IV. Insights which would otherwise have remained unnoticed surfaced through the exploration of interaction analysis.

The limited evidence in the literature (Guilford, 1978, 1980, 1981) reported positive and significant correlations between field independence and originality (clever, remote). This was not the case in this study. Field independence was not significantly correlated with originality measures (See Table 34, Appendix F). No research reports were found on the correlation between field independence and Alternate Uses, which did result in a positive and significant relationship in this study.

Appendix C contains additional selective analysis of main effects and interactions, including specific observations on implications for training.

Unanticipated Results

1. In the regression analysis this study explored the TCREATE dependent variable; that is, "total" creativity, incorporating fluency, flexibility and originality, with originality weighted 2:1. ANOVA and regression results indicated little differentiation between treatment and control groups on flexibility (Alternate Uses). From this it may be concluded that the phenomenon of "spontaneous flexibility" failed to discriminate between treatment and control groups, and, apparently served as a damper, or a control, on TCREATE. The ineffectiveness of training in lateral thinking techniques to stimulate "flexibility" resulted in failure to achieve significance on the TCREATE dependent variable. This damper effect was an unexpected but interesting development.

2. The competency-based (CB) method may inhibit lateral thinking and the free association of ideas. The method aims at the production of learning systems, techniques and tools, as distinct from the less structured developmentally-based method, which is based more on social learning and intuition. Given the "technique" emphasis of deBono's approach to divergent production, it had been expected that the CB method would be more effective than the DB method. This was clearly not the case.

If techniques or tools are essential in the stimulation of divergent production, as suggested by deBono, the results in this study indicate the importance of employing the systems or tools in more open developmentally-based learning environments.

3. A higher level of resistance than expected was observed in the behavior and evaluative comments of participants, in response to the nonjudgmental and nonlogical components of deBono's concepts and techniques. Lateral thinking, in its free association premise, and its relationships to nonsense, humor, risk and surprise, is not easily or quickly learned by adults whose training has been based predominantly on logical or vertical thinking.

More intensive, longer term training in lateral thinking may be in order for some adult subjects. Short time training, while it appears to have worked with more impressionable or flexible children and college students, may not be as effective with adults whose patterns of mind are well established and whose cognitive styles may be less flexible.

4. The representative design basis of the study was employed to control environmental variability. The controls exerted appear to have achieved a fairness of purpose. The modest nature of the results indicated, at least, that the study probably was not biased toward hypothesized directions. Certainly, the attention given to the control group workshop was effective, if performance on Alternate Uses is used as an indicator. It seemed that training in vertical thinking exercises served the control group well in priming subjects for "spontaneous flexibility," if not for fluency and originality.

Recommendations for Future Research

1. The full model of variables for the present study represented a modest "predictor" of divergent production with this sample of subjects. The study and the variables in the model should be replicated with other subject samples of continuing educators. In related research, different variables should be introduced in an effort to attribute larger sources of variance in achieving R^2 accountability.
2. In this study, significant results for training in lateral thinking occurred on the ORIGNL variable. Additional research is recommended to explore further the effects of training in deBono's lateral thinking concepts and techniques in relation to the ORIGNL ratio variable; that is, the production of original ideas, controlling for fluency. The discriminant validity of the divergent thinking tests, as represented in the scoring formula, in terms of the lateral thinking treatment, is a

paramount research consideration. Does the test (that is, the ORIGNL score) accurately gauge the treatment effects?

3. In this study, subjects were not specifically instructed to be "fluent" or "original". A future study, instructing one deBono trained group to be "fluent" and another to be "original", would provide data on the effect of variable instructions on both fluent and original production, on, for example, the four versions of the divergent production dependent variable, as employed in this study.

4. Pearson r correlation comparisons indicated that FLUENT was not correlated with ORIGNL ($r = -.02$), when fluency was controlled by the ratio method; and positively and significantly correlated with TCREATE, ($r = .50$) with fluency included, along with flexibility and weighted originality. These correlational comparisons underscore the fact that TCREATE and ORIGNL are different types of dependent measures of originality. (See Table 35, Appendix F for the intercorrelation results of the Guilford tests and dependent variable components.)

As Hocevar (1978) concluded, discriminant validity is earned in the measurement of creativity or originality when fluency is controlled. Further training research is in order to: (a) clarify the implications of controlling for fluent or low level responses; (b) further explore the dependent variables used in this study; and (c) try new combinations of the components of divergent production (fluency, flexibility and originality), in different dependent variables.

5. The research evidence, that training in creativity improves productive thinking, was based primarily on the results of ANOVA research. As important as those results are, an equally important need is to analyze the effects of treatment and individual difference variables by means of multiple regression and aptitude by treatment interaction analysis. Regression analysis provides more flexibility than ANOVA in allowing several discrete and continuous treatment and individual difference variables to be included in the process of determining main effects and interaction analysis.
6. The study of fixed methods and different instructional techniques is fundamental to interactive research. The competency-based (CB) and developmentally-based (DB) approaches have been established as important methodological variants, possibly related to cognitive style preferences. These two methods deserve continued comparative research attention as alternative bases for training in divergent thinking, decision making and problem solving.
7. The exploratory interaction analysis presented evidence of differential performance of younger and older continuing educator subjects on divergent production. But the present research was hindered by limited N and by narrow age bands. Multivariate research in the area of adult cognition and training should incorporate larger numbers of subjects, reflecting the normal age-curve of the population or professional group. In addition to specifically focussed experimental sample studies, comprehensive programs of institutionally-

sponsored research and evaluation would more directly benefit planning for training in productive thinking.

8. The use of standardized batteries of tests of divergent thinking, as the measure of lateral thinking or "creativity" performance, is the usual practice in creativity research. Some studies have explored common and practical problem solving, but few studies have involved the acquisition of field-based evidence of actual behavioral change, in the application of lateral or divergent thinking skills and techniques. Representative design-based research studies, incorporating field observations and field-testing, would inform professional development programming in more direct ways than theoretically or empirically derived research evidence.

9. A preliminary survey of variable relationships, by one-way ANOVA, indicated "professional class" and "major studies" as potentially interesting variables. Some research in adult education and in the field of creativity, has addressed these themes. Since they have been initiated as areas of inquiry, it would be a natural extension to explore these two categorical variables, in conjunction with treatment and cognitive style and trait variables in multivariate research designs.

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APPENDIX A

Examples of Instructional Materials Used in the Two Treatment Workshops

1. Examples of Participant Materials and Exercises
2. Examples of Overhead Transparencies
3. Anecdotal Examples of a deBono Technique and
Observations on the Use of Specific Tools for
Idea Generation

DEFINITIONS 1. Examples of Participant Materials

- 1) **Patterning** - the mind as a self-organizing, entrenching system
This patterning or embedding faculty of mind is essential to life; however, patterns can become rigid and obsolete, and the facility to change and to create new ideas and patterns may be lost.
- 2) **Breaking Out** - disengaging from the constraints imposed by patterns of mind
Initiating - the unrestrained proliferation of ideas
Together these concepts stimulate decision-makers to relax the rules of relevance by actively taking the current way of looking at a situation and changing it around by means of specific techniques designed to generate new ideas without judgment.
- 3) **Dominant Ideas** - fixed current ideas, the accepted way of doing things, the right way without question.
- 4) **Polarizing Tendencies** - either/or situations, extreme views to the detriment of intermediate positions or alternative views.
- 5) **PO** - deBono's indicator that a conscious "breaking out" technique is being applied; a special catalyst, a functional word for discontinuity, provocation, illogic, and the nonjudgmental generation of new ideas.
- 6) **Delaying Judgment** - avoiding the final solution for a time, questioning the rejection function (YES/NO) by generating seemingly irrational ideas.
- 7) **Envelope** - unnatural juxtaposition of words using a random word technique to break out and initiate.
- 8) **Intermediate Impossible** - the conscious technique of holding on to an apparently incorrect or even ridiculous idea to see what emerges.
- 9) **Reversal** - taking the current view and turning it upside down, looking at it back to front, inside out, considering the direct opposite in order to set off new (not necessarily useful) ideas.
- 10) **Cross Fertilization** - the view from the outside - a random environment provided by people (as distinct from objects); for example, from different occupations or disciplines in one group to study a problem situation. (Similar to W.J.J. Gordon's "synectics").
- 11) **Brainstorming** - formalized setting for the practice of lateral thinking; separating the evaluation from the generation of ideas and encouraging open interaction followed by analysis; Lateral thinking followed by Vertical thinking

JUDGING CLOSES OFF CREATIVITY

*from deBono - see readings and Lateral Thinking for Management reference.

1. Examples of Exercises

ENVELOPE TECHNIQUE (Using a random word)**EXAMPLE:****Problem - Automobile Safety****Envelope - Automobile Safety PO Cheese**

Ideas generated - all cars bright orange, Swiss cheese/pot holes repaired in highways, "cheeze-it, the cops...", fasten your cheese-belt, eat cheese while driving to keep awake, cheese stops for refreshments,....

EXERCISE:**Problem - Polarized politics****Envelope - Polarized politics PO _____****Ideas generated -****INTERMEDIATE IMPOSSIBLE****EXAMPLE:****Problem - To reduce traffic congestion in cities****Intermediate Impossible - PO automobiles should have wings**

Ideas generated: space age heliautos, spiral roadways, soar over (or under) congested areas, automatic pilots on automated roadways,...

EXERCISES:**Same problem as above, use a new Intermediate Impossible****Problem - Racial incidents in a college****Intermediate Impossible - PO _____****Ideas generated -**

1. Examples of Exercises

REVERSAL

EXAMPLE:

Problem - Established pattern - students are required to pay tuition fees for higher education

Reversal - PO pay students to attend

Ideas generated - transfer from unemployment/welfare to educational programs, student vested interest, motivation, egalitarian...

EXERCISE:

Problem - Dominant idea - The lower the student/teacher ratio, the better the learning experience
 - Large class size

Reversal -

Ideas generated -

CROSS FERTILIZATION

EXAMPLE:

Problem - Inadequate computer network for B.C.'s police forces.

Task - Plan a computer link system for the police, on a province-wide basis

Cross Fertilization - a group of non-police of varying work and professional backgrounds undertake the task

Ideas generated - implant micro-chips in police officer's brains, mobile terminals, integrate with hospitals...

EXERCISE:

Problem - The human head is based on an obsolete design.

Task - Redesign the human head

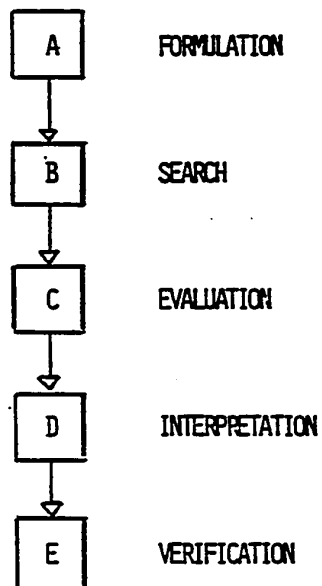
Cross Fertilization - from the view of a : a) computer programmer, b) pilot, c) teacher, d) clergyperson, e) nurse, f) taxi driver

Sets of ideas generated -

OH# 4-I

2. Examples of Material - Overhead transparency of Cornell's SAA Model used in the treatment groups

PHASES OF DECISION MAKING



AFTER CORNELL

OH # 4-II 2. Example of Material - Overhead transparency of Phases of Decision Making as overlay to OH #4 - I used in treatment groups

PHASES OF DECISION MAKING

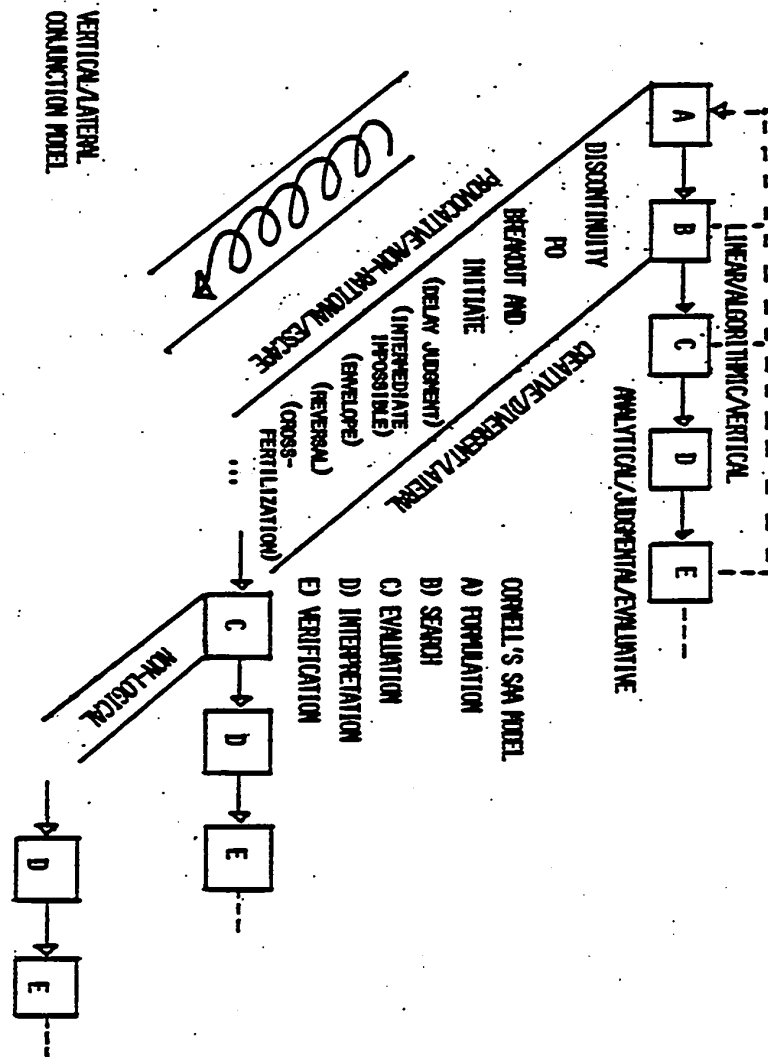
PREDECISIONAL

TRANSITIONAL TO
DECISION POINT

DECISION
IMPLEMENTATION
AND
ASSESSMENT

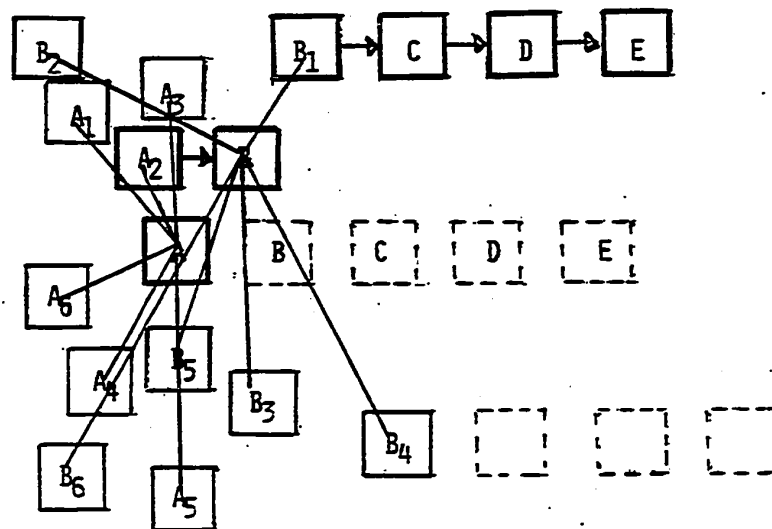
2. Examples of Material - Overhead transparency of a "Vertical-Lateral Conjunction Model" used in the treatment groups

Q# 3



OH #6 2. Example of Material - Overhead transparency to graphically demonstrate the difference and relationships of lateral and vertical thinking, used in treatment groups

DIVERGENT OR LATERAL THINKING



A - PROBLEM SITUATION

A₂ - REFORMULATED PROBLEM SITUATION

B - SEARCH FOR DECISION ALTERNATIVES

B₁/B₂ - BEST POSSIBLE ALTERNATIVES

B₁ - SELECTED AS WITHIN RESOURCE BASE

C/D/E - NEW DECISION/SOLUTION PATH

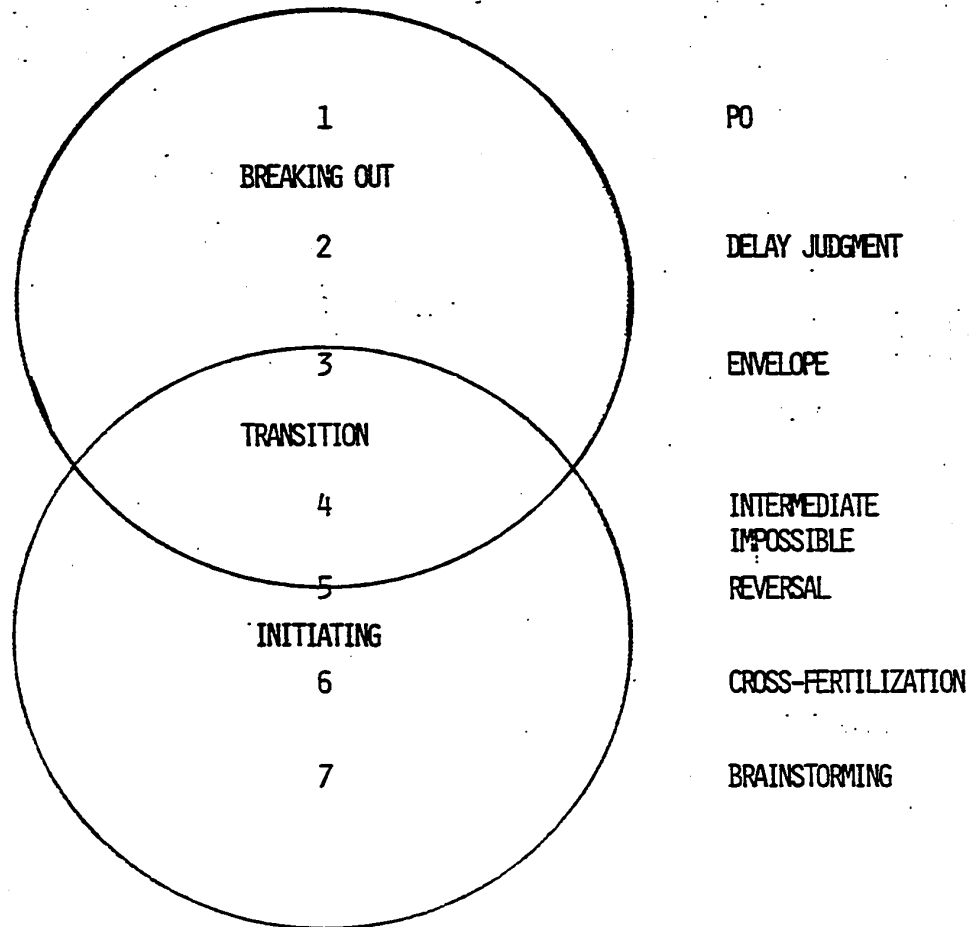
OH # 92. Example of Material - Overhead transparency to emphasize the basic process of lateral thinking, used in treatment groups

RELEASING CREATIVITY

- * RECOGNIZE DOMINANT OR POLARIZING VIEWS AND IDEAS
- * TAKE ON A "PO" ATTITUDE TO EVOKE THE NON-RATIONAL
- * BREAK OUT OF THE PATTERNS OF THE MIND
AND
- * GENERATE NEW CONFIGURATIONS OF INFORMATION AND IDEAS

OH # 12 2. Example of Material - Overhead transparency to emphasize overlapping nature of techniques for lateral thinking, used in treatment groups

TECHNIQUES FOR BREAKING OUT AND INITIATING



2. Example of Material - Overhead transparency to summarize deBono concepts and techniques studied. This version for use in the Competency-based treatment group only, relating to the three stated workshop objectives.

OH # 15

LATERAL THINKING CONCEPTS/TECHNIQUES (SELECTED)

I) DISCONTINUITY (AN ATTITUDE OR POSTURE)

ESCAPE - RECOGNIZE DOMINANT/POLARIZED IDEAS

PROVOKE - NEW POSSIBILITIES THROUGH CHANCE

II) BREAKING OUT (OF PATTERNS OF MIND)

PO - REJECTING REJECTION (LOGIC SWITCH OFF)

DELAYING JUDGMENT - SUSPENDING DECISION (IN A TIME FRAME)

III) INITIATING (PO SWITCH ON)

REVERSAL

INTERMEDIATE IMPOSSIBLE

ENVELOPE

CROSS FERTILIZATION

BRAINSTORMING

THESE CONCEPTS/TOOLS ARE DESIGNED TO SET UP ARATIONAL PROCESSES IN ORDER TO SERVE RATIONAL ENDS. LATERAL THINKING TECHNIQUES ARE NOT ENDS IN THEMSELVES. THEY ARE ESSENTIAL FOR BREAKING ROUTINES AND GENERATING NEW PATTERNS OF THINKING AND DOING.

3. Anecdotal Example of a deBono Technique

DeBono's Intermediate Impossible technique is designed to break out of the routine solutions, or patterns of thinking, by consciously holding onto an apparently incorrect or even ridiculous idea to see what emerges. The following brief example is included to provide an impression of the workshop experience in the demonstration and practice of the deBono techniques. It's inclusion is designed to stress the nature of deBono's lateral thinking techniques for venturing into the non-rational for breaking out of set patterns of mind and stimulating new ideas. Examples, similar to the following, were conducted in both the CB and DB workshops.

Problem - Brain drain

Situation - A finance company invests in the training of client counselling staff who then leave for other companies. The Vice President for Finance and Personnel has informed you, as Training Officer, that the problem must be rectified.

Response: 1. Delay judgment and shift into PO function to break out of logical reactions to the problem solution; for example, do not immediately meet with individual client counsellors to assess their situation.

2. Consciously move into a time-framed Intermediate Impossible mode; for example, allocate a one hour or one week time period to freely probe the problem before moving into a solution pattern.

3. Consider an array of absolutely unacceptable ideas; select one at random; for example, cut off their legs.

4. Generate by self, or in a group setting, without judgment, any ideas that come to mind; for example, stay put, clients feel sorry for them, short cut, short circuit, need wheelchairs, can't see above the counter, can't see the forest for the trees, etc.

5. Select a response for intermediate analysis; for example "short circuit". Perhaps counsellors feel short-changed by the company. Perhaps their circuit, or their area of responsibilities needs to be enlarged. Perhaps they have been given short shrift in recognition of their client contact role, etc.

Select and logically process other "nonrational" responses.

6. Prepare a report on "Problem Resolution Options" for the Vice-President; without necessarily mentioning the recommendation to "cut off their legs."

Observations on the Use of Specific Techniques for Idea Generation

Is it necessary to use specific techniques or tools in order to invoke unusual or even irrational responses to complex or routine problems? Perhaps not necessary, but strongly advisable, concludes deBono (1970, 1971, 1976, 1983). Without a conscious awareness of lateral or divergent concepts and techniques, the decision maker naturally tends to respond routinely to problems, which may perpetuate the cycle of failure. If lateral thinking concepts and techniques are not invoked, creative ideas will still emerge by natural insight and intuition. The purpose of the lateral techniques are to stimulate and to guide this natural intuitive process of mind, to enable creative potential to function more efficiently, and more frequently, in support of the decision making and problem solving processes.

APPENDIX B

Reports from Test Manuals and Sample Problems

1. Reports from Test Manuals: Instrumentation
2. Sample Problems from Plot Titles, Consequences II
and Alternate Uses

Reports from Test Manuals

Group Embedded Figures Test (Witkin, Oltman, Ratkin and Karp, 1971). The GEFT is designed to provide an adaptation of the individually administered Embedded Figures Test (EFT). Reliability coefficients for the EFT are reported as ranging from $r = .61$ to $r = .90$; for example, male college students ($N = 51$) $r = .82$, and female college students ($N = 51$) $r = .79$.

Reliability coefficients for GEFT, by means of split half analysis (Spearman-Brown prophecy formula), produced a reliability of $r = .82$ for both males $N = 80$ and females $N = 97$. On the sex differential, men performed slightly but significantly higher than women $p < .005$ on a comparison of $N = 155$ male and $N = 242$ female college students.

The validity of GEFT has been established in relation to the parent EFT with, for example, validity coefficients from correlations between EFT and GEFT at $r = -.82$ for male undergraduates and $r = -.63$ for female on one analysis, with r 's negative because tests were scored in reverse fashion. "The combined evidence suggests GEFT may prove to be a useful substitute for EFT when individual testing is unpractical. It must, however, be considered a research instrument" (Witkin, 29).

Guilford-Zimmerman Aptitude Survey - Part I - Verbal Comprehension (Guilford and Zimmerman, 1981a). The Verbal Comprehension test measures a dominant factor in predicting academic success, for which intelligence tests were originally designed; that is, word meaning or

cognitive semantic units (CMU). The test emphasizes greater familiarity with words in order to reduce the use of "process of elimination", thus sampling a wider range of word knowledge; and is correlated .85 with the Thorndyke-Lorge (1944) order of word difficulty. Item analysis, performed with 600 undergraduates, determined that items were evenly spread in difficulty, and that the correlation of items with total scores was satisfactory. Odd-even estimates of reliability computed at $r = .91$ on the Kuder-Richardson formula 21 for both men and women college students. In terms of factorial construct validity, or correlation of test with factor r_{tf} , a study of 500 college men reported a correlation coefficient of $r_{tf} = .70$.

Plot Titles: (Berger and Guilford, 1981). The test derives two scores, one for nonclever (fluency), or low quality response, and one for clever, meaning, respectively, ideational fluency (DMU) and originality (DMT). Reliability for fluency is given as $r_{tt} = .80$, and originality as $r_{tt} = .60$. The validity estimates, taken as factor loadings on the constructs, are reported as $r_{tf} = .59$ and $.49$ respectively, and are regarded as within the range of magnitude acceptable for most tests of single abilities. In terms of predictive validity, DMU (0 to .20) predicts some success, but DMT (.10 to .50) is a much stronger faactor, with higher relationship to intelligence.

Guilford reported that a study by Alexander (1970) gained limited supported for the relationship between field independence and scores on tests of divergent thinking. Using multiple regression, Plot

Titles (clever) predicted Embedded Figures at the .05 level of significance.

Consequences II, Form A: (Guilford and Guilford, 1980a). Berger and Guilford, (1981) reported that the Consequences II test measures the same factors as Plot Titles. The test derives two scores, total number of obvious responses (DMU) relates to the ideational fluency factor, and remote responses (DMT) (or remotely associated ideas) relates to transformations, which are likely to require revisions of other ideas. In a condensation of a number of studies on reliability, using the Spearman-Brown formula and alternate forms, the mean of the estimates was $r_{tt} = .66$ for ideational fluency and $r_{tt} = .53$ for originality (transformation). Other higher reliability coefficients are reported, for example, by Olive (1972) of $r = .85$ and $r = .70$, respectively.

Factor loadings for construct validity range from $r_{tf} = .41$ to $r_{tf} = .71$ for ideational fluency and from $r_{tf} = .31$ to $r_{tf} = .70$ for originality. Guilford reports that "...all semantic (verbal) divergent production tests have a low correlation with IQ," for example, .32 between 45 divergent production tests scores and the California Test of Mental Maturity (Guilford, 1980a, 10). Several studies have found that supplementing an IQ measure with Consequences (and with Plot Titles and Alternate Uses) results in better prediction of intellectual performance (Guilford, 1980a, 11).

Guilford reported that Bachelis (1965) found that creative thinking is related to the presence of a differentiated interaction with the environment (field independence); and that Anderson (1968) found field independence positively related to divergent thinking tests, including Consequences, which is a measure of DMT. Guilford (1979) interpreted Witkin's field independent-dependent constructs as a tendency to seek to produce transformation (Berger, 1981, 16-17).

Alternate Uses, Form C (Guilford, Christensen, Merrifield and Wilson, 1978). Formerly the Unusual Uses test, Alternate Uses represents the flexibility of thinking factor (DMC) or "spontaneous flexibility" concerned with number of shifts of category in use, going from one class to another. "Spontaneous" because nothing in the instructions calls for shifting, as distinct from "adaptive flexibility", a convergent (NMT) operation where the examinee has to be flexible to solve the problem. Estimates of test-retest reliability for a composite of six studies of adults on Forms A and B combined was $r_{tt} = .86$, using the Spearman-Brown formula.

On construct validity, factor loadings were on DMC at $r_{tf} = .51$ and on DMT at $r_{tf} = .34$. The involvement of DMT in Alternate Uses is of a secondary (but important) sort, thus resulting in the lower factor loadings. Ibrahim (1976) found a transformation factor, originality, had a loading of $r = .74$ for Alternate Uses; and there are other examples of loadings higher than the $r = .30 - .40$ range.

Semantic verbal divergent production tests tend to have a low correlation with IQ; for example, Anastasi (1971) found Alternate Uses correlated .21 with GPA and .27 with IQ. As was reported in the case of the Consequences tests, on the predictive validity of Alternate Uses, Owen, (1970) in a study of nursing achievement, added scores to the multiple R and raised it from $R^2 = .55$ to .74 in predicting GPA. Guilford et. al. (1978) reported no work on Alternate Uses and field independence; however, there are reports of the use of the test with other trait studies.

Sample Problems from Plot Titles, Consequences II, Alternate Uses

Plot Titles:

WRITE AS MANY APPROPRIATE TITLES AS YOU CAN FOR THE FOLLOWING PLOT:

A bright young man named I.M. Smart built the world's best mechanical brain. It could even talk, and it had feelings. He called it Mr. Big Talk. Smart thought it fun to find problems that Big Talk could not solve. Finally, very angry, Big Talk became insulting, even cursing his builder, until Smart took in hand an ax that was nearby and began slashing right and left at Big Talk. Big Talk then bellowed in a loud voice for all to hear, "Smart is a murderer; Smart is a murderer." So loud was the sound that it completely wrecked Smart's brain.

Consequences II:

LIST AS MANY DIFFERENT CONSEQUENCES AS YOU CAN.

What would be the results if it appeared certain that within three months the entire surface of the earth would be covered with water, except for a few of the highest mountain peaks?

Alternate Uses:

LIST AS MANY AS SIX POSSIBLE USES FOR EACH OF THE FOLLOWING OBJECTS:

1. CHAIR (used for sitting)
2. WATCH (used for telling time)
3. SAFETY PIN (used for fastening)
4. BEDSHEET (used on bed)
5. MILK CARTON (used to hold liquids)
6. NAIL (used for fastening)

APPENDIX C

Further Analysis of Regression Results and Implications for Training

Further Analysis of Results and Implications for Training

Specific aspects of the results for main effects and interactions, reported in Chapters IV and V, are discussed here with observations on implications for training.

Main Effects

Verbal comprehension. In this study, verbal comprehension was clearly a strong predictor of divergent thinking ability. By assessing the Pearson r correlational direction of relationships, it was noted that older subjects ($r = .55$) were significantly more verbally competent than younger subjects.

If the older-younger verbal comprehension differentiation were to be confirmed, opportunities for training in divergent production could employ the verbal competence of older continuing educators, to the mutual benefit of both groups, in developmentally-based training settings.

Age factor. The failure of the career-age hypothesis, (projecting the advantage of middle over early and later), to achieve significance on the divergent production dependent variables, may have been due, in part, to the leptokurtic clustering of subjects, and the relatively low mean age ($M = 40.6$). The age bands were narrow. Regression results indicated the significance ($p < .05$) of linear age on ORIGNL. Statistically controlling for verbal comprehension, younger subjects outperformed older subjects on production of "original" ideas; that is, on the ratio variable

controlling for fluency.

In training, the age factor should be a matter for continual attention in relation to the special and varied needs of trainees at different ages and stages of their career, and to balance age membership in groups for shared learning tasks.

Field Independence. Field independence, as a main effect, accounted for a significant ($p < .05$) amount of variability on FLEXBL. Over all age levels, increasing field independence was related to increasing flexibility of thought as tested by Alternate Uses. The Pearson r correlations were given as: field independence with FLEXBL (Alternate Uses), $r = .32$; and with Verbal Comprehension, $r = .17$; but, lower and nonsignificant with ORIGNL, $r = .12$ with TCREATE, $r = .11$; and with FLUENT, $r = .04$. Field Independence correlated with Plot Titles at a low $r = .07$, and with Consequences II at a negative $r = -.097$.

Notably, level of field independence does not appear to be closely associated with TCREATE, ORIGNL or FLUENT, only with FLEXBL. This finding is in some disagreement with several correlations reported by Guilford in the tests manuals, and contained in Appendix B. Guilford reported no previous work on field independence and Alternate Uses.

For training purposes, diagnostic assessment of a subject's level of field independence (Sternberg's, 1981, "components" research) could inform the adaptation of instructional procedures in order to accommodate more socially and globally-oriented learners (field dependent), and those who are more independent and abstractly incisive (field independent).

Treatment contrasts. Training subjects in lateral thinking, in this study, gave them an advantage, over control group subjects trained in vertical thinking exercises, on the divergent production of "original" ideas, where some measure of control was placed on fluency. Whereas training in lateral thinking did find a measure of success on ORIGNL ($p = .047$) and TCREATE, ($p = .10$) the two originality-oriented dependent variables, the same cannot be said for the FLUENT production of low level responses, or for FLEXBL, where lateral training made no difference in performance.

Knowledge of the relative effectiveness of training in lateral thinking on the production of original ideas, when fluency is controlled, could be used, for example, to base training sessions on the creative economy principle; that is, controlling fluency or low level production, and maximizing the production of high quality but fewer ideas.

Training in lateral thinking by the competency-based (CB) method proved to be less of a stimulant to divergent production than training under the developmentally-based method. The Contrast 2 results on FLUENT ($p < .05$) indicated the DB method to be superior to the CB method, when the preceeding variables are statistically controlled. The univariate ANOVA comparisons, given in Table 28, Appendix F, reported higher means for DB and less variance than CB on Plot Titles and Consequences II. The interaction analyses gave evidence on the possible advantages of either the CB or the DB method, under various circumstances.

Training on competency-based methods may not be compatible with lateral thinking learning techniques to improve divergent production. The more open, developmental workshop method may be more in harmony with the divergent generation of ideas.

Interaction Analyses

AXF on FLEXBL: Level of ability in field independence, a visual abstraction skill, did not appear to have much influence on flexibility of thinking scores among younger members of this sample. On the other hand, the sharp, positive slope of the two regression lines for older subjects indicated considerable differentiation by age. Younger subjects, lower on field independence, were more flexible in their thinking than older subjects lower on field independence. Assuming, as Witkin (1978) concluded, that field independence is a relatively fixed cognitive ability or style, it could be that, as mind patterns set with age, youthful flexibility is constrained for some subjects.

In training settings, if participants experience difficulties with visual abstraction, techniques for alternative delivery of concepts and materials might be incorporated to enhance the learning process; for example, written, verbal and auditory methods to augment diagrammatic or other visual schematic techniques.

AXF on ORIGNL and TCREATE. The pattern of age group performance by field independence is generally similar on FLEXBL, ORIGNL and TCREATE; with older subjects tending to be more extreme than younger subjects. On ORIGNL and TCREATE, the two middle age groups were closer together in performance, and closer to the mean, than either the oldest or youngest groups. The comment that field independence did not appear to be a good indicator of divergent performance for younger subjects, made on the basis of the AXF on FLEXBL interaction, is relevant for both ORIGNL and TCREATE. Controlling for fluency (by a ratio method on ORIGNL, and by weighting originality on TCREATE) may have tended to favour older subjects who were moderate to high on field independence, but not those older subjects who were low on field independence.

SXF on FLUENT: The sharp interaction of the regression lines for field independence by sex on fluency indicates an inverted relationship between males and females on field independence in the production of low level but relevant ideas. One interesting point, in the analysis of this interaction, was that low field independent females performed as well as high field independents males, and better than high independent females, on the straight production of fluent responses, not including originality. For men the situation was the reverse. Why? Were low field independent females less inhibited than their male counterparts at expressing their responses?

For training purposes, a male-female differential on fluency could be capitalized upon in the allocation of learning tasks across the sexes, for example, to encourage more reserved subjects (low field males) to explore fluency through involvement in brainstorming related to task-oriented problem solving.

C2XA on FLUENT: This treatment by age interaction demonstrated an example of the superiority of the developmentally-based (DB) method over the competency-based (CB) on FLUENT. The CB method was less appropriate for older subjects who appeared to prefer the DB method. True to the divergent pattern of older-younger performance in this study, younger subjects on both CB and DB were clustered near the mean, with some indication of preference for the CB method.

The evidence suggests that training to improve fluent production of ideas might best be conducted on a DB method.

C2XA on ORIGNL. This interaction appeared to be at variance with C2XA on FLUENT, with the regression lines reversed. It is notable, though, that FLUENT, as defined in this study, is low level responses only, (nonclever, obvious), and ORIGNL is a ratio variable with originality scores (remote and clever) divided by total responses (remote and clever and obvious and nonclever); and is therefore controlled for fluent production.

Among other interpretations, this evidence suggests the possibility of training older subjects for originality by means of a structured (CB) method, so long as fluency (and time restricted tests?) are not factors.

C2XF on FLUENT: Developmentally-based training was somewhat better for lower field independent subjects on fluency, while having a negative effect on some subjects who are higher on the field independent disembedding task. On the SXF on FLUENT interaction, higher field independence skill also seemed to have little influence on fluency. These results suggest fluency may be relatively independent of the field independence skill; in fact ($r = -.10$).

In terms of training, high field independents, skillful at visual abstraction and characterized as "multimodal" thinkers, (Witkin, 1978) may benefit from opportunities to practice divergent thinking for encouraging fluency, with possibilities for further improving their production of original ideas. Some high field independent subjects may hold sheer fluency as an irrelevant process.

CLXAXS on TCREATE: Younger females under both treatment and control conditions, performed at approximately the same level, whereas, with age, the female differences were more variable with laterally trained scoring higher and vertically trained lower. Training in lateral thinking appeared to be of equal value to younger male and older female subjects, in contrast to older males and younger females.

For training purposes, the divergent production or "total creativity" of subjects of both sexes appears to benefit from instruction in lateral thinking, in contrast with instruction in vertical thinking. Some older males may need special attention in training for "total creativity".

C2XSXF on ORIGNL: Males higher on field independence, trained under the competency-based (CB) condition, performed well on the production of original ideas, when fluency was controlled. On the other hand, the CB condition appeared to be less than satisfactory for females at the upper end of the field independence scale; with the reverse the case for females at the lower end of field independence. The more structured approach may have "turned off" high field independent females in the CB condition, and inhibited their originality; whereas lower field females appeared to have benefitted from the more directive method. Alternatively, the effect of the developmentally-based (DB) mode, on female ORIGNL performance, appeared to be compatible with higher field scores.

These results suggest that training for "original" production, where fluency is not a factor, may be most appropriate for high field females on a DB method, and for high field males and low field females on a more directive CB method.

APPENDIX D

1. Workshop Program - Material Items, Timing and Content
 - A. Competency-Based Method
 - B. Developmentally-Based Method
 - C. Control Group
2. Samples from Instructor and Facilitator Guides
 - A. Sample Page and Test from Instructor's Guide for Competency-Based Method
 - B. Sample Page from Facilitator's Guide for Developmentally-Based Method

1. A.

Workshop Program - Materials, Timing and Content: ET(CB) Competency-Based Method

08:15	Refreshments Materials distributed: 1. Schedule for the workshop - timing, outline, content 2. Selected readings from deBono, keyed to concepts and techniques 3. Case study exercises
08:30	Introduction 1. The nature and purpose of the workshop 2. Reference list keyed to deBono readings handout 3. Workshop goals 4. Formation of small groups and selection of leaders 5. Finalization of workshop program
08:45	Testing: two cognitive aptitude tests
09:30	Section I - Decision making 1. Introduction to decision making after Cornell's (1980) Systems Analysis Approach 2. Small group discussion of case study using SAA guidelines and focussing on the search process
10:15	Break
10:30	Section II - Lateral thinking 1. Introduction to deBono's lateral thinking concepts and techniques 2. Reading and consultation in small group settings
12:00	Lunch
12:30	Section III - Identifying and using knowledge for breaking out and initiating ideas 1. Introduction to specific concepts and techniques 2. Reading and consultation in small group settings 3. Group selection of problem exercises for practice 4. Small group leaders report back to full workshop
3:00	Break
3:15	Testing: three divergent thinking posttests
4:00	Section IV - Conclusion and debriefing 1. Group appraisal of workshop experience 2. Purpose of research explained

1. B.

Workshop Program - Materials, Timing and Content: ET(DB)
Developmentally-Based Method

08:15	Refreshments Materials distributed: 1. Schedule for the workshop - timing, outline, content 2. Selected readings from deBono, keyed to concepts and techniques 3. Case study exercises
08:30	Introduction 1. The nature and purpose of the workshop 2. Reference list keyed to deBono readings handout 3. Workshop goals 4. Formation of small groups and selection of leaders 5. Finalization of workshop program
08:45	Testing: two cognitive aptitude tests
09:30	Section I - Decision making 1. Introduction to decision making after Cornell's (1980) Systems Analysis Approach 2. Small group discussion of case study using SAA guidelines and focussing on the search process
10:15	Break
10:30	Section II - Lateral thinking 1. Introduction to deBono's lateral thinking concepts and techniques 2. Reading and consultation in small group settings
12:00	Lunch
12:30	Section III - Identifying and using knowledge for breaking out and initiating ideas 1. Introduction to specific concepts and techniques 2. Reading and consultation in small group settings 3. Group selection of problem exercises for practice 4. Small group leaders report back to full workshop
3:00	Break
3:15	Testing: three divergent thinking posttests
4:00	Section IV - Conclusion and debriefing 1. Group appraisal of workshop experience 2. Purpose of research explained

1. C.

Workshop Program - Materials, Timing and Content: C Control Group

- 08:15 Refreshments
Materials distributed:
1. Schedule for workshop
2. Selected readings on decision making
3. Case study
- 08:30 Introduction:
1. Nature and purpose of the workshop
2. Workshop goals
- 08:45 Testing: two cognitive aptitude tests
- 09:30 Section I - On decision making
1. Introduction to the decision making process
2. Demonstration of case study examples from the field of higher education
- 10:15 Break
- 10:30 Section II - Decision making and problem solving
1. Linear thinking and decision making
2. Matrix approach to problem solving
3. Methods for evaluating case studies
- 12:00 Lunch
- 12:30 Section III - Case study problem analysis with small group discussion
1. Analyze and present solutions for case studies
2. Developing guidelines for analysis of case studies
- 2:30 Break
- 3:00 Testing: three divergent thinking posttests
- 3:30 Conclusion*
1. Group appraisal of workshop experience

* For the control group, debriefing occurred in the week following the workshop. The researcher made personal visits to inform control group subjects on the nature of the research study.

2. A. Sample Page and Test from Instructor's Guide
for Competency-Based Method

INSTRUCTIONAL OBJECTIVE: /3

Given exercises the participants will use techniques for "Breaking Out" and "Initiating" according to DeBono.

INSTRUCTIONAL DESIGN TEMPLATE

LEARNING TASKS	TYPE OF LEARNING TASK	INSTRUCTIONAL TECHNIQUES	INSTRUCTIONAL RESOURCES
/1 Describe "Breaking Out" Techniques	Verbal Information	H. - Explain & Inform G. - Lecture P. - Questions & Answers	- OH#10 - OH#11-1 and 11 - reading from DeBono pp 132-6 and 85-87 - read definitions handout
/2 Use "Breaking Out" Techniques	Intellectual Skill	H. - Explain & Inform G. - Review Quiz P. - Verbal Demonstration P. - Group Exercise	- OH# 12 - OH# 13 (PO) - OH# 14,15,16
/3 Describe "Initiating" Techniques	Verbal Information	H. - Explain & Inform G. - Lecture P. - Questions & Answers	- read definitions handout
/4 Identify "Initiating" Techniques	Intellectual Skill	H. - Explain & Inform G. - Review Quiz P. - Verbal Demonstration P. - Group Exercise	- OH#15 - readings from DeBono

2. A. Sample Page and Test from Instructor's Guide
for Competency-Based Method

EXERCISE 1.0. #2 L.T. #3

The purpose of this exercise is to enhance your retention of the DeBono types of thinking. Read each of the ten statements below and place the letters of the type of thinking that each statement best describes. L = Lateral V = Vertical

1. Rejection is the central dynamic. _____
2. Concerns the formulation and search phase of decision making. _____
3. Involves escape from established thought patterns. _____
4. Is referred to as first stage thinking. _____
5. Emphasizes discovery rather than manipulation of concepts. _____
6. Welcomes chance intrusions. _____
7. Involves the decisional aspect of decision making. _____
8. Is based on logic and algorithms. _____
9. Is not a method for decision or action. _____
10. Employs a yes/no system. _____

2. B.

Sample Page from Facilitator's Guide for Developmentally-Based Method

Timing	Sequence	Notes
11:30	Section III - TECHNIQUES FOR BREAKING OUT AND INITIATING F₁ - Introduces "Breaking Out Techniques" - designed to get away from set patterns of mind What other kinds of "escape" are there? - The first step in Breaking Out is to recognize DOMINANT IDEAS TETHERING FACTORS POLARIZING TENDENCIES - small groups assigned to give examples of all three concepts F₁ - Describes the concept PO vv YES/NO - Introduces the concept of DELAYING JUDGMENT - small groups give examples of PO in a contrived problem situation	Readings p 52-56 and Notes Section III, p 1 Readings pp 134-6 OH #10 Readings pp 80-1
12:00	Break for Lunch	
12:30	Section III (continued) F₁ - Discusses INITIATING TECHNIQUES ENVELOPE/RANDOM WORD INTERMEDIATE/IMPOSSIBLE REVERSAL - discusses tools for lateral thinking and intuitive lateral thinking - leads a practice session on the ENVELOPE technique and the random word Problem: Self directed learning: <u>shark</u> - has group leaders conduct small group sessions on ENVELOPE techniques: a. select a problem b. choose a random word c. generate ideas F_{1, 2} - Circulate among groups F₁ - has group leaders report on ENVELOPE exercise for their group	Flipchart Readings pp 93-6 Readings p 83 Readings pp 142-6 Flipchart
	F₁ - Facilitator 1 F₂ - Facilitator 2	

APPENDIX E

Research Team Role Definition and Matrix

Research Team Role Definition and Matrix

Member	Role				
A	- first instructor in preliminary study, competency-based and replication workshops, and second instructor in developmentally-based workshop				
B	- first instructor in control group workshop				
C	- second instructor and test administrator in preliminary study and control group workshop				
M	- marker for all tests of all five workshop groups				
O	- observer/evaluator of preliminary study				
R	- researcher, observer in preliminary study, second instructor in competency-based and replication workshops, first instructor in the developmentally-based workshop, and marker				

Member	Preliminary	Experiment		Replication	
		ET(CB)	ET(DB)	C	
A	I1	I1	I2		I1
B				I1	
C	I2,T			I2,T	
M	M	M	M	M	M
O	O/E				
R	O/E,M	I2,M	I1,M	M	I2,M

Key: O - Observer-Evaluator; I - Instructor (first 1, second 2);
M - Marker; T - Test Administrator; ET(CB) - Experimental Treatment, Competency-Based; ET(DB) - Experimental Treatment, Developmentally-Based; C - Control.

Note: A brief report on the preliminary study is contained in this chapter. The replication study is not reported in this study.

Appendix F

Supplementary Analysis of Data: Pearson r , and ANOVA Tables

Supplementary Analysis of Data: Pearson r , ANOVA

The CONDESCRIPTIVE command computed one-way ANOVA data and tables, and the FREQUENCIES command computed frequency distributions to confirm normal distribution of the three groups in the experiment on the moderator variables (sex, age, field independence), and on the covariate, verbal comprehension. The BREAKDOWN command and STATISTIC I command (ANOVA), and OPTION 2 (exclude cases with missing values) computed one-way ANOVA to compare the three groups on the three posttests, the factors comprising the posttests and the six component variables. (See Table 1) The PEARSON CORR and REGRESSION commands computed data for analysis of the intercorrelation of independent and moderator variables, of independent and moderator and dependent variables, and of dependent variables.

Where this supplementary data is pertinent to the analysis of results, it is reported here, in tabular form.

Table 27 - Summary of One-Way ANOVA Results (F) for Moderator Variables by Experimental Groups

Table 28 - Means and Standard Deviations for Three Tests of Divergence by Experimental Groups

Table 29 - One-way ANOVA Summaries for Three Tests of Divergence by Experimental Groups

Table 30 - Consequences II by Experimental Groups: Scheffe Multiple Comparison Test

Table 31 - Summary of F and Sig F Results for Three Tests of Divergent Thinking by Experimental Group

Table 32 - Summary of F and Sig F Results for Dependent Variable Composites by Experimental Groups

Table 33 - Correlation Matrix of Independent and Moderator Variable Correlations (r) and Probability Values (p)

Table 34 - Correlation Matrix of Independent and Moderator with Dependent Variable Components: Correlations (r) and Probability Values (p)

Table 35 - Correlation Matrix of Dependent Variable Components

Table 27

Summary of One-way ANOVA Results (F) Moderator Variables by Experimental Groups

Criterion Variable	F	Sig F
Age	1.06	.35
Gender	1.14	.33
Verbal Comprehension	.65	.53
Field Independence	2.1	.12

*
 $p < .05$

Table 28
Means and Standard Deviations for Three Tests of Divergence by Experimental Treatment Groups

N	Experimental Groups	Plot Titles		Variables		Alt. Uses	
		M	SD	Conseq. II		M	SD
29	ET Competency	17.4	6.09	43.1	12.6	24.2	4.6
23	ET Developmental	19.2	5.9	46	11	23.6	3.6
22	C Control	15.4	5.03	35.9	11.6	24	4.4
	Averages	17.4	5.73	41.9	11.8	24	4.2

Table 29

One-Way ANOVA Summaries for Three Tests of Divergence by Experimental Groups

A. <u>Consequences II</u>					
<u>Source</u>	<u>Sums of Sq</u>	<u>df</u>	<u>Mean Sq.</u>	<u>F</u>	<u>Sig</u>
Between Groups	1224	2	612	4.38	.0160*
Within Groups	9912	71	139.6		
ETA = .3315		ETA Sq = .1099			
B. <u>Plot Titles</u>					
<u>Source</u>	<u>Sums of Sq</u>	<u>df</u>	<u>Mean Sq.</u>	<u>F</u>	<u>Sig</u>
Between Groups	163.58	2	81.79	2.48	.09
Within Groups	2337.6	71	32.92		
ETA = .2557		ETA Sq = .065			
C. <u>Alternate Uses</u>					
<u>Source</u>	<u>Sums of Sq</u>	<u>df</u>	<u>Mean Sq.</u>	<u>F</u>	<u>Sig</u>
Between Groups	3.9	2	1.9	.11	.89
Within Groups	1305.9	71	18		
ETA = .05		ETA Sq = .003			

*
p < .05

Table 30

Consequences II by Experimental Groups: Sheffé Multiple Comparison Test

	Ψ	$\hat{\sigma}_\Psi$	Ratio	
A	-2.9/3.3	=	-.879*	
B	10.1/3.5	=	2.87*	.95F _{2,71} = 2.834 $\sqrt{2(2.834)} = 2.38$
C	7.2/3.3	=	2.15*	
D	8.6/3.2	=	2.74*	

*
p < .05 B = Lateral Training (DB) over control
 D = Lateral Training (CB + DB) over control

Table 31

Summary of F and Sig F Results for Three Tests of Divergent Thinking by Experimental Groups

Plot Titles				Consequences II				Alternate Uses	
Clever		Nonclever		Remote		Obvious		Flexible	
F	Sig	F	Sig	F	Sig	F	Sig	F	Sig
1.87	.16	1.1	.34	4.14	.02*	.51	.60	.11	.89

* $p < .05$

Table 32

Summary of F and Sig F results for Dependent Variable Composites by Experimental Groups

<u>Variable</u>	<u>F</u>	<u>Sig F</u>	<u>Composition</u>
ORIG	4.03	.022*	clever + remote
FLUENC	3.17	.048*	clever + remote + noncl + obvious
ORIGNL	2.6	.08	(ORIG/FLUENC) X 100
TCREATE	2.1	.13	2(clever + remote) = obv + noncl + flx
FLUENT	.88	.42	nonclever + obvious
FLEXBL	.11	.90	flexible

* $p < .05$

Table 33

Correlation Matrix of Independent and Moderator Variable: Correlations (r)
and Probability Values (p)

	Age	Sex	V Comp	Find	C1	C2
Age	—	r=.23 p=.023*	r=.55 p=.000*	r=.10 p=.20	r=.08 p=.25	r=.16 p=.09
Sex		—	r=.17 p=.07	r=.14 p=.13	r=-.04 p=.38	r=.17 p=.07
V Comp			—	r=.17 p=.07	r=.13 p=.13	r=.03 p=.40
Find				—	r=-.15 p=.10	r=-.19* p=.05
C1					—	r=.06 p=.25
C2						—

Note: Pearson r (one-tailed) test

*
p ≤ .05

V Comp = Verbal comprehension

Find = Field Independence

C1 = Contrast 1 (Lateral vs Vertical)

C2 = Contrast 2 (Competency vs Developmental)

Table 34 Correlation Matrix of Independent and Moderator with Dependent Variable Component Correlations (r) and Probability Values (p)

		FLEXBL									
	Plot Titles	Conseq II	Alt.Uses	Clever	Nonclever	Remote	Obvious	FLUENT	ORIGNL	TCREATE	
Age	r=.22 p=.03*		r=.18 p=.06								
Sex		r=.15 p=.09									
VComp	r=.19 p=.056		r=.32 p=.002*	r=.27 p=.009		r=.16 p=.08			r=.24 p=.02*	r=.26 p=.01*	
Find			r=.32 p=.003*								
C1	r=.22 p=.03*	r=.32 p=.003*		r=.22 p=.03*		r=.32 p=.003*			r=.26 p=.01*	r=.22 p=.026*	
C2					r=.16 p=.08						

* $p < .05$

Notes: Pearson r (one-tailed test)

Cut off point for inclusion in Table is $p < .10$

FLEXBL = Alternate Uses

V Comp = Verbal comprehension

Find = Field Independence

C1 = Contrast 1 (Lateral vs Vertical)

C2 = Contrast 2 (Competency vs Developmental)

Table 35

Correlation Matrix of Dependent Variable Components

	(FLEX)									
	Plots	Cons	Alt	Clev	Noncl	Remote	Obv	ORIG	FLUENT	ORIGNL TCREATE
Plots	--	.56	.40	.64	.60	.42	.34	.54	.51	.23
Cons		--	.33	.46	.23	.79	.54	.76	.49	.80
Alt (FLEX)			--	.34	.15	.27	.17	.32	.18	.73
					ns		ns			ns
Clev				--	-.22	.59	-.06	.79	-.14	.72
							ns			.61
Noncl					--	-.09	.51	-.15	.79	-.45
							ns			.42
Remote						--	-.07	.96	-.09	.83
							ns			.63
Obvious							--	-.08	.92	-.48
								ns		.45
ORIG								--		
FLUENT									-.11	.87
									--	.68
ORIGNL										-.02
TCREATE										ns
										--
										.34
										--

Note: Pearson r: (one-tailed test)

"ns" indicates nonsignificant beyond the .05 level of significance

Key: Plots = Plot Titles test; Cons = Consequences II test;

Alt = Alternate Uses tests; Clev = clever; Noncl = nonclever

For definition of capitalized descriptions see Table 1 in Chapter 1.

Appendix G

Contrast Coding for Treatment and Curvilinear Age Group Breakdown

Contrast Coding and Age Group Breakdowns

This section contains definitions and explanations of key adjustments in the development of the regression model.

Coding treatment contrasts: Treatment groups were contrast coded and weighted in order to compensate for unequal n , as indicated in Table 36.

Table 36

Contrast Values for Three Workshop Groups on Two Treatment Contrasts, Weighted for N

N		Contrast 1	Contrast 2	
29	ET(CB)	+1/2 (+.56)	+1 (+1.11)	= 1/2
23	ET(DB)	+1/2 (+.44)	-1 (-.88)	= -1/2
22	C	-1	0	= 0

The contrast coefficients were orthogonal, but weighting, to compensate for unequal cell n , resulted in a model no longer being perfectly orthogonal (Kerlinger and Pedhazur, 1973, 145; Overall and Spiegel, 1969).

Four age group breakdown. In conducting the stratified random assignment of subjects by gender and age, for balanced assignment, four age groups were devised as set forth in Table 3. The full regression model employed the four age group method for residuals analysis and construction of graphs for interaction analysis, except in the case of the curvilinear hypothesis.

Three age group breakdown. In order to test the curvilinear age hypothesis, age groups were transformed from four to three. Curvilinear analysis compared interaction between age and treatment. The full model was held constant and the treatment contrasts by linear age were replaced with treatment contrasts by curvilinear age (CAGE). The two extra terms reduced the df from 52 to 50 in the implementation of the full model. The curvilinear age group breakdown is displayed in Table 37; with contrast values for the three age groups weighted for n displayed in Table 38.

Table 37

Three Career-Age Group Breakdown for Curvilinear Analysis

Groups	Range	$\frac{n}{ET(CB)}$	$\frac{n}{ET(DB)}$	$\frac{n}{C}$	Total	%
#1 Younger	25-34	6	6	6 =	18	.25
#2 Middle	35-44	12	11	12 =	35	.47
#3 Older	45-66	$\frac{11}{29}$	$\frac{6}{23}$	$\frac{4}{22} =$	$\frac{21}{74}$	.28
		29 +	23 +	22 =	74	

Table 38

Contrast Values for Three Career-Age Groups Weighted for N

Groups	Contrast 1	Contrast 2	Totals
#1 Younger	$-1/2(-.53)$	$-1(-.46)$	$+1/2$
#2 Middle	+1	0	0
#3 Older	$-1/2(-.60)$	$+1(.54)$	$-1/2$
	0	0	0

Appendix H

Means and Standard Deviations
for Contrast 1 on ORIGNL

Table 39

Means and Standard Deviations for Contrast 1 Treatment Groups (Lateral)
vs Control Group (Vertical) on ORIGNL

<u>Group</u>	<u>Dependent Variable</u>	<u>Mean</u>	<u>SD</u>	<u>Skew</u>	<u>Min Score</u>	<u>Max Score</u>	<u>N</u>
Vertical	ORIGNL	23.77	9.07	-.256	2.86	38.33	22
Lateral	ORIGNL	30.99	13.07	.92	9.80	74.42	52

Note: The CONDESCRIPTIVE command produced the table of means, standard deviations and descriptive data for Contrast 1 on ORIGNL. The ORIGNL dependent variable is ratio in form (ORIG/FLUENC; see Table 1, p.11). The ratio score results for subjects are multiplied by 100 to obtain scores of the order presented as Min and Max in Table 39. Calculating the difference between means ($30.99 - 23.77 = 7.2$), averaging the standard deviations (11.4), and dividing the average into the difference ($7.2/11.4$), results in a range of difference between the two groups of approximately $3/4$ of a standard deviation, indicative of the significance ($p < .05$) of C1 on ORIGNL. Subjects trained in lateral thinking significantly outperform subjects trained in vertical thinking exercises in the original production of ideas, controlling for fluency by a ratio method.

VITA

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