INNOVATION RESEARCH CENTRE

TRAINING MANAGERIAL EVALUATIVE AND IDEATIONAL SKILLS IN CREATIVE PROBLEM SOLVING: A CAUSAL MODEL

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INTRODUCTION

Most organizations need to be creative. Creative organizations are productive and healthy. Mott (1972) demonstrated that effective organizations were deliberately creative, continuously developing new processes and products by anticipating and solving problems and staying abreast of new methods and technologies. Fortunately, there are methods to enhance and maintain organizational creativity (eg., Amabile & Gryskiewicz, 1989; Rickards & Jones, 1991). Basadur (1993, 1994a) documented the importance of creativity in organizations, the processes by which training can increase organizational creativity, and the processes by which such training must be managed in order to induce and sustain organizational application.

Organizations that intend to remain innovative require creative people. Some individuals possess creative attitudes and skills when they join an organization. Others may not have much practice at being creative and may even have personal inhibitions keeping their talents at bay. Whatever their initial creativity level, virtually everyone can increase his or her potential for creative performance. Kraut (1976) proposes a training model which suggests that changes in understanding lead to changes in attitudes, which in turn lead to changes in behavior and changes in results.

Basadur, Graen and Green (1982) showed that training improved ideational skills and attitudes of an organization's applied researchers. Basadur, Graen and Scandura (1986) reported similar improvements in ideational attitudes among manufacturing engineers who had undergone the same training.

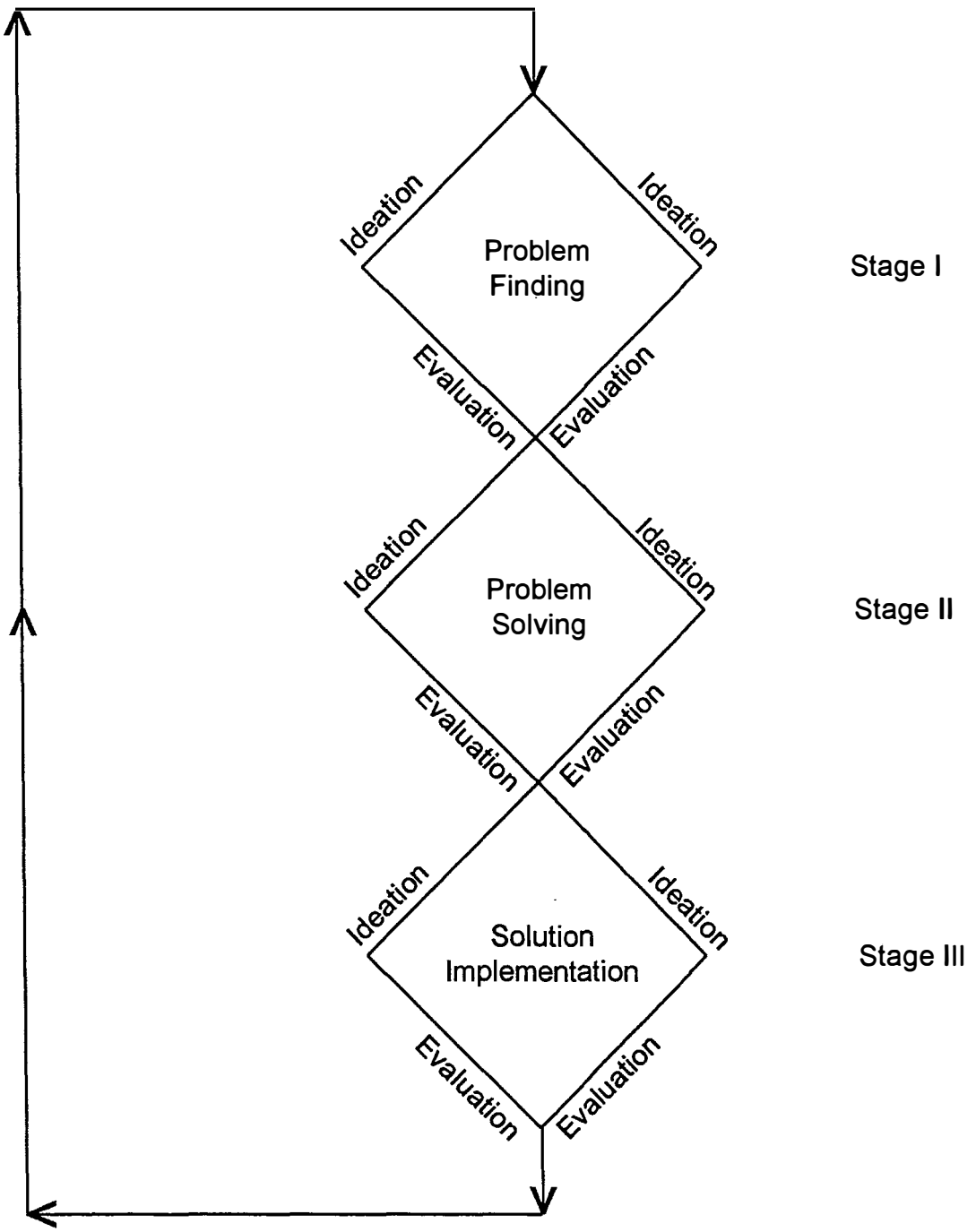
Basadur's process and training build upon the Osborn-Parnes pioneering Creative Problem Solving (CPS) approach (see Basadur, 1995, 1994b; and Basadur, Graen &

Wakabayashi, 1990) but focus on applying training as part of a complete technology for mainstreaming innovation and increasing continuous change-making skill in organizations (Basadur & Robinson, 1993). The training system emphasizes skills in problem generation, problem formulation, and solution optimization and implementation (Basadur, Ellspermann & Evans, 1994). The goal of the training is to encourage organizations to view the creative problem solving process not simply as a tool for handling crises or one-time problems requiring special attention, but as a continuous process of developing improved and innovative procedures, products and services, which ensures organizational effectiveness. Thus, the training includes skills in managing factors that moderate the transfer of creative problem solving process skills and attitudes to everyday work. Managing these factors includes developing and introducing infrastructures that help mainstream participants' use of the three phases of the process trained (see Figure 1): problem finding, problem solving and solution implementation (Basadur, 1992).

Problem finding involves constantly searching not just for things that are going wrong and need fixing; it also involves discovering potentially relevant changes, trends, and challenges which may represent opportunities for innovating new or improved products, services, procedures and processes for enhancing customer satisfaction, enhancing one's job and enhancing the organization. Problem solving involves developing and introducing useful solutions to the identified problems. Solution implementation involves making new solutions succeed. Implementation in turn leads to new problem finding activity. New opportunities are created as customers and others react to the implemented solutions. Thus, the process trained is circular and perpetual.

Figure 1

A "Complete Creative Problem Solving Process" Emphasizing Ideation - Evaluation as a Two Step Process in Each of Three Stages



The goal is to implement these three phases throughout the organization's work and social processes rather than to view them as separate from such processes themselves.

Fundamental to each of the phases is the two-step thinking-process of "ideation-evaluation." Ideation, the diverging sub-phase, is defined as idea generation without evaluation. Evaluation is the converging, judgmental sub-phase. Both are necessary for creativity (Farnham-Diggory, 1972; Runco, 1994). Because the training emphasizes the value of (a) synchronizing both divergent and convergent thinking skills, and (b) using the synchronization repeatedly in each of the multiple (three) phases, this process is called a *complete* process of creative problem solving.

In the problem solving phase, the ideation-evaluation thinking process is first used to generate and select potential solutions. Next, in preparation for final evaluation of these potential solutions, the ideation-evaluation thinking-process is again used to first generate potential criteria, and then to select the most appropriate criteria. These selected criteria are then applied to the selected potential solutions from the previous step to determine the solution(s) worth taking forward to the implementation phase.

Hands-on training in creative problem solving appears sufficient to change long-held attitudinal and cognitive processes that impede divergent thinking. Rickards (1975) emphasized the difficulty and importance of changing such attitudes and processes in order to improve creative performance. Basadur and Finkbeiner (1985) established a 14-item Preference Questionnaire to measure two specific attitudes associated with divergent thinking: the preference for ideation (active divergence) and the tendency to (not) evaluate ideas prematurely (premature convergence). Encouraging active divergence requires aggressive generation of many options, building on options, and conscious

development of many radical, seemingly impossible ideas. Encouraging premature convergence requires deliberate suppression of the urge to prematurely judge or analyze a fledgling option. Basadur and Finkbeiner (1985) also suggested that low premature convergence triggered a preference for high active divergence. The former, a more passive attitude, is a prerequisite trigger for the latter, more active attitude. When people are trained to practice both low premature convergence and high active divergence, they create more, higher-quality options. The principle of extended effort, that generating a greater quantity of ideas leads to more high quality ideas, was originally enunciated by Osborn (1963) and has been empirically supported (Basadur & Thompson, 1986; Parnes & Meadow 1959).

Basadur's approach emphasizes organizational implementation. A critical part of the process lies in showing the organization how to make the training succeed. The training must occur within a meaningful context consistent with strategic goals and must include important real-world problems. Senior management must first undergo the training in order to demonstrate leadership and skill in using the process as well as comprehending the strategic value in sustaining its use. Employing real-world problems in training also provides opportunities to use these problems and the training experience for field research purposes. The present study is an example of this dual approach to training and research.

Training in creative problem solving is particularly important because many people must use creative thinking in their work. Unfortunately, educational systems and society often suppress rather than nurture such cognitive skills (Altmeyer, 1966; Doktor, 1970; Kirton, 1976; MacKinnon, 1977; Rubenson & Runco, 1992; Runco & Okuda, 1993).

Training can give participants awareness, understanding, and skill in important cognitive techniques and processes developed from years of research (Basadur, 1987). Not only does the training in this study present these cognitive techniques and processes, but more importantly, it requires participants to practice them in Basadur's (1992) three-phase process. Indeed, the success of this training depends on its intensive emphasis on practice. The practical training in the three-phase process is designed to demystify creative problem solving by demonstrating to participants that the methods actually work and that they can be applied to their specific work processes. This approach to training creativity could be called *creativity engineering*.

One of the objectives of the present study was to replicate earlier evidence that this complete process training can improve both evaluative skills and ideational skills, as well as to determine whether this can be applied to various organizations. In a pilot study, Runco and Basadur (1993) showed that training improved both evaluative and ideational skills among lower level managers and supervisors (n=35). A second objective of the present study was to extend the work of Basadur et al. (1982), who suggested testing the interaction of training effects with personality traits.

A third objective was to extend the work of Basadur, Wakabayashi and Graen (1990), who tested the moderating effects of one's preferred creative problem solving process style on the impact of training on ideational attitudes. They found that participants who preferred an Optimizer process style were affected more than participants who favored the other three process styles. One's creative problem solving process profile is measured by the Basadur CPSP Inventory (Basadur, Graen & Wakabayashi, 1990) and it is based on two dimensions, each defined as a continuum

between opposing tendencies: (a) direct, concrete experience (X) versus detached, abstract thinking (T) for *gaining* knowledge and understanding; and (b) ideation (I) versus evaluation (E) for *using* knowledge and understanding. Various combinations of the two dimensions result in four dominant styles relevant to organizational innovation performance. These four dominant styles are: (a) experience-ideation (Generator); (b) thinking-ideation (Conceptualizer); (c) thinking-evaluation (Optimizer); and (d) experience-evaluation (Implementor). The Generator prefers to learn by concrete experience (X) and to use knowledge for ideation (I). He or she is an initiator who absorbs diverse information and generates diverse possibilities. The Conceptualizer also prefers to use knowledge for ideation (I) but prefers to gain this knowledge by abstract thinking (T). Unlike the Generator, who prefers working early in the creative problem solving process by finding problems, the Conceptualizer prefers to contribute by defining problems during the middle phases of the process. The Optimizer prefers to learn by abstract thinking (T) and to use knowledge for evaluation (E). He or she is most comfortable solving problems in the middle or later stages of the process. The Implementor prefers to gain knowledge by concrete experience (X) and to use that knowledge for evaluation (E). He or she is most comfortable in the final phase of the process, implementing solutions. One's unique preferred combination of the four process styles is one's *process profile.* The measurement of the process profile is discussed in the "Instrumentation and Procedure" section and also in Basadur, Graen and Wakabayashi (1990).

A final research direction suggested by Basadur (1979; 1994) was to test the internal mechanisms of the training effects by exploring the interrelationships among the

attitudinal and skill variables discussed above. This paper reports such a test and exploration.

Pilot Study

The Runco and Basadur (1993) precursor to this study reported the findings from an empirical pilot investigation conducted to facilitate managers' problem solving. This pilot study extended earlier research by assessing the ideational skills of the managers before and after training in the complete process of creative problem solving along with their ideational attitudes, dominant creative problem solving process styles (i.e., generator, conceptualizer, optimizer, or implementor), and their evaluative skills (i.e., ability to recognize original ideas). As in the work of Basadur, Wakabayashi and Graen (1990), the creative problem solving profile (CPSP) inventory and the 14-item preference questionnaire were administered to lower-middle through upper-middle managers from a large international consumer goods marketing and sales company. The measures of ideational skill assessed the quantity and quality (originality) of solutions to real-world managerial problems. The measure of evaluative skill assessed how well managers recognized creative and original ideas. Presumably, if training is to improve both divergent ideation and convergent evaluation, it will help if the recipients of the training recognize a creative idea when they see (or produce) one.

The most important result of this pilot investigation was that training significantly improved the evaluative abilities of the managers, who improved both their accuracy at identifying original ideas and their accuracy at identifying non-original ideas. (However, it should be noted that the effect on original idea identification was stronger than on non-

original ideas. When corrected for ideational productivity (fluency), the effect on non-original ideas was not statistically significant.) As in Basadur et al. (1982), the training also increased originality and fluency scores. Furthermore, as in Basadur et al. (1986; 1990; 1992), the training increased preference for active divergence scores, and decreased tendency toward premature convergence scores. These results were encouraging, especially in light of the theory that creative performance requires ideational skills, evaluative accuracy, *and* appropriate attitudes.

Another finding of the pilot study was that evaluative accuracy was significantly correlated with the ideational skill scores. This is important, partly because it is consistent with the multiphase view of the creative process (Basadur et al., 1982, 1990, 1994; Isaksen & Treffinger, 1985; Parnes, Noller & Biondi, 1977; Runco, 1990; Runco & Okuda, 1988), and because this relationship suggests how evaluative skills develop. In this regard, Runco and Vega (1990) had previously suggested that individuals with high ideational abilities have more opportunity for exercising evaluative skills. Additional support for this theory was found in the results of a regression analysis in the pilot investigation in that ideational skill scores were associated with the degree of improvement (pre-post-treatment difference) in evaluative accuracy. These results suggested that there was reason for optimism about the efficacy of training programs like the one used in the pilot study and that more research was warranted on the development of evaluative abilities and on the association between evaluative ability and ideational skills (c.f. Runco & Chand, 1994; Runco & Smith, 1992).

The results of the analyses of partialed variance in the pilot study suggested that the impact of training on evaluative accuracy was moderated by individuals' preference

for active divergence, Implementor CPSP score, and ability to generate ideas. Apparently, individuals scoring high on Implementor process style, preference for active divergence, and ideational skill most improved their evaluative accuracy with training. These analyses also indicated that individuals with high Conceptualizer CPSP scores showed the greatest gains in originality, as did individuals with low tendency for premature convergence scores. Runco and Basadur concluded that intrapersonal evaluative accuracy can be reliably assessed; that training significantly influences evaluative and ideational skills; and that improvements resulting from training can be predicted from individual differences in attitudes, process style, and ideational skill.

Although these findings were based on a small sample of subjects, they suggested that certain individuals will respond well to training. In fact, this information might even be useful when hiring new employees, as organizations might want to hire individuals with the potential to provide more creative ideas. Perhaps with all things being equal, preference might be given to candidates with higher Conceptualizer scores and lower tendency for premature convergence scores.

Additional research is needed to examine the validity of inter- and intrapersonal evaluations in organizational and managerial samples. In a sense, the pilot study told us <u>what</u> happened when training was provided: what was done and what the outcomes were. The present study employed a larger sample and a causal analysis model research design including the CPSP styles and ideational and evaluative measures to explain <u>why</u> and <u>how</u> the outcomes happened. The use of causal modeling has several advantages. First, the regression equations are less restrictive in that they allow for measurement error in the explanatory and dependent variables (Bollen, 1989). Second,

it can include factor analysis which allows for direct and indirect effects among the factors -- this does not apply to the models in this research, which have only single indicators per construct. Finally, this approach can encompass and extend regression, econometric, and factor analysis procedures (Bollen, 1989).

Current Study

As in the pilot study, the main approach was to measure ideational skills and attitudes, and evaluative skills before and after training, on real-world business problems. Training these managers in a complete process of creative problem solving emphasizing the "ideation-evaluation" process in all stages (see Figure 1) was hypothesized to:

H1: improve evaluative skills for solutions generated to problems;

H2: improve ideational skills for solutions generated to problems in quantity of solutions (H2A), and quality of solutions (H2B); and

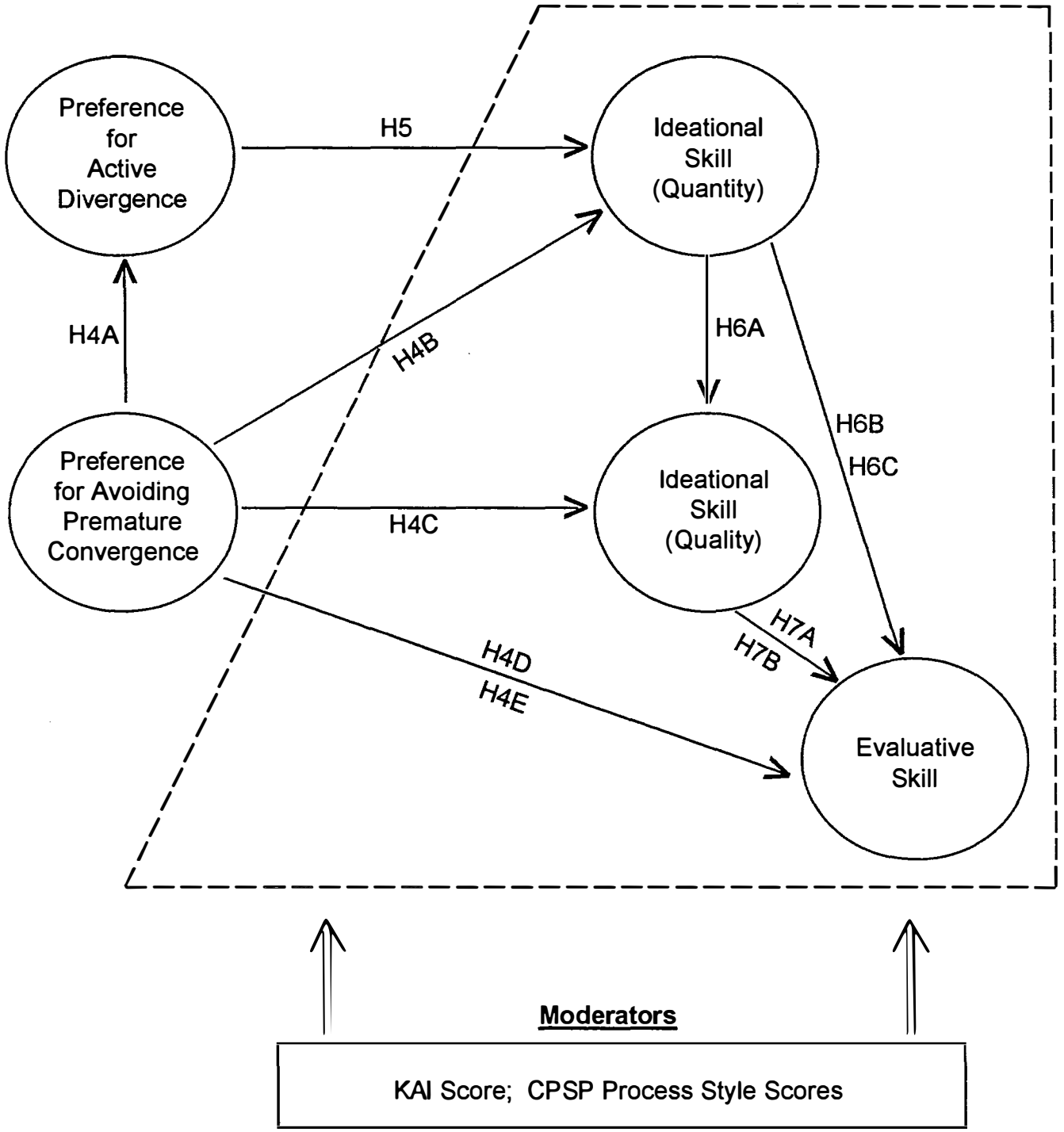
H3: improve ideational attitudes associated with ideational skill.

Because this study was intended to explore relationships among the attitudinal and skill variables identified in the above hypotheses, the special causal analysis model research design alluded to just above, was selected. The selection of alternative models was made on the basis of substantive theory and previous research. The model in Figure 2 predicts the expected relationships from the theory and empirical research discussed above and the conclusions and implications that follow. It is expected that ideational skill will be associated with evaluative skill for the following reasons. First, generating more and better potential evaluation criteria should lead to better criteria selection and

Figure 2

Predicted Causal Model

From Theory and Previous Research



ultimately better evaluation. Second, the preference for avoiding premature convergence should be associated with evaluative skill, as the evaluation will be less hasty. Finally, ideational skill includes being skilled in the two-step, ideation-evaluation sub-process discussed above and further discussed under Training in the Method section. This skill includes being able to separate ideation from evaluation. Just as evaluation during the ideation step prevents good options from being generated, so ideation during the evaluation step prevents good choices and decisions being made on the options. Thus, better evaluation should result from better ideation. The final set of hypotheses follows:

H4: improvements in the preference for (avoiding) premature convergence (ideational attitude) will be associated with improvements in the preference for active divergence (ideational attitude) (H4A); ideational skill (quantity) (H4B); ideational skill (quality) (H4C); evaluative skill (original ideas) (H4D); and evaluative skill (non-original ideas) (H4E);

H5: improvements in the preference for active divergence (ideational attitude) will be associated with improvements in ideational skill (quantity);

H6: improvements in ideational skill (quantity) will be associated with improvements in: ideational skill (quality) (H6A); evaluative skill (original ideas) (H6B); and evaluative skill (non-original ideas) (H6C); and

H7: improvements in ideational skills (quality) will be associated with improvements in: evaluative skill (original ideas) (H7A); and evaluative skill (non-original ideas) (H7B).

METHOD

Participants

The participants (n=112) were lower- through upper-middle managers in a large international consumer goods manufacturer. They represented a wide range of functions, including finance, manufacturing, operations, employee relations, and distribution. Most participants had marketing and sales responsibilities. The organization was keenly interested in enhancing its members' creative problem solving process skills and helping them in responding to a dynamic business environment including changing marketing channels, customer needs, and new technology.

Training

Participants underwent 20 hours of intensive training in creative problem solving over two days. This training was primarily experiential, with exercises and diverse tasks that encouraged participants to discover different creative concepts for themselves such as the value of ideation-evaluation. Training also included hands-on and step-by-step practice in all three phases of the process: finding problems, solving problems, and implementing solutions.

The training also requires intensive practice of techniques and processes rather than merely abstract discussion. One goal is to induce participants to synchronize and balance both divergent and convergent thinking. Another goal is to encourage participants to value concrete experience rather than just abstract thinking processes in learning and problem solving, as well as understand how attitudinal processes affect the cognitive processes underlying creative problem solving.

Instrumentation and Procedure

Two ideational attitudes, "preference for active divergence" and "preference for (avoiding) premature convergence", were measured using the Basadur 14-item inventory, which randomly combines items from two scales measuring each of the two attitudes (Basadur & Finkbeiner, 1985). Each item was rated on a five-point Likert agreement scale with ranges for each scale between 6 and 30 and 8 and 40, respectively. Participants completed the 14-item questionnaire before and after the training.

This study also employed measures of ideational skill and evaluative skill. The two ideational skill measures included quantity (fluency) and quality (originality) of ideas generated to solve real-world managerial problems. The measure of evaluative skill assessed how well managers recognize creative and original ideas. The ideas judged were taken from the four open-ended tasks (two tasks performed before training and two performed after training). Participants were randomly assigned to two subgroups with each subgroup then given two minutes to write down as many ideas as possible for solving each of two work-related problems. All four problems were selected in consultation with senior managers to ensure that the problems were relevant to the participants. The instructions for these problems were as follows:

> "Work alone. Remember that these are not `tests'. They do not receive grades nor are there `incorrect' answers. In addition, your responses are completely confidential."

The tasks were ordered so that one subgroup received two tasks *before* training and the other subgroup received the same two tasks *after* training, and vice versa. This

added precaution was taken to minimize the potential for confounding by differences among tasks, even though great care was taken to ensure that all the problems were equally open-ended and meaningful. The four tasks were:

A: How might we install our vending equipment accounts faster?

B: How might we get in and out of our markets faster?

C: How might we make better decisions as a team?

D: How might we communicate better among ourselves?

Tasks A and B were considered to be equivalent technical problems, and tasks C and D were considered equivalent organizational or behavioral problems. One subgroup received tasks A and C before training and tasks B and D after training, and vice versa for the other subgroup.

The responses to these four problems were scored for quantity and quality as follows. Quantity scores were derived by counting the number of ideas given. Quality scores were derived from the number of original or unique ideas (ideas given by only one participant). Quantity scores therefore represent ideational fluency, and quality scores represent ideational originality (Guilford, 1968; Runco & Albert, 1985; Torrance, 1974).

Evaluative skill was assessed by asking each participant to rate his or her own ideas on a seven-level scale (1 = entirely unoriginal; 7 = highly original). Rather than calculate correlational scores between ratings and actual originality as in Runco and Vega (1990), a simplified scoring technique was used. The evaluative scores were computed by calculating the number of original ideas that were accurately rated (c.f. Runco & Smith, 1992). A second score reflected the number of unoriginal ideas correctly identified.

This evaluative measure was used previously in a smaller sample (n=35) with managers in the Runco and Basadur (1993) pilot study, and it is analogous to that used with parents, teachers and children from previous studies (Runco, 1991; Runco & Vega, 1990), with satisfactory reliability. However, it has been administered only once to managers and only once after training in creative problem solving. One important feature of this study is the replication of the earlier assessment of managers' evaluative accuracy on a larger base, including the combined use of ideation and evaluation. Because significant cognitive differences exist between intrapersonal evaluations and interpersonal evaluations (Runco & Chand, 1994; Runco & Smith, 1992), this measure is important. Because participants know so much about the "associative history" of their own ideas, intrapersonal evaluations are generally much easier than interpersonal evaluations. Conversely, because individuals probably tend to judge their own ideas either extremely strictly or extremely leniently, they may find it easier to remain objective about someone else's ideas.

A procedural check was made to ensure that the responses to the two different problem sets (AC and BD) were not significantly different. There were no significant differences on any of the ideational or evaluational skill measures either pre-test or post-test at $p \leq .05$ (see Table 1).

Two individual styles were also measured to determine their moderating effects on the training. The first was the individual's creative problem solving process style as measured by the Basadur Creative Problem Solving Profile (CPSP) Process Inventory. The second was the individual's creativity style as measured by the Kirton Adaptation Innovation (KAI) personality inventory (Kirton, 1976). The KAI identifies two types of

Table 1

Comparison of Responses to the Two Different Problem Sets

	Pre-test Means					Post-test Means			
	BD	AC	t	Prob		BD	AC	t	Prob
Ideational Skill (Quantity)	9.21	9.22	-0.07	0.99 (n.s.)	Ideational Skill (Quantity)	13.6	14.35	-0.44	0.66 (n.s.)
Ideational Skill (Quality)	3.52	3.48	0.04	0.97 (n.s.)	Ideational Skill (Quality)	5.28	5.89	-0.64	0.52 (n.s.)
Evaluational Skill (Original Ideas)	1.22	0.83	1.55	0.13 (n.s.)	Evaluational Skill (Original Ideas)	2.58	2.32	0.39	0.70 (n.s.)
Evaluational Skill (Non-Original Ideas)	1.76	2.08	-0.16	0.39 (n.s.)	Evaluational Skill (Non-Original Ideas)	2.1	1.94	0.4	0.69 (n.s.)

Note: n.s. not significant at $p \leq .05$.

individuals with two different types of creativity: adaptors, who produce ideas based closely on existing definitions of the problem; and innovators, who are more likely to alter a problem and view it from a new perspective.

The participants completed the two style measures (the CPSP and KAI) during the training program. The CPSP contains 12 item groups, each composed of four adjectives that are force-ranked within the groups to differentiate among ways of gaining and using knowledge and understanding (Basadur et al, 1990). There are also six distracter item groups. The maximum score for a process style preference is 1,764, and the minimum is 288.

The KAI contains 32 items plus one distracter, each with a five-level, Likert-type scale. KAI total scores can range from 32 to 160. The higher the score, the more innovative the individual's style of creativity. The lower the score, the more adaptive the style of creativity.

In the data analyses, the KAI and CPSP Process Style scores were allowed to affect only the Ideational and Evaluational Skills variables. This sample size was not sufficient to test how the moderators also affected Preference for Active Divergence and Preference for Avoiding Premature Convergence. Therefore, in the model in Figure 2, Preference for Active Divergence and Preference for Avoiding Premature Convergence function as moderators. Because of sample size limitations in this research,the models are offered as preliminary and tentative until this work is replicated with a larger sample. For all of our analyses, the moderators were allowed to affect only what is enclosed within the dotted lines in Figure 2.

RESULTS

A. Testing Hypotheses H1A, H2A, H2B and H3

The training effects on participants' evaluative and ideational skills and ideational attitudes were analyzed through multivariate analysis of variance (MANOVA). Table 2 presents the multivariate and univariate results of this analysis and Table 3 provides breakdowns by CPSP and KAI style. As can be seen in Table 2, training produced the intended results for all but evaluation of non-original solution ideas. The production of ideas (quantity) increased dramatically from a mean of 9.1 to a mean of 13.4 ideas (H2A). Perhaps more important for creativity is the significant increase in the quality (or originality) of ideas, from a mean of 3.1 to a mean of 5.4 original ideas (H2B). This increase may partly reflect the participants' improved evaluative skills. After training, they recognized significantly more accurately which of their ideas were original (increased to a mean of 2.48 original ideas accurately evaluated from a mean of 0.98). It is somewhat surprising that the recognition of unoriginal ideas did not improve but, practically speaking, it may not be all that critical. Indeed, even with a drop in this index, the production of original ideas improved. Both ideational attitude means (H3) increased significantly after training. (Note that the preference for premature convergence attitude change score is negative in Table 2 as expected and must be reversed to represent the preference for (avoiding) premature convergence attitude.)

As Table 3 indicates, there were no important deviations from the overall results of Table 1 when training effects were broken out by style. For ideation skill (quantity) and evaluation skill (originality), all four CPSP Process Styles and both KAI creativity styles showed significant effects. The change in preference for premature convergence for the

Table 2

Multivariate Analysis of Variance for the Pre- and Post-Training Test Scores (n = 112, with 84 valid cases)

MULTIVARIATE: Wilks' Criterion: $F(6,78) = 21.75$, $p < .001$

UNIVARIATE:		PRE	POST	t-Value	F-Value	D.F.	Rc
Ideation Skill (Quantity)	M	9.10	13.42***	6.71	45.08	(1,83)	0.57
	(SD)	(4.19)	(6.51)	0.00			
Ideation Skill (Quality)	M	3.11	5.37***	5.64	31.78	(1,83)	0.48
	(SD)	(3.07)	(4.06)	0.00			
Evaluation Skill (Originality)	M	0.98	2.48***	4.74	22.44	(1,83)	0.40
	(SD)	(1.28)	(3.05)	0.00			
Evaluation Skill (Non-originality)	M	2.08	1.96 n.s.	-0.51	0.26	(1,83)	-0.04
	(SD)	(1.81)	(1.91)	0.61			
Preference for Premature Convergence[1]	M	3.11	2.44***	-9.36	87.56	(1,83)	-0.79
	(SD)	(0.54)	(0.73)	0.00			
Preference for Active Divergence	M	3.76	3.99**	2.88	8.31	(1,83)	0.25
	(SD)	(0.60)	(0.68)	0.01			

Note: ** $p<.01$
*** $p<.001$
n.s. $p>.05$

[1] Special Note: In this table, a lower score on the attitude of preference for premature convergence indicates a stronger attitude of preference for (avoiding) premature convergence.

Table 3

Training Effects Broken Down By Style

Means & Standard Deviations for CPSP & KAI Styles

	Ideation Skill (QUANTITY)			Ideation Skill (QUALITY)		
CPS Process Style	Pre	Post	t change	Pre	Post	t change
GENERATOR (n=19/18)	8.21	10.90	4.30**	2.72	3.65	1.69
	(3.3)	(4.7)		(2.5)	(2.3)	
CONCEPTUALIZER (n=10/10)	8.30	15.55	3.62**	3.10	7.27	3.33**
	(3.0)	(8.0)		(2.1)	4.0)	
OPTIMIZER (n=18/17)	7.83	13.06	4.13**	2.65	5.39	4.14**
	(3.8)	(5.4)		(2.1)	(2.6)	
IMPLEMENTER (n=41/40)	11.05	16.02	2.29*	4.28	6.65	1.36
	(7.8)	(11.4)		(7.7)	(6.5)	
(ANOVA F)	(ns)	(ns)		(ns)	(ns)	
KAI Creativity Style	Pre	Post	t change	Pre	Post	t change
INNOVATOR (n=35/34)	8.00	13.18	4.33**	2.44	5.21	3.62**
	(3.6)	(7.3)		(2.1)	4.3)	
ADAPTORS (n=43/42)	11.21	16.09	2.99**	5.00	6.50	1.46
	(7.5)	(9.9)		(7.4)	(4.4)	
(ANOVA F)	(5.4)*	(ns)		(ns)	(ns)	

	Evaluation Skill (ORIGINALITY)			Evaluation Skill(NON-ORIGINALITY)		
CPS Process Style	Pre	Post	t change	Pre	Post	t change
GENERATOR (n=18/18)	0.83	1.65	2.12*	1.78	2.25	.96
	(1.4)	(1.6)		(1.6)	(2.0)	
CONCEPTUALIZER (n=10/10)	1.20	3.64	3.67**	1.40	1.36	.23
	(.9)	(2.2)		(1.2)	(1.4)	
OPTIMIZER (n=17/17)	0.76	1.94	2.23*	2.18	2.06	.34
	(1.0)	(2.2)		(1.5)	(1.9)	
IMPLEMENTER (n=39/39)	1.05	3.00	2.50*	2.31	1.83	1.42
	(1.4)	(4.6)		(2.3)	(2.0)	
(ANOVA F)	(ns)	(ns)		(ns)	(ns)	
KAI Creativity Style	Pre	Post	t change	Pre	Post	t change
INNOVATOR (n=34/34)	0.85	2.42	3.34**	1.74	1.85	.27
	(1.1)	(2.5)		(1.8)	(2.1)	
ADAPTOR (n=41/41)	1.39	2.38	2.98**	2.24	2.19	.14
	(1.5)	(2.1)		(1.9)	(1.8)	
(ANOVA F)	(ns)	(ns)		(ns)	(ns)	

	Preference for PREMATURE CONVERGENCE			Preference for ACTIVE DIVERGENCE		
CPS Process Style	Pre	Post	t change	Pre	Post	t change
GENERATOR (n=17/18)	3.03	2.66	3.61**	4.03	4.12	1.02
	(.6)	(.8)		(.3)	(.4)	
CONCEPTUALIZER (n=*11/11)	2.91	2.40	2.11	3.79	3.91	.51
	(.8)	(.7)		(.6)	(.4)	
OPTIMIZER (n=18/17)	3.28	2.40	4.79**	3.63	3.85	1.90
	(.6)	(.9)		(.6)	(.8)	
IMPLEMENTER (n=40/42)	3.13	2.35	7.03**	3.75	3.93	1.18
	(.5*)	(.7)		(.6)	(.8)	
(ANOVA F)	(ns)	(ns)		(na)	(ns)	
KAI Creativity Style	Pre	Post	t change	Pre	Post	t change
INNOVATOR (n=34/36)	3.36	2.61	6.35**	3.65	3.99	3.63**
	(.4)	(.4)			(.7)	(.8)
ADAPTOR (n=42/43)	2.97	2.20	8.53**	3.77	4.04	2.85**
	(.6)	(.6)			(.6)	(.5)
(ANOVA F)	(12.33)**	(6.8)*		(ns)	(ns)	

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

CPSP conceptualizer style was not significant on the smallest base size (n = 11) (i.e., among the CPSP styles). Similarly, for ideation skill (quality), the gains were not statistically significant for CPSP generators and implementors nor for KAI adaptors, but were significant for the other styles. For evaluation skill (non-originality) none of the styles showed pre-post training differences. For Preference for Active Divergence, both KAI styles showed similar significant increases after training, but none of the increases for the four CPSP styles were significant.

B. Testing Hypotheses H4A, B; H5; H6 A, B, C; H7A

The causal model in Figure 2 and predicted relationships among the various evaluative and ideational skills and ideational attitudes and the moderating effects of KAI and CPSP styles were tested with Maximum Likelihood. Four variables had excessive kurtosis and were normalized using logarithmic transformations. The variables were Preference for Active Divergence, Ideational Skill (Quantity/Fluency), Ideational skill (Quality/Originality), and Evaluation Skill (Original Ideas).

The results of the causal model using Lisrel 8 (Joreskog & Sorbom, 1993) are shown in Figure 3. The fit indices show that the data fit the hypothesized model of Figure 2 quite well, although two of the hypothesized relationships were not supported and the direction of two others was reversed. The fit of the model was thus also evaluated using different criteria (e.g., Bollen, 1989): the chi-square goodness of fit statistic (in which a non-significant chi-square indicates excellent model fit) and the chi-square/degrees of freedom ratio (generally, values below 2.0 are viewed as acceptable); the Goodness of Fit Index (GFI); and the Adjusted Goodness of Fit Index (AGFI) (values over .90 are

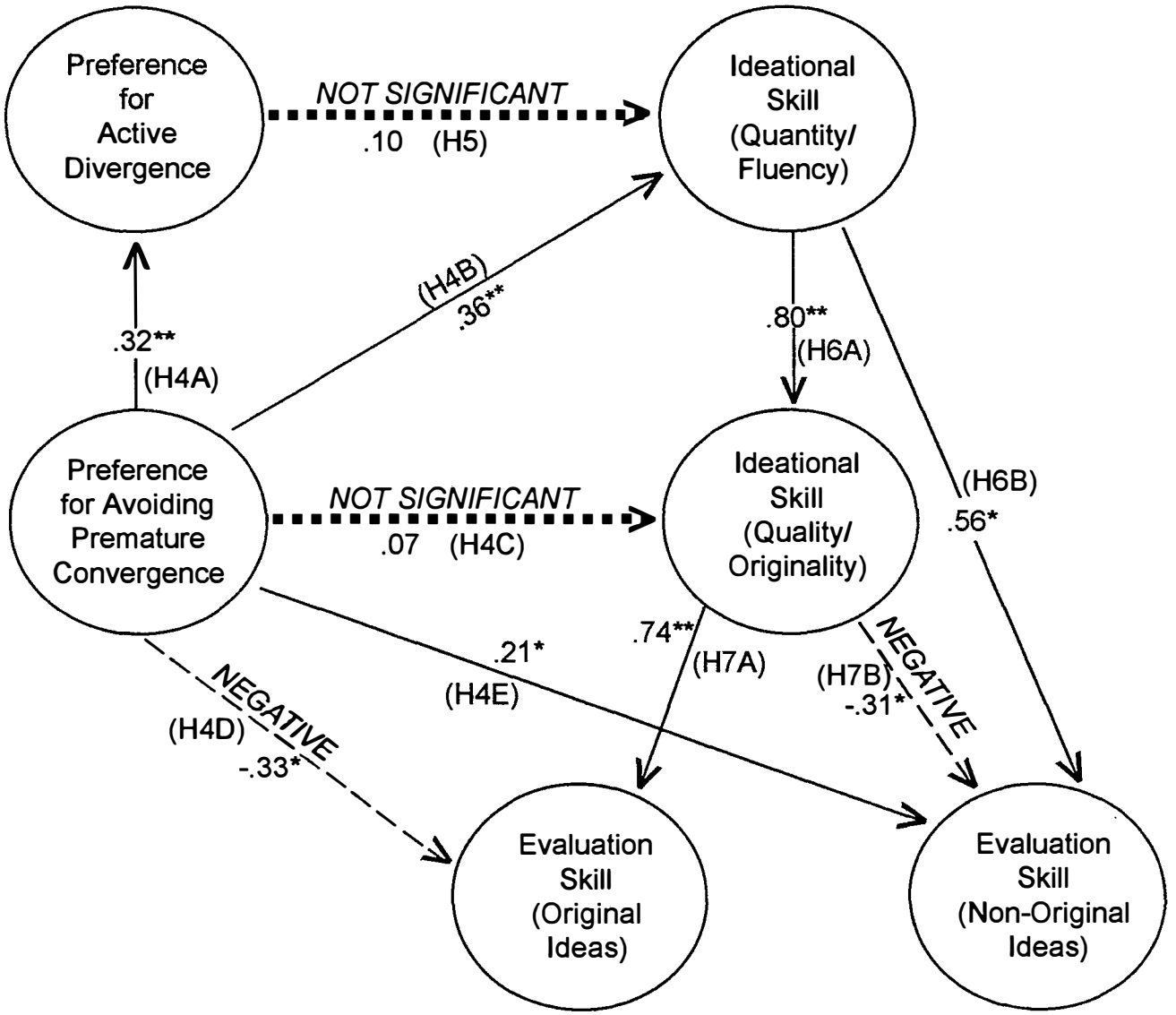
viewed as indicating good fit) (Joreskog & Sorbom, 1986). The AGFI adjusts for the degrees of freedom of a model relative to the number of variables; as a result, the AGFI rewards simpler models with fewer parameters (Bollen, 1989). These indices for the model were Xsq=22.37 (p=.498), Xsq/df (22.37/23=.98), GFI=.975, and AGFI=.870, all indicating excellent fit.

Figure 3 presents the standardized solution to the model. The values in each path are the structural coefficients (i.e., betas) and can be interpreted in the same manner as standardized weights in multiple regression. The gammas, or the coefficients for the moderators, are shown in Table 4, and are interpreted in the same manner (standardized weights). As can be seen in Figure 3, Hypothesis H5, which stated that increased preference for active divergence would be associated with increased ideational skill (quantity), was not supported (i.e., .10, p > .05). Nor was Hypothesis H4C, which stated that increased preference for avoiding premature convergence would be associated with increased ideational skill (quality/originality), (i.e., .07, p. > .05). All other hypothesized relationships were supported. However, contrary to predictions, two relationships were negative -- hypotheses H4D (-.33) (avoiding premature convergence attitude with evaluative skill (original ideas)) and H7B (-.31) (ideational skill [quality/originality] with evaluative skill [non-original ideas]). Paths H6A and H7A were highly significant, associating ideational skill (quantity) with ideational skill (quality/originality) (.80) and ideational skill (quality/originality) with evaluative skill (original ideas) (.74).

The moderating effects of the CPSP scores and KAI score are presented in Table 4. Gains in both ideational skills and one evaluation skill (non-original ideas) were moderated by the Conceptualizer Process style. The Optimizer Process style score

Figure 3

Results of Testing the Predicted Model



Note:

* p < .05, ** p < .01
Chi-square with 23 degrees of freedom 22.37 (p=.498)
Goodness of fit index = .975
Adjusted goodness of fit index = .870
Root Mean Square Residual = 1.16

Table 4

GAMMA MATRIX for Figure 3

Moderators - Standardized Solution

	X Experiencing Dimension	I Ideation Dimension	T Thinking Dimension	E Evaluation Dimension	KAI	X x I Generator	I x T Conceptualizer	T x E Optimizer	E x X Implementor
Ideation Skill (Quantity)	0.12	2.29*	2.11*	0.71	-0.08	-0.62	-2.04*	-1.21	0.69
Ideation Skill (Quality)	0.01	-1.43	-1.94*	-1.27	-0.09	0.28	1.26*	1.81*	-0.43
Evaluation Skill (Originality)	-0.91	-1.23	-0.21	0.04	0.20*	0.30	1.35	-1.02	0.89
Evaluation Skill (Non-Originality)	-1.38	0.94	0.17	-1.94	-0.10	0.71	-2.16*	1.42	0.91

Note: * $p<.05$

moderated the gains in ideational skill (quality) score, and the KAI score moderated the gains in evaluation skill (originality) score. The Implementor and Generator Process style scores did not moderate any of the hypothesized relationships. The "Gaining Knowledge by Abstract Thinking" (T) and "Using Knowledge for Ideation" (I) dimensions of the CPSP provided moderating effects on ideation skills only as components of the Conceptualizer and Optimizer styles.

A moderating variable is defined as *"a variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable"* (Baron & Kenny, 1986). With this definition in mind, the specific significant moderating effects on the hypotheses associated with predicted causal analysis model follow.

The relationship (H4B) between preference for avoiding premature convergence and ideational skill (quantity) (.36) was moderated by the CPSP Conceptualizer score (Gamma = -2.04).

The relationship (H6A) between ideational skill (quantity) and ideational skill (quality) (.80) was moderated by the CPSP conceptualizer style (Gamma = 1.26), and CPSP optimizer style (Gamma = 1.81).

The effects of the preference for avoiding premature convergence (-.33, H4D) and ideational skill (quality) (-.31, H7B) on evaluation skill (original ideas) were moderated by the KAI score (Gamma = .20).

Finally, the effects of ideational skill (quantity) (.56, H6B), ideational skill (quality) (-.31, H7B), and preference for avoiding premature convergence (.21, H4E) on evaluation

skill (non-original ideas) were moderated by the CPSP Conceptualizer style score (Gamma = -2.16).

It is interesting that the active divergence attitude was associated only with preference for (avoiding) premature convergence (H4A, .32), and not with any skills as predicted (H5). Thus, support was provided for Basadur and Finkbeiner's (1985) suggestion that the ideational attitude of preference for (avoiding) premature convergence was a prerequisite trigger for the ideational attitude of preference for active divergence. However, the importance of including the actual divergence attitude in the final causal model could well be questioned. To test this suggestion, an alternative model omitting this path (H4A) was created. Figure 4 and Table 5 display the results. The fit is not as good (p=.075) as the model in Figure 3 where that path (H4A) was included (p=.498) and the moderating effects of the CPSP and KAI are similar to Table 4.

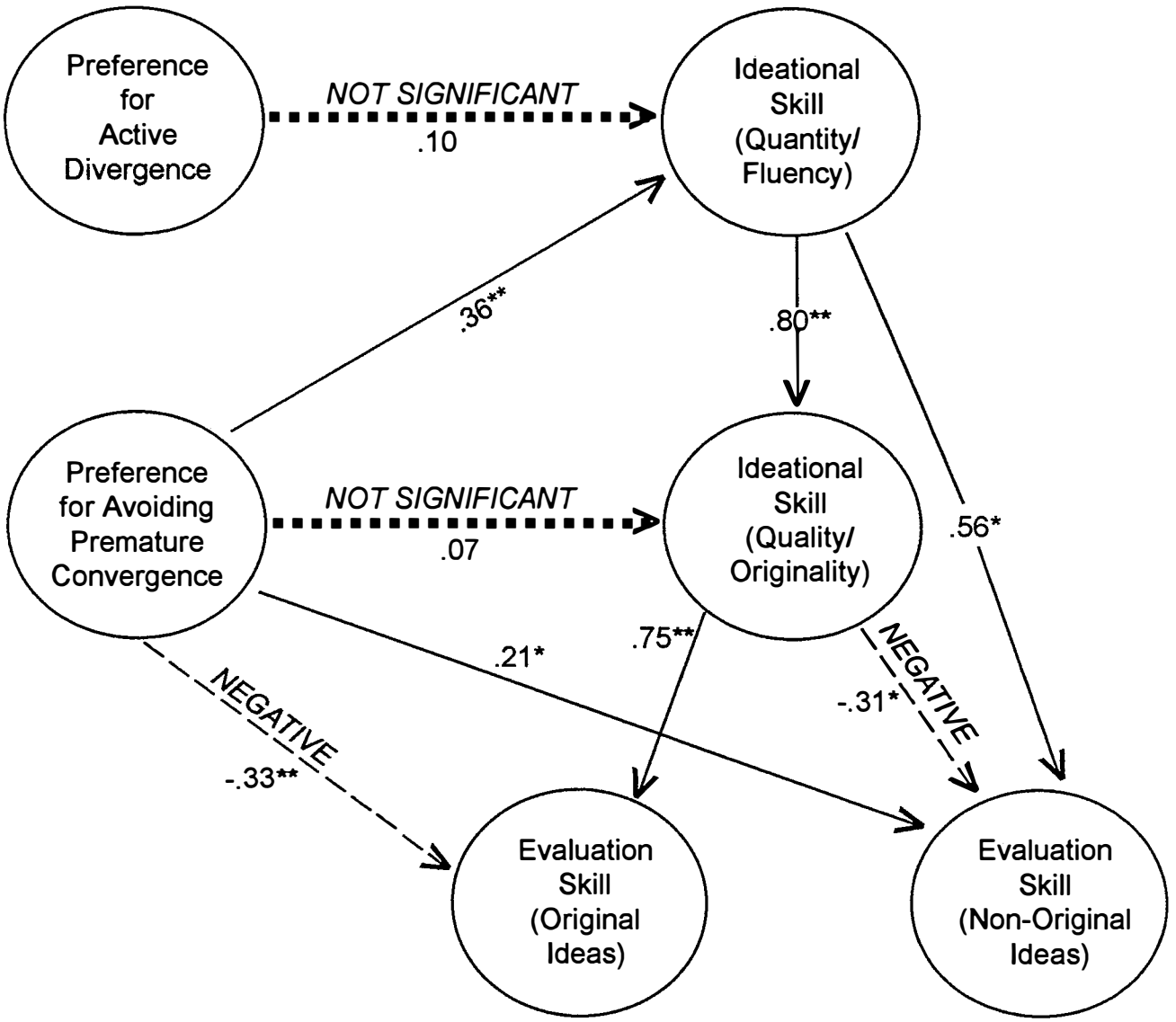
Several other alternative models were explored and all were poorer than that of Figure 3. For example, when the pathway H6B was dropped from Figure 3, the model was clearly inadequate (p=.035). The results of testing this second alternative example are shown in Figure 5 and Table 6. No other alternative model was found to test as well as the model of Figure 3.

DISCUSSION

These results confirm earlier evidence that employing training in a complete process of creative problem solving can improve evaluative skills as well as ideational skills. Interestingly, as in the earlier pilot research on managerial evaluative skills, the evidence of improved skill in original idea identification was stronger than that of non-

Figure 4

Alternative Model #1



Note:

* p < .05, ** p < .01
Chi-square with 24 degrees of freedom 34.55 (p=.075)
Goodness of fit index = .962
Adjusted goodness of fit index = .809
Root Mean Square Residual = 1.16

Table 5

GAMMA MATRIX for Figure 4

Moderators - Standardized Solution

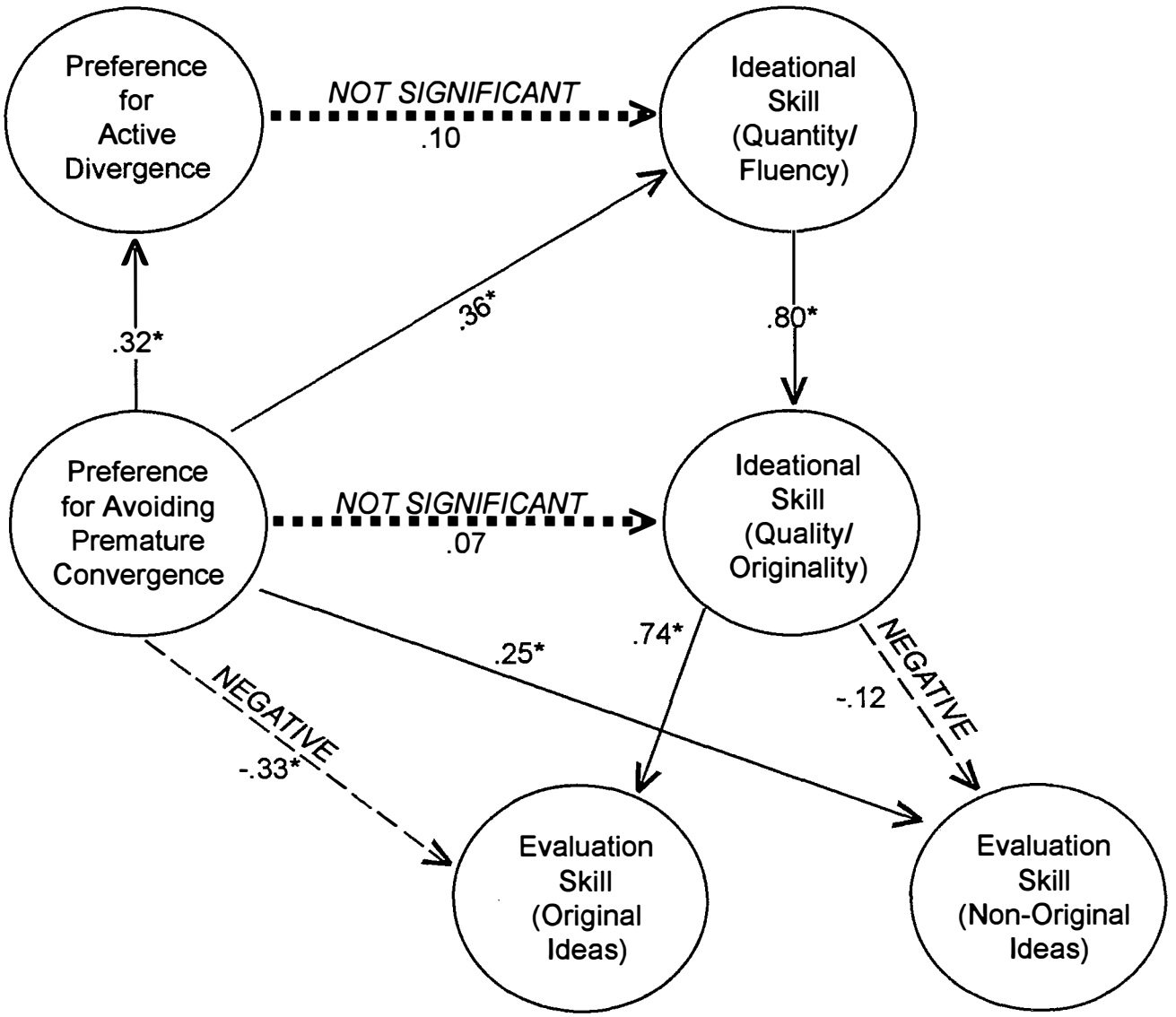
Testing Figure 3 Model But Dropping Pathway H4A

	X Experiencing Dimension	I Ideation Dimension	T Thinking Dimension	E Evaluation Dimension	KAI	X x I Generator	I x T Conceptualizer	T x E Optimizer	E x X Implementor
Ideation Skill (Quantity)	0.12	2.27*	2.08*	0.71	-0.08	-0.62	-2.01*	-1.20	0.69
Ideation Skill (Quality)	0.01	-1.42	-1.92*	-1.25	-0.09	0.28	1.25*	1.79*	-0.43
Evaluation Skill (Originality)	-0.91	-1.23	-0.21	0.04	0.20*	0.30	1.36	-1.02	0.89
Evaluation Skill (Non-Originality)	-1.38	0.94	0.17	-1.93	-0.10	0.71	-2.16*	1.42	0.91

Note: * $p<.05$

Figure 5

Alternative Model #2



Note:

* $p < .05$
Chi-square with 24 degrees of freedom 37.94 (p=.035)
Goodness of fit index = .959
Adjusted goodness of fit index = .796
Root Mean Square Residual = 1.215

Table 6

GAMMA MATRIX for Figure 5

Moderators - Standardized Solution

Testing Figure 3 Model But Dropping New Pathway H7B

	X Experiencing Dimension	I Ideation Dimension	T Thinking Dimension	E Evaluation Dimension	KAI	X x I Generator	I x T Conceptualizer	T x E Optimizer	E x X Implementor
Ideation Skill (Quantity)	0.12	2.29*	2.11*	0.71	-0.08	-0.62	-2.04*	-1.21	0.69
Ideation Skill (Quality)	0.01	-1.43*	-1.94*	-1.27	-0.09	0.28	1.26*	1.81*	-0.43
Evaluation Skill (Originality)	-0.91	-1.23	-0.21	0.04	0.20*	0.30	1.35	-1.02	0.89
Evaluation Skill (Non-originality)	-1.40	2.02	1.43	-1.29	-0.08	0.47	-3.14*	0.42	1.28

Note: * $p<.05$

original idea identification. In this study, there was no improvement in non-original idea identification but strong improvement in original idea identification. Basadur and Runco (1993) showed strong evidence of original idea accuracy but weaker evidence of non-original idea accuracy. Thus, these results confirmed the previous managerial evaluation skill research. The ideational attitude and skill improvement results confirm much of the previous research outlined in the introduction to this paper.

It appears that managers whose personalities reflect more of an innovator style rather than an adaptor approach according to the Kirton Adaptation-Innovation (KAI) scale are more likely to improve the quality of ideation and solutions. This improvement may well result from improving their ideational skill in terms of quantity of solutions generated. Equally important, managers with innovator personality styles of creativity also seem to gain more in evaluative skill in recognizing high quality ideas than managers with adaptor personality styles of creativity. This research suggests that managers with innovative personality styles of creativity are more likely to convert their improved attitudes toward avoiding premature convergence into increased skills in generating quality ideas and in evaluating and recognizing higher quality, more original ideas than are managers with adaptive personality styles of creativity.

It also appears that managers with a conceptualizer process style of creative problem solving are likely to gain more in ideational skills (both quantity and quality of ideas generated) and evaluative skills (recognizing non-original ideas) from training in this complete process of creative problem solving than are managers with other process styles. Like conceptualizers, managers with an optimizer process style will also gain

more than managers with the other two styles (implementors and generators) in ideational skills, but in quality only.

Furthermore, managers with conceptualizer process styles will more likely achieve improved ideational and evaluational skills via a corresponding increase in the ideational attitude of avoiding premature convergence on solution ideas than will managers with the other three process styles. Finally, managers with conceptualizer and optimizer process styles can be expected to improve ideational quality skills by improving ideational quantity skills. This extends the earlier findings by Basadur, Wakabayashi and Graen (1990) that ideational attitudes were preferentially imputed among optimizers by training. It may be that skills are moderated differently by process style than are attitudes.

Finally, managers with conceptualizer process styles of creative problem solving seem likely to improve their skills in recognizing lower quality, less original solution ideas by increasing their skills in ideation (generation) of both quantity and quality of solution ideas generated, as well as by increasing their preference for avoiding premature convergence (evaluation) of new solution ideas. This lends support to the evidence from the smaller sample pilot study by Runco and Basadur (1993) that responses to training in this complete process of creative problem solving may be the strongest among conceptualizer styles.

This study suggests how training in the complete process of creative problem solving "works" to increase a manager's ideational and evaluation skills. The training must increase a manager's acceptance of (preference for) avoiding premature evaluation (convergence) of new solution ideas. This probably triggers an increase in acceptance of (preference for) active divergence - the generation of options without judgment of

quality, or analysis of relevance, and with quantity and free-wheeling paramount. It is unclear what direct role this increased preference for active divergence plays, but increasing the preference for avoiding premature convergence seems to encourage skill in ideational fluency (quantity of solution ideas generated). It also appears to improve the skill of evaluation in recognizing non-original solution ideas more accurately. In contrast, the increased skill in ideational fluency (quantity of solution ideas generated) appears to translate directly into higher skills in ideation from the point of view of quality (originality) of solution ideas and directly into evaluation skill in recognizing non-original solution ideas more accurately. These increases in evaluation skill in recognizing lower quality, non-original ideas emerge both directly from the attitude of preferring to avoid premature convergence and indirectly from greater ideational skill in terms of greater fluency (quantity) of solution ideas generated.

Higher ideational skill in generating higher quality, more original solution ideas leads directly to increased evaluation skill in recognizing original, high quality ideas. It also appears that this skill is required to offset the negative, but smaller effects, of increased preference for avoiding premature convergence on high quality, original idea identification evaluation skill. Similarly, the negative effects of increased ideational skill in generating high quality, original ideas on evaluation skills in terms of lower quality, non-original idea identification are offset by the greater impact of the increase in ideational skill in fluency (quantity) of ideas generated.

The real key to everything appears to be the increase in ideational skill in terms of quantity of ideas generated. A strong direct relationship exists between this skill and ideational skill in quality/originality of ideas generated (.80), and evaluation skill in

recognizing lower quality, less original ideas (.56). In turn, the skill of ideation (quality/originality) is strongly associated with evaluation skill in recognizing more original, higher quality ideas (.74). This key stream of mechanisms tends to offset the milder negative impacts on evaluative skills of the avoiding premature convergence attitude for recognizing higher quality, more original ideas (-.33) and of the ideation skill (quality/originality) for recognizing lower quality, less original ideas (-.31). Overall, with respect to evaluation skills, it appears that the positive impacts of increasing ideational skills and attitudes substantially outweigh the negative impacts.

One might speculate that the mechanism by which the preference for avoiding premature convergence may interfere with evaluative skill in recognizing original high quality ideas may be a reluctance to judge ideas too quickly, thus staying open to all considerations longer. With time a variable, this leaves less time to make a sound judgment. Similarly, increased skill in creating high-quality, original ideas may interfere with identifying non-original, low-quality ideas: the ability to work with ideas to improve them and to make them more original and of higher quality may make individuals reluctant to give up hope that a low-quality idea might not somehow be salvaged and turned into a more unique idea.

The training emphasizes the positive approach to idea generation - continually building ideas that may not be terribly original when first enunciated, but that could be a starting point to be built upon and modified while suspending judgment. This may be the best explanation of the lack of improvement after training in recognizing non-original ideas. For managers and others, improving skill in recognizing a few, original high-quality

ideas may be a far greater priority in solving problems than improving skill in recognizing non-original, and thus less useful ideas, that are unlikely to be employed.

It also appears that increases in preference for avoiding premature convergence do not directly impact skill in ideational quality, but rather indirectly through an increase in skill in ideational quantity. It is well known that attitudes do not always translate directly into behaviors. Thus, the attitude of avoiding premature convergence may have been related directly to ideational quantity skill but only indirectly to ideational quality skill. Osborn's prediction (1963) that "quantity breeds quality" (a primary rule for the brainstorming process) comes immediately to mind as an example. This would explain the indirect effect in our final causal model of the avoidance of premature convergence attitude on ideational quality skill. The intermediate step of increasing ideational quantity skill in order to increase ideational quality skill fits the causal model and provides credibility to Osborn's belief. The strong relationship between quality and quantity of ideation is consistent with the findings of Runco and Albert (1985) and Hocevas (1979). It is also consistent with Mednick's (1962) theory about remote associates being found only after obvious responses, and with laboratory and field research supporting this belief as described earlier in this paper.

Furthermore, perhaps the increased preference for active divergence which is apparently triggered by the increased preference for avoiding premature convergence, indirectly enhances the increased ideational skills in quantity/fluency and/or quality/originality. This raises the possibility of a moderating relationship that could be explored in further research.

The causal model of Figure 3 should now be tested as a predictive model with a larger sample. Additional measures of personality traits and different cognitive aptitudes and abilities associated with creativity could be added to test for moderating effects on the model and on training.

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