INTERNATIONAL

SCIENCE AND TECHNOLOGY

EDITORIAL BOARD
Edward U. Condon, Chairman
Louis P. Hammett
Sir Harrie Massey
Hugh Odishaw
Ernst Weber

EDITOR
Robert Colborn

EXECUTIVE EDITOR
Daniel I. Cooper

ASSOCIATE EDITORS
David Allison
Evan Herbert
Charles J. Lynch
Theodore Melnechuk
Ronald G. Neswald
Ford Park
Seymour Tilson

ASSISTANT EDITOR
Regula Davis

EDITORIAL ASSISTANT
Laura Marshall

ART DIRECTOR
Gerald Ferguson

DESIGN CONSULTANT
Will Burtin

PUBLISHER
William Maass

AUGUST 1963 **No. 20**

CREATIVITY

by Ray Hyman

Can you test for creativity?
Can you train people to be creative?
Maybe . . . but beware of the boomerang

IN BRIEF: *The word "creativity" enjoys great popularity these days, but suffers from a variety of meanings. If you wish that the people who work for you could be more "creative," you should first examine your use of the word: do you really want more creative people, or is it simply more patent applications that you're after? There is a big difference. Technical managements expect the wrong results from creativity research: they ask psychologists to produce tests that will measure creativity, and training programs that will make people perform in more creative ways. These are short-sighted applications of creativity research.*

Psychological investigations into the nature of creativity can influence management practice, but these investigations should not aim at providing "tools," but rather should aim at achieving a better understanding of man as a creator.—D. A.

■ A manager of design engineering, who is a friend of mine, brought me the following problem. He supervises some 18 design engineers in a company that manufactures consumer appliances. Because the company had recently suffered a severe financial setback, everybody was under strong pressure to cut costs and turn out a competitive yet inexpensive product. The manager was worried that with all the emphasis on the current product, his men were neglecting to think about future markets and future products: over the past year, they had not turned in a single patent application.

My friend realized his company had to think of future markets as well as present ones. He believed his group had to turn out patents in areas which might be important in tomorrow's marketplace if his company was to survive. To get more patents, he reasoned, he had to increase the creativity of his group. So the problem he posed to me was how to go about increasing creativity.

His first impulse was to replace some of his men with other engineers who would be more creative. For this purpose, he asked for a test of creativity that would help him to select such creative engineers. After I discouraged him from this, his second impulse was to re-educate his men. He thought of instituting a course in creative engineering. But he vetoed this idea himself after considering the cost and time involved. His third impulse was to find some incentive to motivate his men to be creative. He thought of a contest or some sort of bonus plan.

It was in connection with this alternative that he asked my advice. He wondered if the idea was too "gimmicky." I asked him what his men thought of the idea. "I'm embarrassed to tell you," he said, "that I have never discussed the problem with them."

On the same day, he called his men together and told them the problem: "We need patents or we won't survive." Within a month, several patent applications came from his group. And during the next month, the number increased again.

This story illustrates some of the ways management seeks help from research in creativity. Management—and other potential consumers of creativity research—expects psychologists to provide tools for selecting, training, or motivating men to create. In response to such expectations, and because of financial support for such purposes, the bulk of the research in creativity is explicitly aimed at providing such tools. How good are these tools?

Testers and red bricks

To help identify and select creative personnel, many investigators seek to find what sort of people are more creative. The Institute of Personality Assessment and Research at the University of California, for example, has devoted the past seven years to a search for the distinguishing personality traits of artists, writers, architects, mathematicians, and engineers. In the study of architects, the psychologists chose 40 of the most creative people in the profession, using the nominations of professors of architecture and editors of architectural magazines to help select the group. These creative architects spent three days on

the Berkeley campus where they were observed, interviewed, rated and tested for a number of personality traits, an assessment procedure that yields some 1000 measures or indices for each architect. The psychologists then sought those indices, alone or in combination, which differentiated creative architects from less creative architects, from "average" individuals, from creative groups in other professions, etc. Creative architects, for example, seem to have more theoretical and aesthetic interests, higher self-confidence, greater preference for asymmetrical and complex design than do their less creative counterparts. Thus, the Berkeley psychologists focus on creativity as a personality and temperamental characteristic.

Other psychologists treat creativity as an intellectual quality or ability. Guilford's research at the University of Southern California, for example, concentrates almost exclusively on sorting out creative abilities in terms of performance on short, paper-and-pencil tests. A typical test has a time limit of about ten minutes. In any one study, Guilford and his colleagues will administer approximately 50 different tests to several hundred men, usually a captive audience of air force or naval personnel. Some tests deliberately tap well-known abilities such as verbal fluency, vocabulary, arithmetic facility, deductive reasoning, and the like. Others are deliberately constructed to tap creative abilities other than those that may be tapped by existing tests: one describes the plots of a few stories and the subject is asked to invent clever titles for these stories; another, aimed at tapping originality, requests the subject to invent captions for cartoons. To get at "sensitivity to problems," one test instructs the respondent to suggest what is wrong with existing social institutions; another asks him to suggest improvements for common household appliances. In still another, the testee is asked to list as many uses as he can for a common red brick.

Guilford tries to discover the minimum number of independent abilities that underlie performance on these various tests. He finds, for example, that performance on the cartoon captions and invention of clever plot titles seem to go together. Because the scores on these two tests are independent of scores on tests of known abilities, Guilford infers that he has isolated a new factor. In this particular case, he names that factor "originality."

Guilford's work has led to many new tests and the identification of new test abilities such as "sensitivity to problems," "ideational fluency," "originality," "spontaneous flexibility," etc.

Guilford has yet to demonstrate that his creativity tests are related in any demonstrable manner to creative performance in the real world, but his work has become the basis for almost all current attempts to construct an applied test of creativity. *The AC (Sparkplug) Test of Creative Ability*, for example, reflects Guilford's categories: the subject thinks of reasons to account for a given fact, lists possible consequences of a particular happening, suggests other uses for a common object, and indicates limitations and improvements for household appliances.

So far, none of these tests for creativity has met the requirements for practical use, such as those listed by the American Psychological Association. Indeed, until one can specify quite explicitly the quality he wants to predict, it is almost meaningless to discuss whether a test for creativity—or any test—can be of possible use to him.

Brainstorming and all that

Other investigations concentrate on training individuals to be creative. They search for conditions or training procedures that facilitate creative achievement. Or they try to evaluate the effectiveness of existing training programs. Unlike the work in creativity testing, these investigations start with the assumption that creativity can be changed by imparting skills, knowledge, and techniques during a training program.

Research in creativity training uses principles based on free association. Two interrelated themes guide such work. The first is that creativity is facilitated when the thinker suspends judgment while he is generating his ideas. The second is that quantity of ideas will lead to quality of final solution. One source of these principles is psychoanalytical theory and practice, where emphasis is placed on "releasing" the individual from debilitating constraints. Another popular source is advertising executive Alex Osborn, who has incorporated these principles into his famous "brainstorming" technique. Sidney Parnes and his colleagues at the University of Buffalo, supported by money from Osborn, have conducted experiments which they feel support the quantity–quality hypothesis. They ask individuals to think up uses for a common object —say a newspaper; the individuals are told to "free associate," to generate as many uses as they can, good or bad. Then these ideas are compared with ideas produced by other groups —groups who were told to give only their "good" ideas. Parnes finds that brainstorming yields more "good" responses. He has also studied the effectiveness of a course in creative problem solving. He finds that students who take the course get better scores on a creativity test than do students who did not take the course. Such research, however, is far from conclusive, as Parnes himself will admit.

Other studies, including ones I've done, raise serious questions about the existence of any simple relationship between quantity of ideas and the quality of the final product: Quantity of ideas can facilitate, hinder, or

make no difference to the quality of the final solution. It all depends on a number of other factors: the nature of the task, the prior training of the thinker, the stage in the problem-solving process, and the content of the pool of associations from which the thinker is drawing.

The evidence for the effectiveness of the creative problem-solving course must similarly be qualified. For one thing, other experimenters, including myself, have gotten similar increments in test scores by merely instructing subjects to "be creative," rather than having them go through a full training program. For another thing, we have no evidence that increments in test scores bear any relationship to performance outside the class or testing situation.

Incentives and rewards

So far, research in creativity has provided only indirect evidence about the effectiveness of incentives and rewards upon creativity. The work of Pelz at the University of Michigan suggests that scientific productivity tends to be correlated with a value system that orients the scientist to his profession rather than to the particular institution for which he may be working. Other work, relevant to environment and leadership, relates to the effect of group composition on creative performance: Hoffman and Maier at the University of Michigan deliberately compose groups of students which may be homogeneous or heterogeneous with respect to personality traits or sex. These groups are assigned the task of solving problems—usually of a human relations type—by means of role playing. The investigators find, in line with their hypothesis, that the more heterogeneous groups, when they *do* reach a solution, usually produce a more "creative" solution than do groups who tend to "see things in the same way."

"Manager, retrain thyself"

What is the effect of environment and leadership on creative performance? I find it significant that my manager of design engineering—mentioned earlier—thought only of changing the men under him as a way to increase creativity. He did not ask about replacing or retraining himself. Nor did he suggest changing the work environment, the compensation system, the "climate" for creativity, or otherwise altering the company situation to fit the workers, rather than vice versa. Managers often turn to psychologists for tools to implement their objectives. They want research in creativity to give them the means to select or change men to function within the existing framework.

I believe such hopes are shortsighted, for they are based on a misconception of the most useful role of psychological research in the area of creativity. The manager's quest for tools to help him implement existing policies will yield a poor return for the investment made in research aimed at providing such tools. Let me go on to say why.

Let's assume the unlikely possibility that psychologists can succeed completely in supplying management with tools to select and to train men to create within existing setups. Such "success" may create some immediate, short-run gains, but these gains might come at the expense of long-run adaptability and flexibility. The success of tests or training programs can only be measured in terms of current standards and values. To the extent that we maximize the adaptation of men to a particular set of standards, we may irretrievably lose the necessary flexibility to survive when these standards and values change in response to changing values, consumer demands, and economic situations.

Even more serious is the possibility that the use of such tools may backfire in terms of increased frustration and resentment on the part of employees. Unless we simultaneously overhaul the entire company from top to bottom, the successful selection or training of men for creativity can produce false expectations. What can creative men accomplish when they enter an environment that is not prepared for them, an environment that may be hostile, that fails to provide opportunities that such individuals need?

Everyman's creativity

The following incident will illustrate this last point. I was interviewing some managers concerning their views on hiring engineers who had been through a creative engineering program. When one manager told me that he had hired several engineers from such a program, I asked how these graduates compared with his other men. "They're good," he explained. "The only complaint I have is that it takes me two years to beat all the creativity nonsense out of them. Then they settle down to do what they're told to do."

Before I turn to my own recommendations on what to do about creativity, it may help to pause for a moment to consider what we mean by it. Because "creativity" is a noun and because psychologists study "creativity," we sometimes carelessly talk as if it is a "thing" to be studied in its own right, something we can isolate and deal with as a separate entity. But it is not a thing or entity; rather, it is a *quality* of things. To some, creativity is a quality of people; to others it is a quality of behavior or performance; and to still others—the manager of design engineering, for example—it is a quality of products.

The previous discussion about what managers expect from research in creativity and the description of what psychologists are doing under the name "creativity research" implies these different meanings. The work on

HERE ARE SAMPLES OF CREATIVITY TESTING AND TRAINING...SEE HOW YOU DO

But note: a good score on a "creativity" test does not necessarily mean that you are a creative scientist or engineer. This is a correlation the psychologists cannot make.

1. Make as many four-word sentences as you can using the following initial letters:

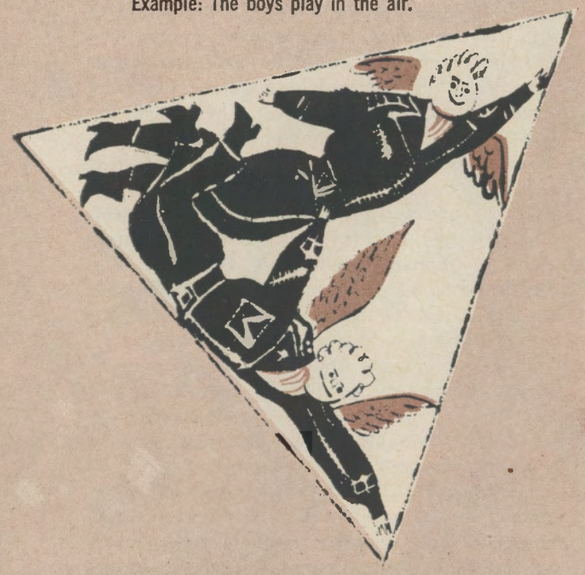
T_____ e_____ f_____ d_____ .

Example: The elephant falls down.

2. In the next three minutes, compose as many different sentences as you can using combinations of any of the following words:

boys air play which the quick of in

Example: The boys play in the air.



3. List all the uses you can for 5,000 used red bricks.

4. Imagine that everyone born after 1968 had an extra thumb on each hand, just like our present thumbs but on the other side of the hand. List as many practical consequences, good and bad, as you can.

personality assessment and Guilford's investigations deal with creativity as a quality of people. It represents another attribute by which we can sort people into groups or by which we can order them along a continuum. For one group of psychologists, "creativity" is a quality much like temperamental and personality traits; it represents a tendency to feel, value, and act in certain ways. For others, such as Guilford, it is a quality more like intelligence, representing a capacity to perform with certain skills or at a given level.

Research that is oriented toward training deals with creativity as a quality of performance, or of different states of a particular individual. It represents another way of differentiating one state of an individual from a previous state. Thus it makes sense from this viewpoint to talk about a particular individual as being more creative on occasion A than on occasion B.

Much of the interest in creativity, especially by industry, does not refer to a quality of individuals or performance; instead, the concern is with "creativity" as a quality of products. There is nothing wrong with this particular use of the term "creativity," so long as we keep clear the distinction between the creativity of the *outcome* of a man's efforts and his creativity in *producing* that outcome. In turn, these usages of the term "creativity" must be distinguished from the more general, relatively stable "creativity" characteristics which set one man apart from others. In light of these different meanings, it makes sense to refer to the painting of a chimpanzee as "creative" while, at the same time, denying that the chimpanzee is creative or that he behaved creatively. Also, it makes sense to deny that the solution to a well-known puzzle is creative, but to describe a child's behavior in achieving this solution as creative because he had to perform in ways that were novel in terms of his own past experience. And finally, we know the meaning when someone laments that so-and-so—a creative individual—is wasting his time in uncreative work. These different meanings and expectations can cause misunderstanding, especially between psychologist and client. The psychology of creativity must restrict itself to creativity of performance and/or of individuals; the relationship of such creativity to creativeness of products may not be close.

One implication we can derive from this discussion of the meaning of "creativity" is this: While industry and management focus purely upon the results or payoff in terms of the creativity of products, the psychology of creativity focuses entirely on people and their behavior. To a manager, it makes sense to pay for results—to reward a man only after his contribution has been judged to be creative. To a psychologist, such a compensation system makes no sense at all, because "creativity" that refers to results cannot be treated as a meaningful, functional entity in psychological terms. Hence, the psychologist will tell you: to encourage creativity, you should reward a man for behaving creatively, even when he fails entirely. Because the factors that lead to a "creative" product are complex—and often accidental—rewarding for the product may actually reinforce accidental or noncreative aspects of behavior. Such a reward system may lead to supersitition and false notions. It may, alas, even stifle creativity. Emphasis on the "creative" product, like emphasis on the grade in school, may lead to a mistaken set of values, to imitation rather than to innovation.

Is management ready?

If the attempt to provide tools to help management develop creativity within the present industrial framework is shortsighted, what positive steps can we take? One answer, of course, is implied in my earlier criticism of the one-sided attempt to change employees without changing the environment into which they are placed.

It is at the level of company policy, of management objectives, and organizational principles that I believe psychological research will have its biggest impact, if it is to have any impact at all. To have an impact at this level we must think of creativity research in terms other than application and tool-orientation. I believe the type of creativity research that will provide this impact is that which we call "basic" or "pure." I use the term basic to mean research that has *no* applied objectives, that is not oriented toward payoff, either now or in the long-range future. In this sense, basic research refers to investigations of creativity whose major objective is an understanding of the most general laws that govern man's psychological behavior in the realm of creative achievement, and whose only justification is in terms of theoretical significance or potential ability to help us clarify issues at a fundamental, conceptual level. The goal is not payoff; the goal is purely one of greater understanding.

Basic research, then, does not aim at producing tools or prescriptions. Rather, it aims at helping us make explicit our basic assumptions about man as a creator. It does this to enable us to test these assumptions, revise or correct them, and eventually replace our present image with a more adequate one.

It is at the level of our assumptions and our image of man, rather than at the level of test and training principles, that psychological research may possibly influence company policies and objectives: When we examine the basis of current policies and organizational principles, we find each of them based upon some bedrock of major, often implicit management assumptions about human nature. Such assumptions, because they are implicit and rare-

ly brought to the scrutiny of consciousness, often contradict one another. One management assumption, for example, might be that employees are "rational" and will choose to vote in favor of the company if they are presented with all the "facts." Another assumption, often made by the same policy makers, is that workers are like children and do not know what is best for themselves; therefore management should make decisions for them about retirement plans, stock bonus plans, etc. Another assumption is that men are guided by the profit motive, that without adequate financial incentives, men will not work their best, etc.

Such assumptions do not hold up well under psychological investigation. The areas management has reserved to itself—union policy, compensation principles, organizational levels, division of responsibility, decentralization or centralization, etc.—imply major assumptions about what makes men behave as they do. The hope for creating change at this level lies in basic research that goes right to the heart of the assumptions we tend to make implicitly about ourselves and our fellow humans.

Such changes in our image of man do not come about easily or quickly. But they do come about and they can be brought about. Witness the great changes in our image of ourselves that came because of the theoretical and scientific speculations of Darwin, Pavlov, and Freud. Freud, alone, has been responsible for widespread changes in how we deal with individuals—not only in psychiatric practice, but also in political and economic policy, in legal decisions (even in the Supreme Court decision on segregation). It was Freud more than any man who established the image of man as the slave of powerful, often unconscious, motivations and irrational determinants.

In our own times, the man who seems destined to have an impact upon psychology and on man's image of himself, comparable in scope to that of Freud and Pavlov, is the Swiss psychologist, Jean Piaget. For almost 40 years, most of which he was largely ignored by the mainstream of psychology, Piaget has studied the development of thought structures in children from birth through adolescence. It is only recently that American psychologists have been aware of the enormous implications that Piaget's work has for our understanding of the nature of intelligence and intelligence tests. Until the Second World War, American psychology and the American school system were dominated by the assumption of fixed intelligence and fixed development of intellect. Some assumptions led to notions about child rearing and education that stressed, for example, the desirability of keeping the child from being overstimulated during his formative years, lest he be overloaded or challenged. Partly as a result of Piaget's fundamental work, we now believe that an individual's intellectual development depends crucially on the amount and kind of stimulation he had during his formative years. The implications for child rearing are now almost completely the reverse of what they were with the older assumptions. Instead of protecting the child from too much stimulation, the implication is that if he is not stimulated, the child will fail to reach his full intellectual capacity.

Creativity and management

What do we conclude from all of this? Especially, how can creativity research relate to current management practice? I believe that psychological investigations into the nature of creativity can have a major impact on industrial and management practices. But . . .

In seeking tools and prescriptions for increasing creativity, management is asking the wrong questions of psychological research in creativity. Such research is limited in its scope and generality. At best, its results are transitory. Even when such research succeeds, the ultimate benefit may be negligible or even negative. This is because "success" has to be measured in terms of present standards and objectives . . . and these standards and objectives may be the barriers to creativity within any company.

Although management tends to deal with the "creativity problem" by seeking ways to change its employees, any success in changing the employees' creativity may boomerang, unless—at the same time—changes are made in the company organization and leadership. False expectations and consequent resentment can occur when creative people are put into an environment that is not ready for them. Hence, before changing the environment *and* the creativity of the people in it, we must modify the assumptions on which the environment is based—company policies, unwritten rules, etc. Such assumptions can only be altered by basic research in creativity: research whose objective is *understanding*.

Hence, though I believe psychological investigations into the nature of creativity *can* influence management practice, I believe the major impact of such research will come at the level of our basic assumptions about the nature of man. And this new image of man can come only from fundamental research in creativity. Research that aims at giving managers what they now think they want—better tools to implement their current image—will contribute little.

The books mentioned in To Dig Deeper, p 85, will give you a feel of what is now being talked about under the label "creativity." The author also cites some of the research now under way which he feels will lead to a better understanding of the creative process, including research that "is not obviously aimed at creativity."

when the first attempts were made to analyze the vibration of aircraft structures in response to jet engine noise. A summary of this first work will be found in "New Methods for Understanding and Controlling Vibrations of Complex Structures" by Heckl, Lyon, Maidanek, and Ungar, a report for the Aeronautical Systems Div. of Wright-Patterson Air Force Base [Document ASD TN-61-122 (June 1962) also carries ASTIA No. AD-281798].

It was not until the 1960's that rigorous treatment of the subject began to appear in the technical literature, principally the *Journal of the Acoustical Society of America.* Five important papers from this source are cited below: The complex problem of force resolution is treated by Smith in "Response and Radiation of Structural Modes Excited by Sound," 34, No. 5, 640 (1962). Modal density equations for shells are derived by Heckl in "Vibrations of Point-Driven Cylindrical Shells," 34, No. 10, 1553 (1962). To see how a thermodynamic or heat-flow analogy can be applied to vibration problems, see Lyon's and Maidanek's "Power Flow between Linearly Coupled Oscillators," 34, No. 6, 623 (1962). In Heckl's "Measurements of Absorption Coefficients on Plates," 34, No. 6, 803 (1962), an analogy to architectural acoustics is used to characterize the localized damping at boundaries of structures in terms of absorption coefficients. Statistical methods are extended to complex, built-up shapes in Maidanek's "Response of Ribbed Panels to Reverberant Acoustic Fields," 34, No. 6, 809 (1962).

Although there exists no "handbook" treatment of the statistical approach to vibration analysis, the following two references are of an applications nature, and may help in this respect: The first is "Estimation of Sound-Induced Vibrations by Energy Methods" by Franken and Lyon in the *Proceedings of the 31st Symposium on Shock, Vibration, and Associated Environments.* To request a copy, write to Mr. W. W. Mutch, Code 4021, US Naval Research Laboratory, Washington 25, D. C. The second is "Response of Space Vehicle Structures to Rocket Engine Noise" by our author Ira Dyer, Chap. 7 of Crandall's *Random Vibrations,* Vol. 2 (MIT Press, 1963).

To review the classical methods of vibration analysis, get Lord Rayleigh's *Theory of Sound,* Vols. 1 and 2 (Dover, 1945) and Timoshenko's *Vibration Problems in Engineering* (Van Nostrand, 1955). For a summary of how statistical methods were employed in the black-body radiation problem, on which their use in acoustics was based, see p. 164 of *Introduction to Modern Physics* by Richtmyer and Kennard (McGraw-Hill, 1955). And if you are intrigued by the Chladni patterns in our article, see Waller's fascinating monograph, *Chladni Figures—A Study in Symmetry,* (G. Bell & Sons, 1961).

THE ORIGIN OF OIL 42

Two excellent books on the earth science of oil are Levorsen's *Geology of Petroleum* (Freeman, 1954, $9) and Landes' *Petroleum Geology* (Wiley, 1959, 2nd ed., $9.50).

A survey of hypotheses and evidence is given in the review article "Origin of Petroleum—A Review," by Stevens, on p. 51 of *Bull. Amer. Assoc. Petrol. Geol.,* Vol. 40, 1956. On p. 645 of the same journal, but in Vol. 30, 1946, is another recommended article, by Cox, on "Transformation of Organic Materials into Petroleum Under Geological Conditions."

Calculations of the content of hydrocarbons and other oil-precursor organic compounds appear in "Further Observations on the Paraffins and Primary Alcohols of Plant Waxes," by Waldron et al, in *Biochem. J.,* Vol. 78, 1961, p. 435.

A fuller account of microbial involvement in oil formation is given in our author's paper "Part Played by Bacteria in Petroleum Formation," *Sedimentary Petrology,* Vol. 22, 1952, p. 42.

The classic in that field is Beerstecher's *Petroleum Microbiology* (Van Nostrand, 1954, $8.50).

The question of supply and reserves is covered in a good book, *Oil for the World,* by Schackne and Drake (Harper Bros., 1960, 2nd revised ed., $2.50, paper $1.75), and in the periodicals *World Oil* and *The Oil and Gas Journal.*

CREATIVITY 51

Scientific Creativity: Its Recognition and Development (Wiley, 1963, $7.95) will give you a sample of what is now being talked about or being investigated under the label "creativity." This volume, ed. by Taylor and Barron, contains selected papers from the proceedings of 3 conferences at the University of Utah, held in 1955, 1957, and 1959, and is titled *The Identification of Creative Scientific Talent.* Proceedings of another conference in this series, held last year, will be published soon. A less technical collection, *A Source Book for Creative Thinking,* ed. by Parnes and Harding (Scribner, 1962, $4.50), will tell you who is doing creativity research and where; this book also contains a section on current educational programs under way in the field of creativity.

If you want to know what psychologists think about creativity, see *Contemporary Approaches to Creative Thinking* (Prentice Hall, 1962, $6) by Gruber, Wertheimer, and Terrell. The contributors, all well-known psychologists, are not closely associated with research in creativity. The article by Newell, Shaw, and Simon, describing their methods for programming a computer to simulate human thinking, is excellent. The discussion of creativity in terms of a machine program adds clarity and precision to our concept of "creativity." If you want to understand the psychology of imagination, read McKellar's *Imagination and Thinking* (Basic Books, 1957, $4.25): McKellar says that all creative imagination must stem from previous perceptual experience; he bases this on investigations of dreams, mental imagery, drug-induced states, etc. The book is especially valuable because it includes material that is typically overlooked in psychological treatments of creativity.

Author Hyman believes that some of the best work in this field is not done under the label "creativity." If you are investigating developments, therefore, you should be aware of the following—among others: The animal work of Harry Harlow (Wisconsin) and D. O. Hebb (McGill), especially as it relates to the role of early experience on subsequent problem-solving ability; Jerome Bruner's work (Harvard) on how people go about attaining concepts; the work of Charles Osgood (Illinois), Fritz Heider (Kansas State), and Leon Festinger (Stanford) on mental models: how attitudes are organized and how the mind reacts when confronted with new information.

CHANGING THE WEATHER 60

For an easygoing introduction to matters meteorological, including techniques for modifying the weather and for the statistical evaluation of such efforts, see a pair of paperbacks written by one author, L. J. Battan: *The Nature of Violent Storms* (1961) and *Cloud Physics and Cloud Seeding* (1962), both Doubleday Anchor Books. Considerably