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Effects of Brainstorming or Short-Term Incubation on Divergent Production in Problem-Solving

Roger L. Firestien

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EFFECTS OF BRAINSTORMING
OR SHORT-TERM INCUBATION
ON DIVERGENT PRODUCTION
IN PROBLEM-SOLVING

ROGER L. FIRESTIEN

Effects of Brainstorming or Short-Term Incubation
on Divergent Production in Problem-Solving

by
Roger L. Firestien

An Abstract of a Thesis
in
Creative Studies

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Master of Science

August 1979

State University of New York
College at Buffalo
Interdisciplinary Center for Creative Studies

ABSTRACT

This study was designed to investigate differences in divergent production performance among students who were involved in a brainstorming session while incubating and subjects who only incubated. Effects of the treatments were assessed by subjects' responses on a written problem-solving inventory.

Analysis of variance indicated that the performance of subjects who were trained in divergent production, i.e., brainstorming, was greater than that of subjects who were not trained in divergent production. The incubation treatment, however, did not seem to influence subjects' divergent production scores significantly.

New directions are proposed to study effects of various attributes of incubation as compared with certain attributes of creativity.

State University of New York

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This work is respectfully and lovingly dedicated to my parents:
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CHAPTER ONE

STATEMENT OF THE PROBLEM

This study involved determining the effects of a brainstorming session or a period of incubation on divergent production in solving problems. It attempted to accomplish this through the use of five experimental groups. The groups were: control group, brainstorming treatment group, incubation treatment group, initial incubation treatment group, and initial brainstorming treatment group.

Research Questions

Ten specific research questions were investigated.

(1) Does a specific effort to facilitate incubation during problem-solving, using guided imagery, facilitate divergent production in Creative Problem-Solving?

(2) Does the introduction of brainstorming during problem-solving facilitate divergent production in Creative Problem-Solving?

(3) Does a specific effort to facilitate incubation prior to problem solving facilitate divergent production in Creative Problem-Solving?

(4) Does the introduction of brainstorming prior to problem-solving facilitate divergent production in Creative Problem-Solving?

(5) How does a specific effort to facilitate incubation during problem-solving, using guided imagery, compare to a specific effort to facilitate incubation, prior to problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving?

(6) How does the introduction of brainstorming, prior to problem-

solving, compare to the introduction of brainstorming, during problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving?

(7) How does the introduction of brainstorming, during problem-solving, compare to a specific effort to facilitate incubation, during problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving?

(8) How does a specific effort to facilitate incubation, prior to problem-solving, compare to the introduction of brainstorming, prior to problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving?

(9) How does a specific effort to facilitate incubation, during problem-solving, using guided imagery, compare to the introduction of brainstorming, prior to problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving?

(10) How does the introduction of brainstorming, during problem-solving, compare to a specific effort to facilitate incubation, prior to problem-solving, in facilitating divergent production in Creative Problem-Solving?

RATIONALE

For centuries people have been concerned with solving problems. Ancient problems of food and shelter are no longer major problems for people. Today we are faced with more sophisticated problems. Possibly as a result of encountering these problems, and with the rise of modern

psychology, people have turned inward and have become more concerned with the processes we use to solve problems. As a result of this concern, many models have been developed for solving problems. One of those models is the five-step Creative Problem-Solving process initially described by Osborn (1963) and elaborated by Parnes and his associates (Parnes, Noller, and Biondi, 1977). A major component of this model is a technique known as brainstorming. Brainstorming is an active way for a group to generate ideas as leads toward possible solutions to problems. It is used explicitly throughout the Creative Problem-Solving process.

Another technique, utilization of which is implied throughout the Creative Problem-Solving process, is incubation. Incubation is that period of time when one is not actively or consciously working on the problem. Guilford (1979) defined incubation as "a period in the behavior of the individual during which there is no apparent activity on his part toward the solution of a problem" (p.1). Incubation could be considered the time when the problem-solver has taken a break from his/her active, explicit work on the problem.

This study involved determining the effects of a brainstorming session or a period of incubation on divergent production and problem-solving in order to seek insights into the effectiveness of various techniques for solving problems. For example, if a person is working on a difficult problem and has not come to a satisfactory solution to that problem, one thing that the problem-solver might consider is to put the problem out of his/her mind and allow for some incubation time to occur. During this incubation period the problem might surface occasionally and a solution might present itself. If however, that solution does not present

itself in a reasonable amount of time, what can be done? Perhaps the person might do some brainstorming, even on a totally unrelated topic, so as to "stir up" additional ideas or associations.

This study was designed so that while some problem-solvers were encouraged to incubate, they also became involved in an active brainstorming session. Others were provided only with a period of incubation. By comparing the problem-solvers' scores on a pencil and paper problem-solving inventory, stressing divergent thinking, inferences might be made concerning the advantages or disadvantages of a brainstorming session or a period of incubation in solving problems.

CHAPTER TWO

REVIEW OF LITERATURE

In this chapter, we shall review the literature concerning incubation and Creative Problem-Solving. Theory and research will be summarized to demonstrate the basis for the research questions presented in Chapter One.

INCUBATION

Incubation has been defined in several ways. The definition that most clearly expresses the focus of this investigation describes incubation as a period of inactivity which occurs in the process of solving a problem. Incubation occurs after the problem-solver has saturated him/herself with all the information or data concerning the problem. The incubation period is a time during which the person is not thinking overtly about the problem. Guilford (1977) defined incubation as: "holding off actual work on a problem for a time, but keeping up the desire to solve it" (p.174).

Wallas (1926) included incubation as the second step in his description of stages in problem-solving (preparation, incubation, illumination, and verification). He believed that incubation was the stage during which no conscious thought was devoted to the problem, but 'work' still continued on nonconscious levels. Sidney J. Parnes (1977) described incubation as letting the problem "simmer" in the back of the mind, "on our back burner." Amy Lowell, the poet, (Ghiselin, 1952) described incubation as dropping her subject into the subconscious

much as one would drop a letter into a mailbox. "Six months later, the words of the poem began to come into my head, the poem--to use my private vocabulary--was 'there'" (p.110).

Incubation is usually followed by a breakthrough or a new insight for solving the problem. This breakthrough instant is variously described as the illumination, the aha, or the eureka. Wallas (1926), in discussing the third step in his paradigm concluded: "Illumination is the stage during which the 'happy ending' occurs together with the psychological factors that immediately preceded and accompanied its appearance" (Stein, p.14).

The illumination, or new insight, is characterized by a state of ecstasy or a heightened state of consciousness. May (1975) described this moment as one in which:

everything around me became suddenly vivid. I can remember that on the particular street down which I walked the houses were painted an ugly shade of green that I normally would prefer to forget immediately. But by virtue of the vividness of this experience, the colors all around were sharpened and were imbedded in my experience, and that ugly green still exists in my memory. (p.64)

May proposed that the idea or breakthrough "came in order to complete an incomplete Gestalt with which I was struggling in conscious awareness" (p.66).

Not only is there the vivid or ecstatic experience that occurs at the breakthrough instant, there is also the feeling of certainty that the idea is the correct solution to the problem:

I did not verify the idea; I should not have had time, as, upon taking my seat in the omnibus, I went on with a conversation already commenced, but I felt a perfect certainty. On my return to Caen, for conscience's sake I verified the result at my leisure. [Poincaré, in Ghiselin (1952), p.37]

May (1975) affirmed this in his analysis of Poincaré's testimony. He cited "brevity and conciseness of the insight, along with the experience of immediate certainty," as the fourth of seven attributes of Poincaré's illuminating experience (p.71).

Why does a feeling of certainty accompany that vivid, ecstatic, breakthrough experience? Perhaps it is because the solutions to these problems upon emerging into the consciousness are so appealing to the person or so elegant. Poincaré believed that the useful combinations are the most beautiful. He believed they are able to charm a special sensibility that all mathematicians know, "but of which the profane are so ignorant as often to be tempted to smile at it" (Ghiselin, 1952, p.40).

May continued to describe illumination as a completion of a Gestalt when he proposed that:

insights emerge not chiefly because they are 'rationally true' or even helpful, but because they have a certain form, the form that is beautiful because it completes an incomplete Gestalt. (1975, p.74)

One might conclude, then, that incubation is a period of relative inactivity, followed by illumination. It is that instant in which emerges the often elegant solution to the problem.

Attributes of Incubation

What are some of the events or activities that characterize incubation? Four basic sets of attributes may be identified: (1) relaxed attention, (2) difference in mental states, (3) sleep, naps, or removal of fatigue, (4) musing, reverie, daydreaming, or letting the mind "meander." These sets of attributes were developed by a careful review of written accounts

from great thinkers relating their experiences concerning the period of incubation. They were then grouped together by examining similar basic attributes.

Relaxed Attention. Albert Einstein once asked a friend of Rollo May, "Why is it I get my best ideas in the morning while I'm shaving?" May's friend explained, "Often the mind needs the relaxation of inner controls--needs to be freed in reverie or daydreaming--for the unaccustomed ideas to emerge" (May, 1975, p.67). This example, and several following examples, illustrates that creative breakthroughs occur while the mind is attending to some activity in a relaxed, almost automatic way. The mind is occupied with some simple or routine activity which seems to relax the vigil of the judgmental, conscious, mind thus allowing the breakthrough to occur.

Shaving, driving to work, taking walks, etc., aid the thinker in occupying his/her attention long enough for the breakthrough process to occur. The sought after idea then, as Einstein said, "modestly presents itself" (Gowan, 1975, p.306). An example of shaving, as an activity which allows the underlying creative process to function, is related by A. E. Housman in Ghiselin (1952).

Experience has taught me, when I am shaving of a morning, to keep watch over my thoughts, because, if a line of poetry strays into my memory, my skin bristles so that the razor ceases to act. (p.90)

Taking walks was another favored way for Housman, and other thinkers, to occupy the mind in that relaxed, automatic way.

I would go out for a walk of two or three hours. As I went along, thinking of nothing in particular, only looking at things around me and following the progress of the seasons, there would flow into my mind, with sudden and unaccountable

emotion, sometimes a line or two of verse, sometimes a whole stanza at once, accompanied, not preceded, by a vague notion of the poem which they were destined to form part of. (Ghiselin, 1952, p.91)

Alex Osborn, while walking through Syracuse, New York, one evening in the rain, was struck with the idea of establishing a consumer-research panel of 1,000 families from that county. Osborn's observation of the community as a cross section of America occurred to him while taking that walk (1963, p.322). Poincaré was struck with the answer to some arithmetical questions one morning at the seaside while "walking on the bluff." [Poincaré, in Ghiselin (1952) p.37]

Lawrence Kubie, while driving home from the hospital one night after working fruitlessly on a theoretical psychological problem, saw his route from the hospital to the office as:

the symbolic bridge between neurosis and psychosis, and at the same time the bridge between tensions generated on the psychological level of experience and its translation into somatic dysfunction. (1958, p.86)

Graham Wallas related that many of his best ideas occurred to him while taking a bath. He went so far as to state a need for: "creative tools in the form of waterproofed pencils and waterproofed notebooks" (Osborn, 1963, p.324).

Harriet Beecher Stowe, while seated in her church pew in Brunswick, saw during the communion service:

The unrolling of a picture scroll, the scene of the death of Uncle Tom seemed to pass before her. . . . She was so affected she could scarcely keep from weeping. . . . That Sunday afternoon she went to her room, locked the door and wrote out, substantially as it appears . . . the chapter called "The Death of Uncle Tom." [Prince, in Gowan (1977), p.83]

These examples illustrate that for a person to have breakthroughs during a time of "relaxed attention" it is necessary for them to be

involved in some other activity. This activity seems to be a pastime that doesn't involve much conscious thought. As stated before, when the mind is occupied with these automatic activities the opportunity is then ripe for breakthroughs to occur.

Difference in Mental States. Travel, hobbies, turning in another direction, taking time out, and being "differently occupied" are all aspects of the second type or attribute of incubation. In the following passage, Poincaré related how the "changes of travel" allowed him to have a breakthrough idea.

The changes of travel made me forget my mathematical work. Having reached Coutances, we entered an omnibus to go some place or other. At the moment when I put my foot on the step the idea came to me, without anything in my former thoughts seeming to have paved the way for it. [Poincaré, in Ghiselin (1952), p.57]

A change, or difference in mental states, seems to be one of the classic forms of incubation. Many times when one is confronted with a problem with no conceivable answer, a change of pace provides a refreshing and beneficial interlude for that answer to surface. May (1975) believed that "insight comes at a moment of transition between work and relaxation" (p.66). This moment seems to be the period of time when the problem-solver has turned from his fruitless quest for an answer to take that needed change of pace. Poincaré had this to say about changes of pace:

Thereupon I left for Mont-Valerin, where I was to go through my military service; so I was very differently occupied. One day, going along the street, the solution of the difficulty which had stopped me suddenly appeared to me. I did not try to go deep into it immediately, and only after my service did I again take up the question. [Poincaré, in Ghiselin (1952), p.37]

Rollo May affirmed the value of taking time out also. It seems he had been working on a difficult case problem. He was tired and tried to put the

whole "troublesome business" out of his mind. "About fifty feet away from the entrance to the Eighth Street station, it suddenly struck me 'out of the blue'" (May, 1975, p.60).

Osborn (1963) believed that one of the active ways to reap the benefits of incubation was to deliberately turn creative lines of thought into other directions. These other directions could be anything from model ship building to buying a new hat.

Sleep, Naps, Removal of Fatigue. "Let me sleep on it; I'll give you my answer in the morning." Perhaps the most classic example of incubation is sleep. Thinkers from all walks of life have learned the benefits of a good night's sleep in solving difficult problems. Lawrence Kubie's formula for solving difficult problems is to work on a problem until late at night when he becomes tired; he falls asleep with the problem unsolved. Kubie reported, "Frequently I will awaken four or five hours later, sometimes in the middle of the very sentence on which I was hung up as I went to sleep, but with a new assembly of the material" (1958, p.84).

Another example of the value of sleep and dreaming came with the breakthrough of Mendeleev's Table of the Elements, reported by Krippner:

In 1869, D.I. Mendeleev went to bed exhausted after struggling to conceptualize a way to categorize the elements based upon their atomic weights (cited by Kedrov, 1957). He reported, "I saw in a dream a table where all the elements fell into place as required. Awakening, I immediately wrote it down on a piece of paper. Only in one place did a correction later seem necessary." (1972, p.218)

Often a nights sleep is not necessary for the breakthrough to occur. Naps and dozing are also ways to court the muse of illumination. Perhaps there is none so classic a nap as the one taken by Kekule one afternoon in 1865 and related by Koestler:

I turned my chair to the fire and dozed, he relates. Again the atoms were gambolling before my eyes. This time the smaller groups kept modestly in the background. My mental eye, rendered more acute by repeated visions of this kind, could now distinguish larger structures, of manifold conformation; long rows, sometimes more closely fitted together; all twining and twisting in snakelike motion. But look! What was that? One of the snakes had seized hold of its tail, and the form whirled mockingly before my eyes. As if by a flash of lightning I awoke. (1964, p.118)

The snake biting its tail gave Kekule the clue to the insight that:

molecules of certain important organic compounds are not open structures but closed chains or 'rings'--like the snake swallowing its tail. (Koestler, 1964, p.118)

Naps, good nights' sleep, any forms of fatigue removal seem to be another way for those solutions to problems to "bob" up into our conscious minds. Osborn (1963) gave a detailed description of how to make the most out of a good night's sleep. He advised not rushing at things too hard on first awakening in the morning. A leisurely breakfast and even a bit of loafing in the morning should "thus prevent the premature pressure from nipping the buds of our nocturnal illumination"(p.319).

Musing, Reverie, Daydreaming--Letting the Mind "Meander." Musing, daydreaming, or periods of reverie are all examples of states of letting the mind wander, giving the mind free reign to make whatever connections it wishes. These states are somewhat likened to hypnogogic states, that time between falling asleep and being asleep. This hypnogogic state is the time when much of our conscious processes are being shut down and thoughts surface from somewhere deeper in our being.

Lord Tennyson induced this state of reverie by repeating his name to himself silently till "all at once out of the intensity and conscious of the individuality, the individuality itself seems to dissolve and fade

away into boundless being" [Prince, in Gowan (1977), p.83]. Tennyson called this state a "kind of walking trance" [Prince, in Gowan (1977), p.83]. This form of incubation seems to be characteristic of a process of emptying or quieting the mind. Emerson did this when he took time out each day to "meditate quietly before brooks" (Osborn, 1963, p.314). Einstein also attested to this state when he said, "If we quiet the mind and relax, we find to our surprise that a new idea modestly presents itself" (Gowan, 1975, p.306).

A quiet mind, however, is not always the case when new ideas occur in this particular mental state as Poincaré related in the following passage, cited by Ghiselin:

One evening, contrary to my custom, I drank black coffee and could not sleep. Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination. By the next morning I had established the existence of a class of Fuchsian functions . . . I had only to write out the results, which took but a few hours. (1952, p.36)

Osborn (1963) liked to allow his mind to "meander" while getting a haircut. He described this state as not trying to think but just letting the mind "wander" (p.318).

Another productive form of this type of incubation is daydreaming. Burdette Wright, the World War II airplane manufacturer, used to eat a light lunch, lock himself in his office, and "just dream with his eyes open" (Osborn, 1963, p.319). Almost every afternoon after one of these sessions, he would bring a valuable idea to his planning conferences. Finally, Beardsley Rummler, known in 1963 as the "national idea man," locked himself up for at least an hour a day to do nothing but muse. He described this as "a state of dispersed attention" (Osborn, 1963, p.320).

There seem to be two forms of activity that take place when we relax

our controls on the mind. These activities can be quiet states or states of dynamic production of vivid thoughts and images.

CREATIVE PROBLEM-SOLVING

Creative Problem-Solving is a five-step process initially described by Osborn (1963) and developed by Sidney J. Parnes and his associates at the State University College at Buffalo (Parnes, Noller, and Biondi, 1977). This process includes: recognizing a "mess" or initial problem situation; gathering facts about that situation; generating several ways to restate the problem; generating many ideas for possible solutions to the problem; developing evaluative criteria for solutions, generating multiple ways of implementing the chosen solution, and generating a plan of action for the chosen idea or ideas. The previous activities are incorporated into the five fundamental steps which make up the Creative Problem-Solving process. Those steps are: fact-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding (Parnes, Noller, and Biondi, 1977).

The means by which all of these facts, ideas, and criteria are generated is the principle known as deferred judgment. Deferred judgment is the "main ingredient" in the group process known as brainstorming, developed by Osborn in the late 1930's. There are four guidelines which are followed in brainstorming. They are:

- (1) No criticism of any ideas--defer judgment.
- (2) Strive for quantity, in generating ideas this breeds quality.
- (3) Strive for remote associations, "shoot wild and freewheel."
- (4) Hitchhike, use other people's ideas to spur your own ideas.

In each of the five steps of the Creative Problem-Solving process, deferred

judgment is used. It is used to generate as many facts, restatements of the problem, ideas, criteria, and implementation ideas as time allows.

RELATIONSHIP OF CREATIVE PROBLEM-SOLVING AND INCUBATION

In this section, Creative Problem-Solving methods and techniques will be related to incubation.

The Creative Problem-Solving process is a dynamic process that allows for great divergence in idea production, then converging on one or two solutions. In Creative Problem-Solving sessions, participants experience a great amount of conscious activity, manipulating ideas, facts, criteria, etc., in the process of solving a problem. Parnes (1977) advocated a balance in this process of deferred judgment, which is divergence, and judgment, which is convergence. This concept of balance can be carried further with the idea of alternation of active thinking with incubation.

One purpose of this study was to determine whether there is a difference in ideas produced after a period of incubation, in comparison with ideas produced after participating in a brainstorming session. Parnes (1977) made an analogy comparing incubating on an idea to that of a pot simmering on a back burner. To further that analogy, this study attempted to determine whether there is a difference between letting that pot simmer or stirring it up a bit.

Much has already been said concerning the attributes of incubation. The discussion will now address some related issues concerning this "stirring up process" which could occur during incubation.

Parnes (in Biondi, 1972) stated that while incubating on a particular problem, random input from the environment bombards the fringes of the problem. What often occurs is "the momentary surfacing of the problem and

the formation of a new idea" (p.44). Poincaré (in Ghiselin, 1952) compared thoughts to atoms hooked to the walls of the mind. While the mind was in complete repose, these atoms remained motionless and no connections were made. However during a period of unconscious work:

certain of them are detached from the wall and put in motion. They flash in every direction through the space . . . where they are enclosed as would, for example, a swarm of gnats or . . . like the molecules of gas in the kinematic theory of gasses. Then their mutual impacts may produce new combinations. (p.41)

Poincaré called the activity of these atoms a dance, as he continued:

after this shaking up imposed upon them by our will, these atoms do not return to their primitive rest. They freely continue their dance. [In Ghiselin (1952), p.41]

Lawrence Kubie (1958) expanded more on the "shaking up" concept.

Certainly such experiences justify the conviction that the process of free association, which shakes us out of our ruts, thereby making it possible to bring together new combinations of ideas, allowing these new combinations to fall into recognizable patterns. (p.84)

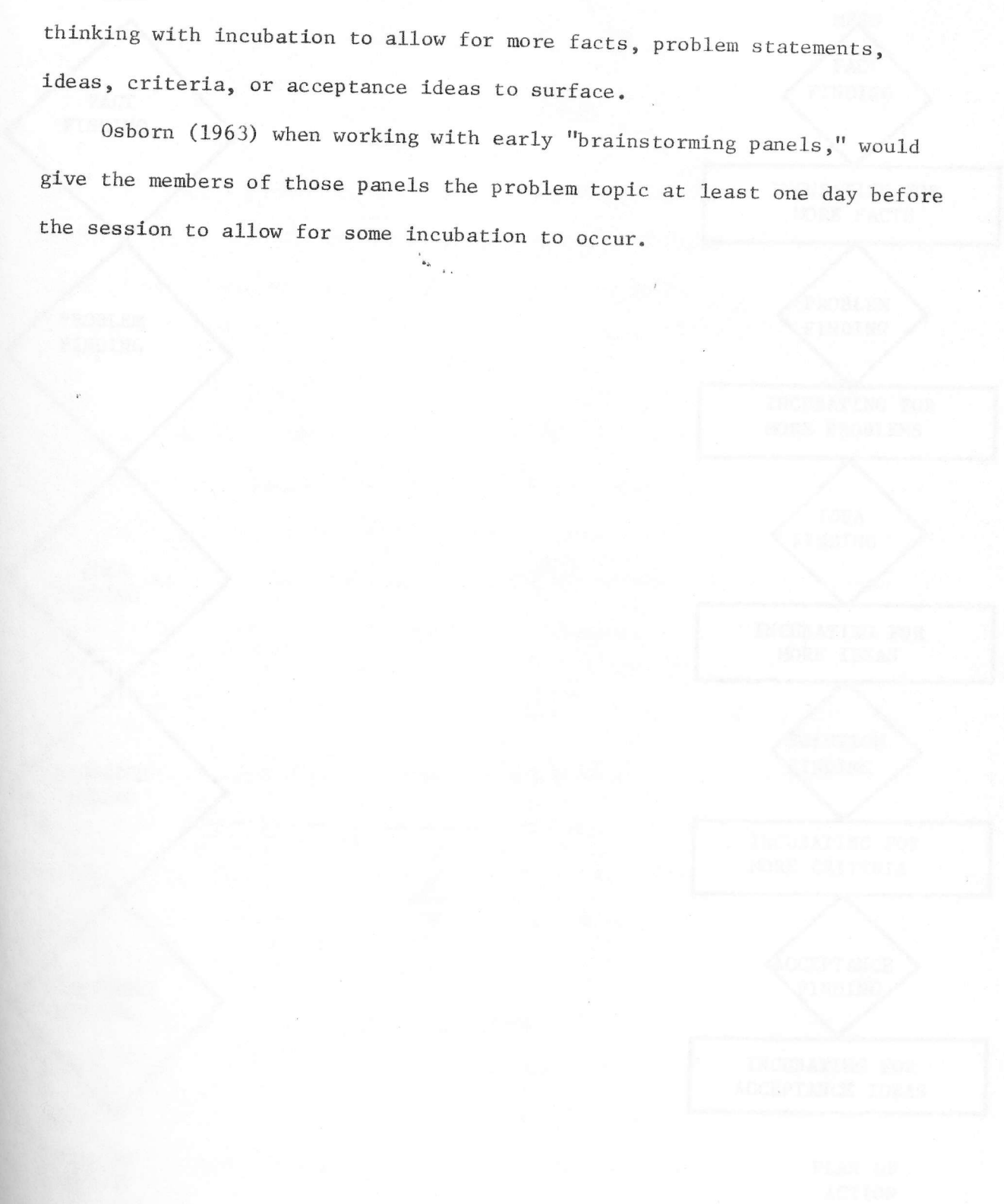
This "shaking up" process is demonstrated by the use of brainstorming in this study.

Parnes (in Biondi, 1972) "relates incubation directly to the principle of deferred judgment" (p.43). He proposed that in order for incubation to occur, "the problem-solver must step away from the problem for a period of time, thus deferring judgment or closure on the problem" (Biondi, 1972, p.44). Incubation is often seen as occurring somewhere between Idea-Finding and Solution-Finding in the five-step Creative Problem-Solving model. But as Biondi (1972) stated, "it may occur or recur at any stage of the total Creative Problem-Solving process" (p.44). Figure 1 illustrates this concept.

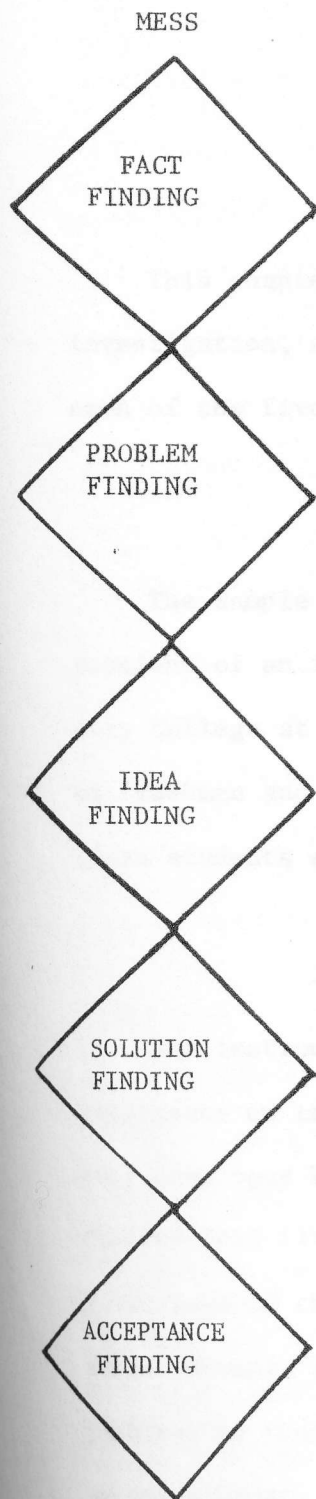
As shown in Table 2, the problem-solver can alternate active

thinking with incubation to allow for more facts, problem statements, ideas, criteria, or acceptance ideas to surface.

Osborn (1963) when working with early "brainstorming panels," would give the members of those panels the problem topic at least one day before the session to allow for some incubation to occur.

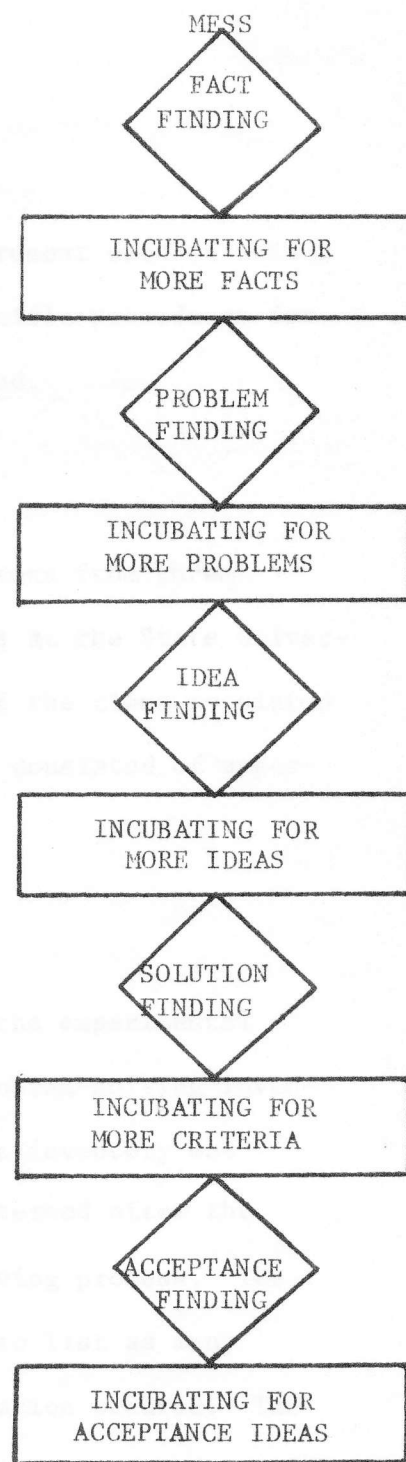


CPS MODEL



PLAN OF ACTION

CPS MODEL ADAPTED TO INCLUDE INCUBATION



PLAN OF ACTION

Figure 1. Incubation and the Creative Problem-Solving Model.

CHAPTER THREE

METHODS AND PROCEDURES

This chapter will describe the sample, the instrument used in this investigation, and the experimental treatments. Specific procedures for each of the five experimental groups will be presented.

SAMPLE

The sample for this study consisted of 113 students from three sections of an introductory class in Creative Studies at the State University College at Buffalo. Approximately 70 percent of the class consisted of freshmen and sophomores; the remaining 30 percent consisted of upper-class students and continuing education students.

INSTRUMENT

The instrument used to determine the effect of the experimental treatments on the subjects was a paper and pencil problem-solving inventory developed by Johnson and Treffinger (1978). The inventory was divided into five subtests. Those subtests were patterned after the five steps of the Osborn-Parnes Creative Problem-Solving process. The first subtest, Identifying Problems, asked students to list as many problems as they could think of if a particular situation occurred. The second subtest, Stating Basic Problem, asked the subjects to read a particular passage and then list several responses as to what they thought the real problem was. Subjects were then asked to identify and list various subproblems that would result from the problem they listed. Producing Alternate Solutions was the third subtest. After reading a

particular problem situation, subjects were asked to list as many possible solutions to the problem as they could think of. Evaluating Alternate Solutions, the fourth subtest, asked subjects to propose evaluative criteria for a list of ideas chosen for solving a particular problem. They were then asked to place the criteria into a matrix and evaluate the chosen ideas. The fifth subtest, Planning Idea Implementation, gave subjects a particular problem and a solution to the problem. Subjects were asked to list possible problems that might occur if the particular idea was implemented and then propose possible solutions for overcoming those problems.

The total length of the problem-solving inventory was six pages. It was designed to be completed in approximately 30 minutes. A copy of the inventory is included in Appendix A.

EXPERIMENTAL TREATMENT

Background

The students in this study were members of three sections of an introductory course in Creative Studies. One of these sections met every Tuesday and Thursday morning for 75 minutes; the other section met Tuesday and Thursday afternoons for 75 minutes. The third section met late every Monday afternoon and one Saturday per month. The experiment was conducted Tuesday, October 24, in the morning and afternoon sections of the class and Saturday morning, November 4, 1978.

Method

As students arrived for class, they were randomly divided into five different groups. The groups were separated and escorted by the test

proctors to different rooms on the campus where different treatments of the test were to occur. Those groups were: control, brainstorming treatment, incubation treatment, initial incubation treatment, and initial brainstorming treatment.

This study was designed so that all experimental groups received a total of thirty minutes to work through the problem-solving inventory. In the case of the brainstorming treatment groups and the incubation treatment groups, the thirty minutes were divided into two equal sections of fifteen minutes each to allow for the 20-minute intervention. This experimental design is similar to the one suggested by Olton (1979, p.14). The total time involved for this study was 50 minutes for all groups except the control group. Since no 20-minute treatment was necessary for the control group, subjects were finished with the study in 30 minutes. The initial brainstorming and incubation groups received 20 minutes of treatment and then were allowed 30 minutes to complete the problem-solving inventory.

The instructions on all of the problem-solving inventories asked participants to read over the entire inventory before beginning. This activity allowed some incubation time to occur before beginning on specific exercises.

Procedures

Group 1, Control. Subjects in the control group were escorted to the testing area by the test proctor. They were given the problem-solving inventory and instructed to fill in their names and section of the class they were in, i.e. morning class, afternoon class, or Saturday class. As

soon as participants had completed the preliminary information, the proctor instructed them to begin and commenced timing. Subjects were allowed exactly 30 minutes to work on the test. Since the test did not take the entire class period to complete, when the 30-minute time period was over and the tests were collected, students were free to leave. They were not allowed, however, to return to the classroom where they reported for their usual class because another group was still involved with testing. Test proctors were not allowed to answer any questions concerning the tests. There were ten students in the morning control group, seven students in the afternoon control group, and five students in the Saturday control group.

Group 2, Brainstorming Treatment. Subjects were escorted to their assigned test area and completed the necessary preliminary information on the problem-solving inventory. The instructions on this set of problem-solving inventories notified subjects that about half-way through the inventory they would be asked to stop working on the inventory and become involved in another activity. This activity was the brainstorming exercise.

When all preliminary information was completed, the test proctor started subjects working on the inventory. After subjects had been working on the inventory for fifteen minutes, they were asked by the proctor to stop and become involved in a brainstorming exercise. Their inventories were collected; they were divided into two groups, and the following explanation was read to them:

Today we are going to do an exercise in deferred judgment, brainstorming. This should be an enjoyable exercise so I want you to really shoot wild

with ideas. Remember the guidelines of brainstorming: No criticism, defer judgment, which means don't judge or criticize other people's ideas or your own ideas. Strive for quantity which breeds quality, try to get as many ideas as you can in the amount of time you have to get those ideas. Shoot wild--Freewheel, go way out and try to think up the wildest, craziest ideas you can. Hitchhike, use other person's ideas to spur your own ideas.

In your small groups, I want you to choose a recorder and a back-up recorder. The job of the recorder is to get as many ideas written down as possible, the back-up recorder records all the ideas that the recorder misses. Remember, both recorders should contribute ideas to the group.

Now I want you to relax, lean back in your chair or on the floor, and close your eyes./ I want you to think of something that you encounter daily./ In fact you encounter this thing several times daily./ I want you to think of a bathroom./ I want you to think of all the bathrooms you have ever been in your life./ I want you to think of your bathroom at home, at school, at work./ Now I want you to think of all the times you have been frustrated while in a bathroom, I mean really, you run out of toilet paper, the shower water is cold, you run out of soap, the shampoo gets all over the floor, the toilet seat is cold, towels get wet, and you always have to clean that bathroom. (long pause) Now I want you to imagine that you have unlimited money; you can defy the laws of nature, anything you wish can come true. With all of that in mind, I want you to design the perfect bathroom. Think for a minute what your perfect bathroom might look like./ Now open your eyes. In your small groups, I want you to brainstorm all the ideas that you would incorporate in the perfect bathroom. You have 5 minutes. Go!

Subjects brainstormed for five minutes on the topic of the perfect bathroom. The number of ideas generated were recorded on a blackboard and subjects were encouraged to strive to get more ideas in the next part of the brainstorming exercise. The directions continued:

Now in your same small groups--you can change recorders if you like--I want you to try to double the number of ideas you came up with in the last session. If you had

25 ideas, I want you to generate 50 ideas, if you had 50 ideas, I want you to come up with 100 ideas. You are going to have another five minutes to generate more ideas for the perfect bathroom, but you cannot use any of the ideas you have generated so far. Now is your chance to really get wild. Now you have five minutes to generate all the ideas for the perfect bathroom. Ready, Go!

At the end of the second five minutes of brainstorming effort, subjects were asked to look through both lists they had generated and choose approximately 10 to 15 ideas that were interesting and unusual and share those ideas with members of the other group.

This treatment lasted for exactly 20 minutes. After the sharing of ideas, subjects' tests were returned to them and they were allowed to continue working on the problem-solving inventory.

There were nine students in the morning brainstorming treatment group, eight students in the afternoon brainstorming treatment group, and six students in the Saturday brainstorming treatment group.

Group 3, Incubation Treatment. Subjects were escorted to their test area and allowed to complete the necessary preliminary information on the problem-solving inventory. Instructions on this set of inventories, as in the brainstorming treatment group, notified subjects that they would be interrupted about halfway through the inventory to become involved in another activity. This activity was the incubation experience. When all preliminary information was completed, the test proctor started timing and allowed subjects to begin working on the inventories. After fifteen minutes, the subjects were stopped, their inventories collected and the following instructions were read to them by the test proctor:

I want you to spread out on the floor around the area. Lie down on your backs or get comfortable in any way you like. (Allow them to do that) We are going to have an experience that will allow you to relax and focus on the images that might form in your mind. In a few moments I'm going to put on a tape that will ask you to relax your body while some soothing music is played and an experience is related to you. If you choose not to participate in the pleasant imaginary trip that we will experience, you can have an experience of your own. The important thing is that you relax, rest a bit, and not think about anything that might be on your mind at this time. Please close your eyes.

A 20-minute tape was developed for this incubation experience. After the previous explanation was read to subjects, the proctor turned on the tape.

The background music for this experience was original guitar music written and recorded by this researcher in the communications studio at the State University College at Buffalo. The script for this experience appears in Appendix B.

After the 20-minute incubation experience, subjects' tests were returned to them and they were allowed to work for 15 more minutes on the problem-solving inventory.

The incubation treatment developed for this study was a guided imagery experience. It was designed to incorporate the four attributes of incubation discussed in the review of literature. Those attributes were: relaxed attention, difference in mental states, removal of fatigue, and musing or reverie.

Perhaps Gowan's (1978, p.23) definition of incubation is the one that most closely relates to the incubation treatment when he says: "Incubation involves any technique of relaxation which allows us to pay attention

to the imagery which is continually going on in the right hemisphere."

There were eight students in the morning incubation group, seven students in the afternoon incubation group, and six students in the Saturday incubation group.

Group 4, Initial Incubation Treatment. Subjects were escorted to their test area by the test proctor and became involved in the 20-minute incubation treatment as described previously. They were then given the problem-solving inventory and allowed to complete the preliminary information. The test proctor instructed subjects to begin and allowed them 30 minutes to work on the inventory. After 30 minutes, problem-solving inventories were collected by the proctor.

There were seven students in the morning initial incubation treatment group, five students in the afternoon group, and six students in the Saturday group.

Group 5, Initial Brainstorming Treatment. Subjects were escorted to their test area by the test proctor and became involved in the 20-minute brainstorming treatment as described previously. The problem-solving inventory was distributed and subjects were allowed to complete the preliminary information. The proctor instructed subjects to begin and allowed them thirty minutes to work on the inventory. After 30 minutes, problem-solving inventories were collected by the proctor.

There were nine students in the morning initial brainstorming group, seven students in the afternoon group, and six students in the Saturday group.

Group 4	Group 5
Initial Incubation Treatment	Initial Brainstorming Treatment
N=18	N=22
20-minute incubation treatment	20-minute brainstorming treatment
30 minutes to work on problem-solving inventory	30 minutes to work on problem-solving inventory
Group 3	Group 2
Incubation Treatment	Brainstorming Treatment
N=21	N=23
15 minutes to work on problem-solving inventory	15 minutes to work on problem-solving inventory
20-minute incubation treatment	20 minute-brainstorming treatment
15 minutes to work on problem-solving inventory	15 minutes to work on problem-solving inventory
Group 1	
Control	
N=22	
30 minutes allowed to work on problem-solving inventory	

Figure 2. Summary of experimental arrangements.

SCORING PROCEDURES

Tests were scored employing a prepared score guide supplied by the developers of the tests. Tests were scored individually, by hand, by the experimenter. To prevent bias in scoring, a colleague placed tape over the students' names and group assignments, randomly shuffled the tests, and assigned each a number. Test results were compiled on a prepared score sheet, totaled and transferred to cards for computer analysis. Each subtest of the test battery was scored separately for all students.

Fifteen random tests were rescored after all 113 tests were scored and correlated with their counterparts for accuracy. Scores for each subtest were correlated separately. The reliability coefficients were: subtest 1, Identifying Problems, $r=.997$ ($p<.01$); subtest 2, Stating Basic Problems, $r=.935$ ($p<.01$); subtest 3, Producing Alternate Solutions, $r=.996$ ($p<.01$); subtest 4, Evaluating Alternate Solutions, $r=.986$ ($p<.01$); subtest 5, Planning Idea Implementation, $r=.936$ ($p<.01$). Table 1 shows the means and standard deviations for the five scoring dimensions and for both the original scoring and the rescoring.

TABLE 1
 SCORER RELIABILITY
 FOR
 FIVE PROBLEM-SOLVING SCORING DIMENSIONS

(N=15)

Scoring Dimension	Time 1 \bar{x} (s.d.)	Time 2 \bar{x} (s.d.)	$r_{1,2}$
Identifying Problems	10.73 (5.24)	10.86 (5.30)	.997*
Stating Basic Problem	5.33 (2.6)	5.06 (2.75)	.935*
Producing Alternate Solutions	15.4 (7.53)	15.2 (7.52)	.996*
Evaluating Alternate Solutions	7.46 (3.77)	7.6 (3.73)	.986*
Planning Idea Implementation	2.13 (3.91)	2.33 (3.94)	.936*

PLAN FOR DATA ANALYSIS

A separate one-way analysis of variance (Edwards, 1968) was conducted for each of the five problem-solving variables comparing the five experimental groups. When significant F values were obtained, Duncan's Multiple Range Test (Edwards, 1968) was used for post-hoc comparisons of means. The .05 significance level was adopted for all tests of significance.

Duncan's Multiple Range Tests were significant for F values were obtained in the ANOVA.

Identifying Problems. As shown in Table 2, the analysis of variance for the problem-solving variable Identifying Problems (IP) was not significant ($F=1.004$). Since the ANOVA was not significant, no further analyses were conducted.

TABLE 2

ANALYSIS OF VARIANCE FOR IDENTIFYING PROBLEMS

Source	D.F.	S.S.	M.S.	F	p
Between groups	4	181.198	45.299	1.004	n.s.
Within groups	101	1897.180	18.783		
Total	105	2078.378			

Stating Basic Problem. As shown in Table 3, the analysis of variance for the problem-solving variable Stating Basic Problem (SBP) was not significant ($F=1$). Since the ANOVA was not significant, no further analyses were conducted.

CHAPTER FOUR

RESULTS

This chapter will describe the results of the statistical analyses of the test data for the five problem-solving variables. The .05 level of significance was adopted for all tests of significance. For each variable one-way analysis of variance procedures were employed, followed by Duncan's Multiple Range Tests when significant F ratios were obtained in the ANOVAS.

Identifying Problems. As shown in Table 2, the analysis of variance for the problem-solving variable Identifying Problems (IP) was not significant ($F=1.484$). Since the ANOVA was not significant, no further analyses were conducted.

TABLE 2
ANALYSIS OF VARIANCE FOR IDENTIFYING PROBLEMS

Source	D.F.	S.S.	M.S.	F	P
Between groups	4	111.195	27.79	1.484	n.s.
Within groups	101	1892.160	18.73		
Total	105	2003.355			

Stating Basic Problem. As shown in Table 3, the analysis of variance for the problem-solving variable Stating Basic Problem (SBP) was not significant ($F<1$). Since the ANOVA was not significant, no further analyses were conducted.

TABLE 3
ANALYSIS OF VARIANCE FOR STATING BASIC PROBLEM

Source	D.F.	S.S.	M.S.	F	P
Between groups	4	15.42	3.856	<1	n.s.
Within groups	101	838.14	8.298		
Total	105	853.56			

Producing Alternate Solutions. As shown in Table 4, the analysis of variance for the problem-solving variable Producing Alternate Solutions (PAS) was significant at the .05 level ($F=2.71$). Because the ANOVA was significant, Duncan's Multiple Range test was conducted to determine which treatment groups differed significantly on the PAS problem-solving variable.

TABLE 4
ANALYSIS OF VARIANCE FOR PRODUCING ALTERNATE SOLUTIONS

Source	D.F.	S.S.	M.S.	F	P
Between groups	4	584.80	146.20	2.71	<.05
Within groups	101	5434.97	53.81		
Total	105	6019.77			

The results of Duncan's Multiple Range test, as shown in Table 5, revealed that treatment groups 2 and 5, or Brainstorming Treatment and Initial Brainstorming Treatment, differed significantly from groups 1, 3, and 4, Control, Incubation Treatment, and Initial Incubation Treatment.

TABLE 5
DUNCAN'S MULTIPLE RANGE COMPARISON FOR
PRODUCING ALTERNATE SOLUTIONS*

	IT 3 12.5238	IIT 4 14.4444	C 1 17.2727	BT 2 18.3913	IBT 5 18.4545	r	q value
12.5238							
14.4444				5.8675	5.9307	5	4.861
17.2727						4	4.750
18.3913						3	4.597
18.4545						2	4.368

*Only significant values are reported

Evaluating Alternate Solutions. As shown in Table 6, the analysis of variance for the problem-solving variable Evaluating Alternate Solutions (EAS) was significant at the .05 level ($F=2.45$). Because the ANOVA was significant, Duncan's Multiple Range test was conducted to determine which treatment groups differed significantly on the EAS problem-solving variable.

TABLE 6
ANALYSIS OF VARIANCE FOR EVALUATING ALTERNATE SOLUTIONS

Source	D.F.	S.S.	M.S.	F	P
Between groups	4	187.79	46.95	2.45	<.05
Within groups	101	1937.78	19.19		
Total	105	2125.58			

The results of Duncan's Multiple Range test, as shown in Table 7, revealed that treatment groups 2 and 5, or Brainstorming Treatment and Initial Brainstorming Treatment, differed significantly from groups 1, 3, and 4, Control, Incubation Treatment, and Initial Incubation Treatment.

TABLE 7
DUNCAN'S MULTIPLE RANGE COMPARISON FOR
EVALUATING ALTERNATE SOLUTIONS*

	IT 3	IIT 4	C 1	IBT 5	BT 2	r	q value
6.3810	6.3810						
8.6667		8.6667		3.4372	3.7494	5	2.907
9.0455			9.0455			4	2.840
9.8182						3	2.749
10.1304						2	2.612

*Only significant values are reported

Planning Idea Implementation. As shown in Table 8, the analysis of variance for the problem-solving variable Planning Idea Implementation (PII) was significant at the .05 level ($F=6.31$). Because the ANOVA was significant, Duncan's Multiple Range test was conducted to determine which treatment groups differed significantly on the PII problem-solving variable.

TABLE 8
ANALYSIS OF VARIANCE FOR PLANNING IDEA IMPLEMENTATION

Source	D.F.	S.S.	M.S.	F	P
Between groups	4	700.44	175.11	6.31	<.05
Within groups	101	2802.32	27.75		
Total	105	3502.76			

The results of Duncan's Multiple Range test, as shown in Table 9, revealed that groups 1 and 2, Control and Brainstorming Treatment, differed significantly from groups 3, 4, and 5, or Incubation Treatment, Initial Incubation Treatment, and Initial Brainstorming Treatment.

TABLE 9
DUNCAN'S MULTIPLE RANGE COMPARISON FOR
PLANNING IDEA IMPLEMENTATION*

	IT 3	IIT 4	IBT 5	C 1	BT 2	r	q value
1.6190	1.6190	2.6111	4.8636	6.1364	8.7826		
2.6111		2.6111	4.8636	6.1364	8.7826	5	3.493
4.8636			4.8636	6.1364	8.7826	4	3.413
6.1364				6.1364	8.7826	3	3.303
8.7826					8.7826	2	3.138

*Only significant values are reported

CHAPTER FIVE

DISCUSSION AND INTERPRETATION

This chapter will answer the ten specific research questions proposed in Chapter One, discuss these results, and attempt to develop conclusions and recommendations for the use of incubation and brainstorming in problem-solving.

Research Questions

(1) Does a specific effort to facilitate incubation during problem-solving, using guided imagery, facilitate divergent production in Creative Problem-Solving? According to the results of this study, the introduction of incubation during problem-solving, did not significantly facilitate divergent production in Creative Problem-Solving.

(2) Does the introduction of brainstorming during problem-solving facilitate divergent production in Creative Problem-Solving? The introduction of brainstorming during problem-solving did significantly facilitate divergent production in Creative Problem-Solving.

(3) Does a specific effort to facilitate incubation prior to problem-solving facilitate divergent production in Creative Problem-Solving? The introduction of incubation prior to problem-solving did not significantly facilitate divergent production in Creative Problem-Solving.

(4) Does the introduction of brainstorming prior to problem-solving facilitate divergent production in Creative Problem-Solving? The introduction of brainstorming prior to problem-solving does facilitate divergent production in Creative Problem-Solving.

(5) How does a specific effort to facilitate incubation during problem-solving, using guided imagery, compare to a specific effort to facilitate incubation, prior to problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving? There seemed to be no significant difference between groups involved in a specific effort to facilitate incubation during problem-solving as compared to a specific effort to facilitate incubation prior to problem-solving in facilitating divergent production in Creative Problem-Solving.

(6) How does the introduction of brainstorming, prior to problem-solving, compare to the introduction of brainstorming, during problem-solving in their effects on facilitating divergent production in Creative Problem-Solving? Both brainstorming groups were shown to significantly facilitate divergent production in Creative Problem-Solving on the problem-solving variables Producing Alternate Solutions and Evaluating Alternate Solutions. However, on the problem-solving variable, Planning Idea Implementation, the performance of the group that brainstormed during problem-solving was significantly greater than the performance of the group that brainstormed prior to problem-solving.

(7) How does the introduction of brainstorming, during problem-solving, compare to a specific effort to facilitate incubation, during problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving? The performance of the group that brainstormed during problem-solving, was significantly greater than the performance of the group that became involved in an incubation experience during problem-solving, in facilitating divergent production in Creative Problem-Solving.

(8) How does a specific effort to facilitate incubation, prior to problem-solving, compare to the introduction of brainstorming, prior to problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving? The performance of the group that brainstormed prior to problem-solving, was significantly greater than the performance of the group that became involved in an incubation experience prior to problem-solving, in facilitating divergent production in Creative Problem-Solving.

(9) How does a specific effort to facilitate incubation, during problem-solving, using guided imagery, compare to the introduction of brainstorming, prior to problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving? The performance of the group that brainstormed prior to problem-solving was significantly greater than the performance of the group that became involved in an incubation experience during problem-solving in facilitating divergent production in Creative Problem-Solving.

(10) How does the introduction of brainstorming, during problem-solving, compare to a specific effort to facilitate incubation, prior to problem-solving, in their effects on facilitating divergent production in Creative Problem-Solving? The performance of the group that brainstormed during problem-solving was significantly greater than the performance of the group that became involved in an incubation experience prior to problem-solving in facilitating divergent production in Creative Problem-Solving.

DISCUSSION OF RESULTS AND CONCLUSIONS

It is interesting to observe the results of the statistical analysis of the various subtests of the written problem-solving inventory used in this study. Considering the first two subtests, Identifying Problems and Stating Basic Problems, the one-way analysis of variance showed that there were no significant differences between the five treatment groups on those two problem-solving variables. However, on the last three problem-solving variables, Producing Alternate Solutions, Evaluating Alternate Solutions, and Planning Idea Implementation there was a significant difference between the groups. The question then arises: Why did this difference occur? It is important to consider the particular testing instrument involved and the two treatments performed in this study.

The testing instrument used in this study to measure the effects of various treatments on the subjects was an instrument that emphasized divergent production. Brainstorming, one of the treatments, is a technique that is used to create many possible solutions to a problem. Brainstorming is a proven, effective tool that is used for divergent production (Parnes, Noller, and Biondi, 1977). There has been little statistical evidence to show that incubation, the other treatment explored in this study, enhances or impedes divergent production. The groups scoring highest on the last three problem-solving variables were groups in which students were involved in the brainstorming experiences. It is not unusual, then, to find that when students were trained for divergent production, as in these groups, they subsequently performed better on tests that measure divergent production.

But creativity is not just divergent production (Guilford, 1967, 1977). The nature of creativity is much more complex than merely the generation of alternate solutions (Parnes, Noller, and Biondi, 1977). Divergent thinking may be a necessary, although not sufficient component of creativity (Treffinger, Renzulli, and Feldhusen, 1971). A model of the relationship of divergent functions with other aspects of creative learning is illustrated in Figure 3 (Treffinger and Johnston, in press). Divergent thinking is classified in this model as a level "I" activity; it is the problem-solver's entrance into creative behavior. Divergent thinking may be a primary tool in Creative Problem-Solving, then, but it is not the only tool. It is possible that the effects of incubation would be more readily observed in Level II or Level III activity.

From information gathered thus far concerning various attributes of incubation and the elusive qualities of incubation (Olton, 1979), one also finds that the process of incubation itself is very complex. Although the proper conditions may have been established to facilitate incubation, it cannot be concluded with certainty that incubation will actually occur. Incubation is also a process that calls for high personal involvement in a situation or problem. A person who has had a solution occur to him/her through incubation is most likely to have spent a good deal of time in preparation and research on that problem. The testing instrument used in this study called for some amount of incubation and preparation on the particular problems by having participants initially read through the problem-solving inventory. However, the incubation and personal investment involved in this problem-solving inventory may have been very low compared to the investment one makes in an important personal or professional prob-

<u>Cognitive:</u>	Level	<u>Affective:</u>
Independent Inquiry	III	Internalization of values
Self-Direction		Commitment to Productivity
Resource Management		Towards Self-Actualization
Productivity	INVOLVEMENT IN	
"The Practicing Professional"	REAL CHALLENGES	
<u>Cognitive:</u>	Level	<u>Affective:</u>
Application	II	Awareness Development
Analysis		Open Complex Feelings, Conflict
Synthesis		Relaxation, Growth
Evaluation	COMPLEX THINKING	Values Development
Methodological and Research Skills	AND FEELINGS PROCESSES	Psychological Safety in Creating
Transformations		Fantasy, Imagery
Metaphor, Analogy		
<u>Cognitive:</u>	Level	<u>Affective:</u>
Fluency	I	Willing to Respond
Flexibility		Open to Experience
Originality		Curiosity
Elaboration	DIVERGENT	Risk-Taking
Cognition & Memory	FUNCTIONS	Problem Sensitivity
		Tolerance for Ambiguity
		Self-Confidence

Figure 3. A preliminary model of creative learning (Gifted Child Quarterly, in press).

lem, in which one works for weeks, months, or even years.

Because of the complex nature of both creativity and incubation, one cannot simply assume that incubation produces divergent thinking, which in turn produces creativity. In fact, by the very nature of the various descriptions of the "incubated breakthrough," the incubated "aha" was the answer to the problem. There was generally one answer to the incubated problem. This answer may have had many far reaching, divergent implications, but the process of incubation seems to result in a convergent product. A consideration for some future research then might be: Where in a more complex sequence of Creative Problem-Solving activity does incubation occur, if in fact it does?

Let us next consider some of the results of the statistical analysis of the students' responses on the testing instrument. Becoming involved in an "incubation experience" prior to or during problem-solving was found to not facilitate divergent production in Creative Problem-Solving. However, brainstorming during problem-solving and prior to problem-solving did facilitate divergent production in Creative Problem-Solving. It is important now to examine the various problem-solving variables and how scores were obtained on those variables.

Subjects' responses on the first two problem-solving variables, Identifying Problems and Stating Basic Problems, resulted in no significant differences among treatment groups. Six scoring elements, or criteria, were used to evaluate students' responses on the problem-solving variable Identifying Problems. Of those six scoring elements, three elements could be identified as divergent and three as convergent. Subjects in all of the treatment groups consistently responded and scored on five out

of the six scoring elements.

On the problem-solving variable Stating Basic Problem, eight scoring elements were used. Of these eight scoring elements, six could be considered convergent and specifically related to "correct" responses that might be called for while working with the Osborn-Parnes Creative Problem-Solving process. The other two scoring elements could be considered divergent. Students consistently did not respond or score on the six convergent scoring elements; however, they did respond and score on the two divergent elements.

The variable on which subjects scored highest in this test was Producing Alternate Solutions. There were only two scoring elements for this particular problem-solving variable. Those elements were fluency and flexibility. These elements clearly called for divergent production. It is no surprise then to note that the problem-solving variable designed to measure almost purely divergent thinking, was the highest scoring variable in a group that was trained for divergent thinking, i.e. the brainstorming groups. When facilitating divergent aspects of creativity, aspects clearly calling for divergent behavior seem to be most effective.

When examining the scoring elements for the problem-solving variable Evaluating Alternate Solutions, one finds that of the eight elements, five of them could be identified as convergent and three as divergent. This fact, however, provides a rather incomplete picture of why the brainstorming groups scored significantly higher than the incubation groups. When reviewing the raw data pertaining to this problem-solving variable, one finds that one of the reasons that the incubation groups scored so low on this variable was that 38 percent of the students in the Incubation

Treatment Group and 19 percent of the students in the Initial Incubation Group did not respond at all to this task. The possible reason for this will be explained below.

In the case of the problem-solving variable Planning Idea Implementation, of the seven scoring elements used, four of them could be identified as convergent and three as divergent. But again there were obvious influences on the low scores in the incubation groups. Seventy-six percent of the students in the Incubation Treatment Group and 62 percent of the students in the Initial Incubation Group did not respond to the PII problem-solving variable.

Perhaps after becoming involved in a relaxed, free flowing experience participants lacked motivation to begin work on a structured pencil and paper inventory. They also might have chosen to work more slowly and deliberately than the groups that were "stirred up" by the brainstorming experiences. Also the extended effort required in real problem-solving, not stressed in a test-like situation, might have resulted in a more observable incubation effect. Finally, the shift between relaxing imagery experiences and pencil and paper problem-solving may have provided people with a contrast that required additional recovery time.

How then can we test for or foster incubation? This question calls for the consideration of the two constructs with which we are dealing. These constructs are incubation and creativity. Incubation and creativity are two very complex processes. There are countless aspects to the process of Creative Problem-Solving, and likewise the process of incubation. To effectively study incubation and creativity, one needs to break incubation and creativity down into some of their attributes or component parts.

This study identified four aspects or attributes of incubation. Those attributes were: (1) relaxed attention, (2) difference in mental states, (3) sleep or removal of fatigue, and (4) musing, reverie, or daydreaming. For the purpose of illustration, consider the dimensions of creative performance proposed by Guilford (1977). Figure 4 shows Guilford's Structure-of-Intellect Problem-Solving Model.

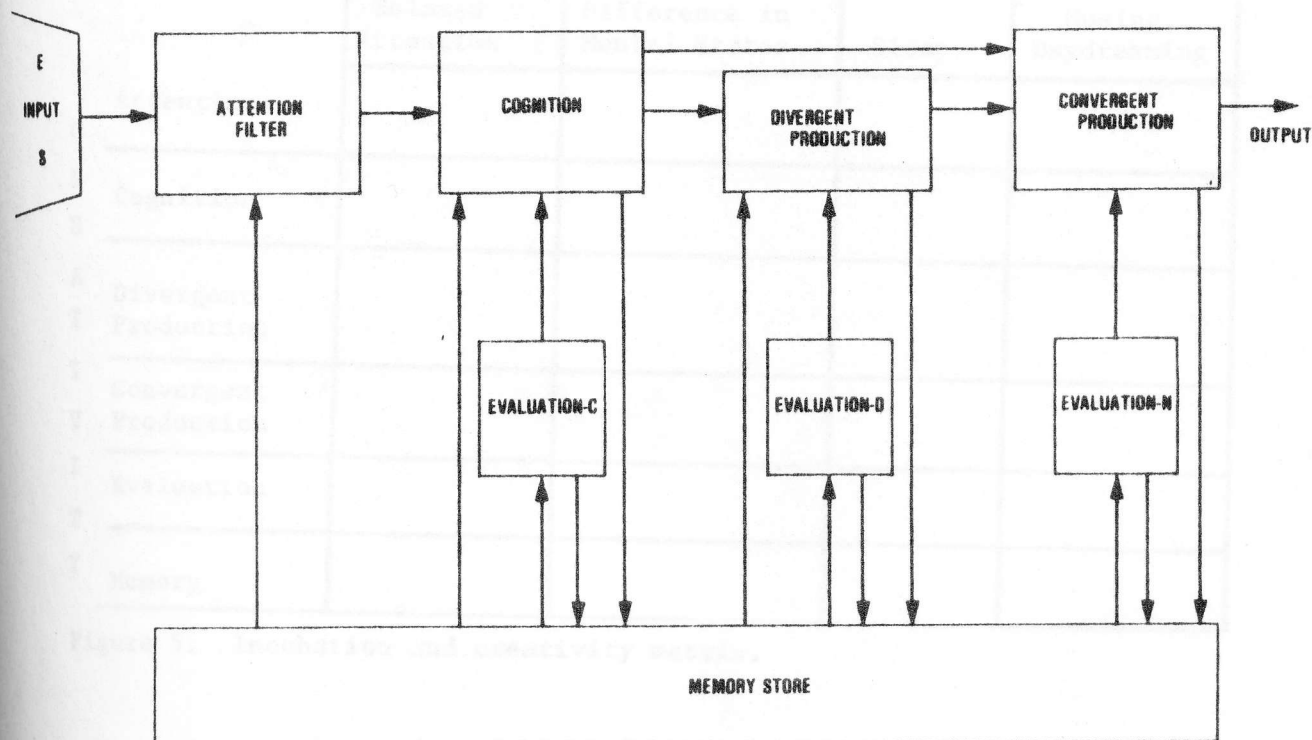


Figure 4. Structure-of-intellect problem-solving model.
From Guilford (1977), p. 163.

Figure 4 identifies six dimensions of creativity: (1) attention, (2) cognition, (3) divergent production, (4) convergent production, (5) evaluation, and (6) memory. It may be possible to develop various treatments to foster the specific dimensions of incubation, i.e. relaxed attention, difference in mental states, etc., and investigate these in relation to the various dimensions of creativity. Figure 5 illustrates a matrix that could be used to develop possible combinations for future research investigations of the nature and facilitation of incubation.

I N C U B A T I O N

	Relaxed Attention	Difference in Mental States	Sleep	Musing, Daydreaming
C Attention				
R E Cognition				
A T Divergent Production				
I V Convergent Production				
I T Evaluation				
Y Memory				

Figure 5. Incubation and creativity matrix.

By designing various treatments and evaluating those treatments on testing instruments available, a more specific understanding of the role of incubation in creative behavior might be obtained.

APPENDIX A

This appendix contains the problem-solving inventory developed by Johnson and Treffinger (1978) which was used to assess the effect of the experimental treatments.

The first set of directions were given to the subjects in the Control Group, Initial Incubation Group, and Initial Brainstorming Group. The second set of directions were given to the subjects in the Brainstorming Treatment Group and the Incubation Treatment Group.

[Faint, illegible text, likely bleed-through from the reverse side of the page]

Name _____
Class _____

DIRECTIONS

This set of exercises will not influence your grade in this class in any way. They are designed to help you explore your creative potential, to allow you to have some fun, and to help you grow in new directions. To gain the full benefits of these exercises, we suggest you do the best you can and complete as many as possible.

There are no right or wrong answers to these exercises; there are many possible answers. When asked to do so, give as many answers as you can think of. It is not necessary to use complete sentences; it is your ideas which are important.

This set of exercises should not be attended to as you would take a regular test. To be able to effectively explore your creative potential, we ask you to PLEASE READ OVER ALL OF THE EXERCISES BEFORE BEGINNING ON THE FIRST ONE. You have a reasonable amount of time to complete the exercises. If you finish earlier than your classmates, go back and add to or polish your work. Again, PLEASE READ OVER ALL OF THE EXERCISES BEFORE BEGINNING ON THE FIRST ONE. We will discuss these exercises in class soon. Please fill in the information below.

Name _____

Class Section ___ A.M. ___ P.M. ___ Sat.

DIRECTIONS

This set of exercises will not influence your grade in this class in any way. They are designed to help you explore your creative potential, to allow you to have some fun, and to help you grow in new directions. To gain the full benefits of these exercises, we suggest you do the best you can and complete as many as possible.

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About half-way through these exercises, you will be asked to stop and become involved in another activity for a short time. You are not expected to be finished with these exercises at that time; you will have time to finish them later in the class period. Again, PLEASE READ OVER ALL OF THE EXERCISES BEFORE BEGINNING ON THE FIRST ONE. We will discuss these exercises in class soon. Please fill in the information below.

Name _____

Class Section ___ A.M. ___ P.M. ___ Sat.

Read the paragraph below and the problems listed under it. Then follow the underlined directions.

A researcher at the Population Studies Center has investigated women's preference for the sex of their children. It was found that two times as many women said they would rather have a son than a daughter. If mothers could choose, it is possible that two boys would be born for every girl.

Here are some possible problems which might occur if mothers could--and did--choose to have boys.

1. Girls would be scarce and would become spoiled from too much attention.
2. Some boys would not have wives when they grew up.
3. Boys would have to learn to cook, sew, and clean house for themselves.
4. The women's clothing industry would be bankrupt.
5. There would be fewer families.

Look carefully at the paragraph and the possible problems. Has the real problem been stated? If it has, write in in your own words on the lines below. If it has not been stated, write it yourself on the lines below.

Make your problem statement as clear as possible.

Look at the problem you have written. In the space below, list some smaller problems which result from the problem you have written. If you had to solve the problem, these might be the places you would start.

Read the paragraph below and the basic problem stated below it.

Then follow the underlined directions.

Every week, the entire neighborhood hauls its trash out to the curb for the trash collector to haul away. The bags and sacks sit there, smelly in the summer and blown over by the wind in the winter. Neighborhood dogs are the only ones who enjoy the sight and smell. Eventually the clanking trash truck appears to carry off the trash.

On the lines below, list as many possible solutions for the problem as you can.

Use the back of the page if you have other solutions.

Read the information below. Then follow the underlined directions.

Popcorn in movie theaters is a profitable item, but crumpled boxes and scattered corn are a disposal problem.

Given Problem: How can we encourage people to be responsible for their own litter.

Suggested solutions for the problem:

1. Develop boxes which can be eaten.
2. Develop a large variety of popcorn, about apple size, which would need no box.
3. Install automatic floor brushes.
4. Train animals to pick up discarded boxes and eat the dropped corn.
5. Start a movie theater cleanliness campaign.

How would you decide which solution holds the most promise of success?

List the things--the factors--on which you would base your decision.

Use the spaces below.

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | 6. _____ |

Use the chart below to rate the five solutions against the decision-making factors you have listed. Circle the idea you decide is best.

Solutions	<u>Decision Factors</u> (write in yours)			
1. Edible boxes				
2. Giant popcorn				
3. Floor brushes				
4. Trained animals				
5. _____				

Read the material at the top of the page. Then follow the underlined directions.

Complex household robots should be available by 1990. They will cost as much as the average car, and will be able to perform a number of household tasks, including cleaning, laundry, and meal preparation.

Given Problem: How will people use their extra time?

Here is a possible solution, which was arrived at by combining two solutions.

Do away with the 8-hour working day. People can share jobs, working out their schedule. People will have to be educated in the use of free time, just as they now are in math and science.

In the chart below, list beside the idea stated above some problems you might face if you tried that idea. Be sure to use the correct column of the chart.

SOLUTION	POSSIBLE PROBLEM	OVERCOMING PROBLEM
Flexible		
working day		
with leisure		
education		

Find the column marked OVERCOMING PROBLEM. For each problem you have listed, think of possible solutions. Write them in the OVERCOMING PROBLEM column.

APPENDIX B

This appendix contains the script for the guided imagery experience which was developed as an incubation treatment for this study.

Please begin to relax with me now./ I want you to become aware of your breathing./ Take several deep breaths, hold them and then let them out./ Now I want you to become aware of your body./ Feel it relaxing./ Begin with your feet and systematically relax./ Feel your feet relaxing./ Feel your lower legs relaxing./ Your knees and upper legs relaxing./ Your thighs/ Your lower back/ Your middle back is now relaxing/ Relax your upper back and shoulders/ Relax your neck./ Relax your facial muscles and the upper part of your body/ Let your mind be freed of the daily thoughts and tasks that confront it./ Continue to breathe deeply./ (pause for about 30 seconds)

Imagine yourself being the person that you are./ You are a busy person and the time has come for you to take a weekend off./ You have decided to go to your cabin in the mountains. You're driving in your car up to that cabin./ You're anxious to get to this cabin because you have always had good experiences there. This cabin holds many fond memories of good times, and you hope to experience some good times while you are there this weekend./ The drive up into the mountains is wonderful. You begin to notice all the wonderful things around you. It's late spring and there is still some snow on distant mountain peaks./ You can smell the fresh clean air. The air is cool but not cold./ Flowers are beginning to bloom and you can smell them and see their bright colors./ The scent of pine is in the air./ Birds are soaring gracefully around pine trees and mountain peaks./ You know this area. This is an area that you have come to enjoy and appreciate./ Fields and meadows are beginning to turn green, new life is returning to the dormant grass./ You continue to drive up farther into the mountains, closer to your special cabin and farther from your life below./ Experience that trip up into the mountains and notice all those special things around you./ (thirty second pause)

You finally arrive at your cabin. It has been a long ride but you are not tired. To be at that cabin is like coming home./ You unpack the things from your car and open the door to the cabin./ There is your second home, that beautiful mountain retreat of yours. It has all the comforts of home but none of the pressures./ Look around your cabin and experience some of the things there./ (45 second pause) Before lighting a fire you decide to take a walk around your cabin and the mountains nearby. It's late afternoon now and you are beginning to feel the night coming on./ You begin to follow a path that takes you up to a higher meadow./ As you go up that path notice all the things around you./ The pine trees growing straight and tall, the cool smell of the evening coming on./ You follow your path higher and higher./ Experience all those wonderful things around you, the sights, the smells, the feeling of freedom and relaxation./ (45 seconds to 1 minute pause)

You climb higher and higher to your meadow. This meadow is the place where during the day the sun seems to always shine, and at night the stars shine more brilliantly here than anywhere else you have ever been./ It's early evening now and dusk is coming on./ You reach that upper meadow and sit down to rest./ You look up and there off in the distance the sun is beginning to set./ This is one of the most magnificent sunsets you have ever seen./ Notice all the shades of blue and gold, orange and red./ Watch that big glistening ball sink slowly below distant mountain peaks./ You are here alone, but this area is your home; you are content here./ Spend some time wandering around this meadow of yours./ (one minute pause here)

Find a comfortable place to sit here in the meadow, you might want to lie back and look at the evening stars coming on./ Enjoy this time that you have here now, breathe in that cool, fresh, sweet mountain air./ (30 second pause) The time has come for you now to wander back down that path toward your cabin./ Your relaxed but still not very tired./ As you wander back down that path, again notice some of the things that you experienced here before, that tall pine tree, the grass below your feet, the rocks. Notice now how the coming night has changed them, has darkened their colors, has added richness to them./ (15 seconds) You begin to see

the cabin off in the distance and notice the warm light of a fireplace shining out through the windows./ But wait, you didn't light a fire, someone must be there. You walk closer to the cabin and notice another familiar car parked out in front. You're feeling quite good now because you recognize that car as one that belongs to a very special friend of yours./ You reach the door of the cabin and go in./ There, sitting in front of the fire, is that special friend. Greet that friend in the way that only you know how to greet each other./ Sit beside your friend now and talk, experience each other./ (45 second pause) Spend the rest of the evening talking and experiencing your friend./ Prepare a meal for yourselves from some of the things you have brought with you./ Smell your food cooking over the fire./ Taste how good it tastes here in this mountain paradise./ (15 seconds) Spend some time now enjoying the feeling of total contentment, nothing is on your mind, you feel good from eating and you have the companionship of a very special friend. Nothing could be better, nothing could be more perfect./ (45 seconds here)

Now take that perfect feeling you have from this place and begin to return to your everyday world./ Start coming back to this room that you are in now. You have no regrets about leaving the cabin because you know that you can return here anytime that you wish. Anytime you like, you can experience the companionship, the contentment, the joy of this experience./ (10 seconds) Return here, and spend some time experiencing this place, bring with you that contentment you experienced while in the cabin./ Now please open your eyes.

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