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ABSTRACT

Six experiments were conducted to determine whether idea checklists increased idea quantity and quality. College students were allowed 10 or 20 minutes or unlimited time to find ideas for product improvement problems. Results indicated that the only checklist which significantly stimulated productivity was composed of just seven general categories of solutions (e.g., change shape, change material). Another creative thinking technique, the morphological synthesis procedure (Allen, 1962), also significantly stimulated idea production, but a direct comparison with the brief checklist condition was not meaningful. Subjects provided with longer checklists, including Osborn's (1963) 73 idea spurring questions, performed no better than controls. With additional problem solving time, rate of idea generation decreased but idea quality increased. Object complexity, manipulated in two timed studies, was not systematically related to product improvement scores, and instructional constraints to be original and be practical decreased idea frequency. It was thus concluded that creative output can be increased by teaching deliberate techniques for generating new combinations of ideas. (Author/JD)

Technical Report No. 94

LABORATORY STUDIES OF CREATIVE THINKING TECHNIQUES:

THE CHECKLIST AND MORPHOLOGICAL SYNTHESIS METHODS

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Report from the Creative Thinking Project
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This Technical Report is from the Task and Training Variables in Human Problem Solving and Creative Thinking Project in Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and to develop educational materials suggested by the prior activities. Contributing to these Program objectives, this project is focused on investigating creative problem solving as a trainable cognitive skill. The development and testing of creative thinking programs follow research on basic problem-solving variables in different situations.

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ABSTRACT

The main purpose of six experiments was to demonstrate that using idea checklists, a standard and intuitively appealing creative thinking technique, will increase idea quantity and quality. College students were allowed 10 minutes, 20 minutes, or (in one experiment) unlimited time to find ideas for "product improvement" problems. The results indicated: (1) In the timed and untimed experiments, the only checklist which significantly stimulated productivity was composed of just seven general categories of solutions (e.g., "change shape," "change material," etc.). (2) Another creative thinking technique, the morphological synthesis procedure (Allen, 1962), also significantly stimulated idea production, but a direct comparison with the brief checklist condition was not meaningful. (3) Ss provided with longer checklists, including Osborn's (1963) 73 "idea-spurring questions," performed no better than untrained control Ss. (4) With additional problem-solving time, rate of idea generation decreased but idea quality increased. (5) Object complexity, manipulated in two "timed" studies, was not systematically related to product-improvement scores. (6) Instructional constraints to "be original and be practical" decreased idea frequency. It was concluded that creative output can be increased by teaching deliberate techniques for generating new combinations of ideas.

I
INTRODUCTION

Virtually every program, course or book concerned with training creative thinking includes instruction in techniques for the conscious and deliberate production of new combinations of ideas (Davis, 1969; Davis & Houtman, 1968; Davis, Manske, & Train, 1967; Edwards, 1968; Gordon, 1961; Mason, 1960; Osborn, 1963; Parnes, 1962). One of the best-known techniques is the checklist procedure, in which the individual considers each item on a prepared list as a possible source of innovation with respect to a given problem. Using idea checklists in creative problem solving would appear to be an intuitively valid means of stimulating idea production: If one group of individuals is given a list of general or specific ideas relevant to a specified problem, and if a second group does not possess that list, then the first group by definition is better prepared to generate problem solutions. Another procedure, morphological synthesis (Allen, 1962), requires the thinker to list specific ideas for improving one aspect (or dimension) of a problem along one asix of a two-dimensional diagram, and specific ideas for another aspect of the problem along the other axis; novel idea combinations are found in the intersecting squares of the matrix. In practice, three or more dimensions of a problem may be considered when using the morphological synthesis approach.

While these and other creative thinking techniques have considerable appeal, they rarely have been subjected to close examination under controlled laboratory conditions. Nor is there an existing literature regarding the comparative effectiveness of different creative thinking procedures.

The main purpose of the present series of six experiments was to demonstrate that idea checklists do, in fact, successfully increase idea production. In all, five different, though related, checklists were tested. After this first and unexpectedly difficult task was achieved, the productivity of Ss taught to use a particularly effective idea checklist was compared with the productivity of Ss trained in the morphological synthesis procedure. In addition, the authors examined the effects of complexity of the problem object, verbal instructions (e.g., to "be original," "be wild"), and first half vs. second half of the problem-solving period upon idea quantity and quality. College students, primarily juniors and seniors, solved problems of a "product-improvement" variety (Torrance, 1962, p. 230), which required them to "think of changes or improvements' for a simple object, e.g., a door knob. Although most experiments allowed a fixed 10- or 20-minute problem-solving time, the final study allowed Ss to work as long as they wished.

This series of experiments, rather than being a "preplanned whole," evolved over a period of approximately 2 years. The purpose, nature, and design of a particular experiment were thus affected not only by the preceding experiments, but by our related developmental research.

II
EXPERIMENT I

Experiment I, in seeking to demonstrate that available idea checklists do, in fact, stimulate idea production, compared a Checklist Group with a Control Group on a product-improvement task. The specific checklist used (see Appendix A) was comprised of 55 of Osborn's (1963) "73 idea-spurring questions." Using as problem objects a car, an office desk, or a kitchen sink, it was predicted that Ss possessing the checklist would produce a greater number of ideas for changing or improving each object than Ss who did not have the checklist. It also was predicted that ideas produced by Ss in the Checklist Group would be of higher quality than ideas produced by Control Ss.

METHOD

Subjects

The Ss were 24 volunteers from undergraduate educational psychology courses at the University of Wisconsin who were randomly assigned to either the Checklist Group (12 Ss) or the Control Group (12 Ss).

Task and Procedure

The task was the same for both groups: The Ss were asked to "list as many changes and/or improvements as you can for a kitchen sink/office desk/car," and were allowed 10 minutes to respond to each of the three problem objects. The order of presentation of the three objects was determined by the rows of two 3 x 3 Latin squares.

The 12 Ss in the Checklist Group were provided with the 55-item checklist (Appendix A) and were instructed in how it might be used. Both Checklist and Control Ss received instructions regarding the mechanics of their task, such as using the score sheets, and the 10-minute time limit for each problem.

Scoring and Dependent Measures

The seven dependent measures used were (1) Mean number of responses given per 10-minute session; (2) mean level of originality (uniqueness), as rated on 9-point scales (1-9) by two judges; (3) mean level of practicality (usefulness), also rated by two judges on 9-point scales; (4) mean number of original responses (responses with ratings of "6" or higher on the originality scale by both judges); (5) mean per cent original responses (original/total); (6) mean number of "good" ideas (ideas with ratings of "6" or higher on both the originality and practicality scales by both judges); and (7) mean per cent "good" ideas ("good"/total).

RESULTS AND DISCUSSION

Experimental data for all seven measures are summarized in Table 1. An analysis of variance on each of these measures showed no significant differences in performance between the Checklist and Control Groups. The object main effect did reach significance for the response frequency measure, $F(2, 80) = 18.27$, $p < .001$. More responses were listed for the car (18.04) than for the desk (15.02) or for the sink (13.71).

Apparently the availability of the idea checklist did not facilitate creative productivity in the present tasks. In fact, Ss in the Control Group produced noticeably (but not significantly) more ideas than did Ss in the Checklist Group, and these ideas were generally rated as slightly more original. An informal study of the responses suggested that most of the Ss in the Checklist Group largely ignored the apparently not-too-helpful checklist of ideas.

Table 1

Summary of Experimental Data
(Experiment I)

Dependent Measure	Checklist Group	Control Group
Mean Number Responses	13.81	18.81
*Originality Ratings (mean)	4.03	4.60
*Practicality Ratings (mean)	6.55	6.29
Mean Number Original Responses	1.47	3.55
Per cent Original	10.58	18.73
Mean Number "Good" Responses	.30	.30
Per cent "Good"	2.39	1.54

* 9-point scales

III
EXPERIMENT II

Since the results of Experiment I were clearly negative (i.e., idea production in the product-improvement task was not facilitated by the availability of an idea checklist), the investigators hypothesized that the results might have been due to the high degree of complexity of the problem objects (car, desk, sink). Perhaps less complex objects would elicit fewer ready ideas for changes or improvements, and Ss would thus be more likely to draw ideas from the checklist.

Experiment II, therefore, compared changes and improvements listed for a simple problem object (a cup) with those listed for a relatively more complex object (kitchen sink). Other procedural variations were as follows: Ss in the Checklist and Control Groups were allowed 20 minutes to work on a single problem. The 20-minute period was divided into two 10-minute periods, allowing a "first-half vs. second-half" comparison of idea productivity. Also, a third group of Ss was given the idea checklist, with an explanation of its use, after the first 10-minute thinking period.

METHOD

Subjects

The Ss were 42 undergraduate students from the same population as in Experiment I.

Task and Procedure

The task was essentially the same as in Experiment I: Ss were to list as many changes or improvements as they could for either a cup (simple object) or a kitchen sink (complex object). Unlike Experiment I, Ss worked on just one problem object, the cup or the sink. The total amount of problem-solving time was 20 minutes, which was divided into two 10-minute sessions. The idea checklist was the same as before (Appendix A).

There were three instructional conditions with 14 Ss per condition: (1) In Checklist Group A, the checklist procedure was introduced at the beginning of the first session, allowing Ss to refer to their idea checklist during both 10-minute sessions. (2) In Checklist Group B, the introduction and explanation of the checklist technique was delayed until the start of the second 10-minute session. (3) The Ss in the Control Group were not provided with the idea checklist. Half of the Ss in each group worked on the cup problem, half worked on the sink.

The dependent measures were the same as in Experiment I.

RESULTS AND DISCUSSION

The results of Experiment II are summarized in Tables 2 and 3. As in Experiment I, the availability of the idea checklist again did not noticeably stimulate idea production, even with the simpler object, which elicited as many ideas as did the complex object, and with the longer problem-solving time. The quantity and quality of ideas produced by Ss in the two Checklist Groups were nearly identical to the performance of Ss in the Control Group.

Consistent with Parnes' (1961) research on the effects of extended effort in creative problem solving, originality ratings were significantly higher for ideas produced in the second 10-minute session, $F(1, 36) = 26.78$, $p < .001$, even though Ss generated significantly fewer ideas in the second session, $F(1,36) = 27.14$, $p < .001$. Also, Ss produced a considerably larger number of "good" (original and practical) ideas for the cup than for the kitchen sink, $F(1, 36) = 15.18$, $p < .001$. This latter finding stems from the fact that while originality ratings were about equal for the two objects, the cup elicited ideas of higher rated praticality, and therefore a larger number of "good" ideas.

Table 2
Summary of Experimental Data (Experiment II)

Dependent Measure	Checklist Group A		Checklist Group B		Control Group	
	Cup	Sink	Cup	Sink	Cup	Sink
Mean Number Responses	15.07	14.71	12.21	15.50	15.00	13.29
*Originality Ratings (mean)	5.92	5.44	5.11	4.77	4.88	6.01
*Practicality Ratings (mean)	5.79	4.96	6.01	5.26	5.99	4.35
Mean Number Original Responses	7.57	7.21	5.14	4.57	4.87	7.21
Per cent Original	50.23	49.03	34.24	34.41	39.76	46.54
Mean Number "Good" Responses	2.21	.29	1.79	.57	.86	.36
Per cent "Good"	14.69	1.94	14.61	3.68	5.71	2.68

*9-point scales

Table 3
Summary of Experimental Data (Experiment II)

Dependent Measure	Group A		Group B		Group C	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
Mean Number Responses	16.64	13.14	15.21	12.50	16.71	11.57
*Originality Ratings (mean)	5.41	5.94	4.61	5.28	4.96	5.94
*Practicality Ratings (mean)	5.49	5.26	5.82	5.44	5..	4.79
Mean Number Original Responses	7.29	7.50	4.50	5.21	5.57	6.50
Per cent Original	43.78	57.06	29.57	41.71	33.33	56.17
Mean Number "Good" Responses	1.29	1.21	1.36	1.00	.57	.64
Per cent "Good"	7.72	9.24	8.92	8.00	3.42	5.56

*9-point scales

IV
EXPERIMENT III

In Experiment II, as in Experiment I, the Ss in the Checklist Groups appeared not to make good use of the idea checklist. In reviewing the negative results obtained in both Experiment I and Experiment II, the authors speculated that perhaps the checklist items were not specific enough in suggesting new ideas. Perhaps a more detailed checklist would better provide new ideas and idea combinations.

In Experiment III, therefore, the checklist used in Experiments I and II was expanded (see Appendix B): Osborn's Change Form became New Form (square, triangle, oval, rectangle, sharp corners, asymmetrical, doughnut shape, other forms?). Osborn's Change Color was elaborated to include many specific (silver, gold, copper, bronze, brass, red, purple, green, white, black, grey, blue, plaid, striped, polka-dotted, op-art, other colors or patterns?), and so on. The basic procedures and problems were the same as in Experiment II.

METHOD

Subjects

Fourteen undergraduate students were drawn from the same population as in Experiments I and II. All Ss were in one experimental group, the Checklist Group. The Control Group from Experiment II was used for comparison purposes.

Task and Procedure

The task and procedure were identical to those of Experiment II: Ss were to list as many changes and/or improvements as they could for either a cup or a kitchen sink. They worked on just one problem object, and total problem-solving time was again 20 minutes, divided into two 10-minute sessions.

The Ss were explicitly instructed: "Don't worry about being original or whether or not you are stealing ideas (from the detailed checklist). The goal is for you to use the checklist and write down as many changes or improvements as you can for the object, taking your ideas from the checklist."

Dependent measures were the same as before.

RESULTS AND DISCUSSION

Data for the Checklist Group of Experiment III, along with the Control Group data of Experiment II, are summarized in Tables 4 and 5. An analysis of variance on each of the seven dependent measures showed no significant differences between the Checklist Group and the Control Group.

As in Experiment II, Ss produced significantly fewer ideas in the second 10-minute session than in the first, $F\ (1, 24) = 22.26$, $p < .001$, and again the second-session ideas were significantly higher in rated originality, $F\ (1, 24) = 24.02$, $p < .001$. The session effect markedly influenced practicality ratings as well, $F\ (1, 24) = 21.38$, $p < .001$, with mean practicality decreasing from Session 1 to Session 2. These effects are essentially the same as those found in Experiment II, for as S continues to respond, his later suggestions tend to be more original but less practical in nature.

Just one difference between problem objects reached significance: Sink received higher scores along the originality scale than did cup, $F\ (1, 24) = 5.61$, $p < .05$.

Table 4
Summary of Experimental Data (Experiment III)

Dependent Measure	Experiment III		Experiment II (Control Group C)	
	Cup	Sink	Cup	Sink
Mean Number Responses	19.57	14.57	15.00	13.29
*Originality Ratings (mean)	5.66	5.92	4.88	6.01
*Practicality Ratings (mean)	4.73	5.61	5.99	4.35
Mean Number Original Responses	8.50	6.50	4.87	7.21
Per cent Original	43.43	44.61	39.76	46.54
Mean Number "Good" Responses	.50	1.29	.86	.36
Per cent "Good"	2.55	8.82	5.71	2.68

9-point scales

Table 5
Summary of Experimental Data (Experiment III)

Dependent Measure	Experiment III		Experiment II (Control Group C)	
	Session 1	Session 2	Session 1	Session 1
Mean Number Responses	18.50	15.64	16.71	11.57
*Originality Ratings (mean)	5.52	6.06	4.96	5.94
*Practicality Ratings (mean)	5.36	4.98	5.55	4.79
Mean Number Original Responses	7.00	7.86	5.57	6.50
Per cent Original	37.84	50.23	33.33	56.17
Mean Number "Good" Responses	1.00	.79	.57	.64
Per cent "Good"	5.41	5.02	3.42	5.56

*9-point scales

V

EXPERIMENT IV

The purpose of Experiment IV was to evaluate any effects of still another idea checklist upon idea production (a) with problem objects of varying complexity and (b) under different instructional sets. This checklist (see Appendix C), a further extension and revision of Osborn's (1963) original list, was taken from a creative thinking program (Davis & Houtman, 1968) developed for junior high school students.

Experiment II showed no significant effects of object complexity upon total number of ideas produced, although significantly more improvements for the simple object (cup) were rated as "good" (both original and practical) than for the more complex object (kitchen sink). In the present experiment, five levels of complexity were used to better clarify any independent or interactive effects of object complexity upon idea production.

Regarding the instructional variable, earlier experiments with an unusual uses test (Davis & Manske, 1966; Manske & Davis, 1968), in which Ss listed uses for common objects, showed that such simple instructional sets as "be original," "be practical," or "be wild," significantly influenced the number and quality of ideas produced. Five types of instructions therefore were included in Experiment IV to assess the effects of instructions in a product-improvement kind of test. The experimental design allowed the authors to examine any interactions of checklist availability (presence-absence) with type of instructions or with object complexity.

METHOD

Subjects

Fifteen Control and 21 Checklist Ss were recruited from introductory educational psychology courses. To create equally sized groups, 6 Ss were randomly discarded from the Checklist Group.

Task and Procedure

Each of the 30 Ss listed as many changes or improvements as he could for each of five problem objects, with 10 minutes allowed for each object. The five objects, in increasing order of judged complexity, were a thumb tack, a door knob, scissors, pop-up toaster, and kitchen sink.

In addition to "List as many changes as you can for a _____," instructions printed at the top of four of his five answer sheets asked S either to "try to be original," "try to be practical," "try to be both original and practical," or "feel free to use your wildest imagination." On the remaining score sheet, no specific directions were given beyond the instructions to list changes for the particular object.

The presentation orders of the five problem objects in combination with the five instructional conditions were determined by the rows of a 5 x 5 Graeco-Latin square, with objects represented by Latin letters and instructions by Greek letters.

The 15 Ss in the Checklist Group were provided with the highly detailed checklist shown in Appendix C. They also received an explanation of how this checklist might be used to change or improve a product. The Ss in both groups were given instructions concerning the nature of the five tasks, the use of the score sheets, time limits, and the meaning of the specific instructions to "be original," etc.

RESULTS AND DISCUSSION

Table 6 shows the mean number of ideas produced by Ss in the Checklist and Control Groups for each problem object and under each set of instructions. An analysis of variance on these data indicated once again that a long, detailed checklist would not facilitate idea production with college students, $F < 1.0$.

Table 6

Mean Number of Ideas Produced as a Function of Groups (Experimental-Control), Problem Objects, and Instructions (Experiment IV)

Instructions	Group			Problem Object	Group		
	Checklist	Control	Mean		Checklist	Control	Mean
"Be original"	16.1	21.3	18.7	Thumbtack	18.9	20.3	19.6
"Be practical"	16.3	18.2	17.2	Door Knob	16.6	23.9	20.25
"Be original and be practical"	15.8	16.5	16.2	Scissors	14.9	16.4	15.6
"Be wild"	17.4	19.5	18.4	Pop-up Toaster	15.2	15.0	15.1
(None)	18.1	25.2	21.6	Kitchen Sink	18.4	25.2	21.8
Means	16.7	20.5	18.6		16.7	20.5	18.6

The object complexity main effect also did not reach significance, $F < 1.0$, nor did the variable interact with the checklist availability factor, $F(4,96) = 1.35$, n.s.

While the instructions variable approached statistical significance, $F(4,96) = 2.51$, $.05 < p < .10$, the data do not exactly duplicate those of the earlier experiments with an unusual uses test (Davis & Manske, 1966; Manske & Davis, 1968). As before, instructions to "be practical and be original" placed the most constraints upon Ss, resulting in the fewest responses. However, in the earlier experiments, the largest numbers of ideas were produced by instructions to "be practical" (which produced large numbers of extremely common uses) or to "be wild." In this experiment, the greatest number of responses was produced under no specific instructions (see Table 6).

Since the analysis of the idea frequency measure was not fruitful, particularly with regard to the important checklist availability variable, further investment of time and facilities in evaluating the originality and practicality of ideas generated in Experiment IV was judged unwarranted and unprofitable.

VI
EXPERIMENT V

The upshot of the four previous experiments is that college students clearly resist drawing ideas from a checklist when they are capable of generating their "own" ideas. Apparently the detailed checklists used in these experiments do not fully challenge the capabilities of college students.

Experiment V, in a further investigation of the checklist procedure, tested the effectiveness of a brief, seven-item checklist containing only general categories of problem solutions (see Table 7). This checklist, in fact, is comprised only of the section headings of the checklist taken from Davis and Houtman (1968; Appendix C), i.e., the very long checklist which was unsuccessfully tested in Experiment IV. The present authors predicted that the brief checklist would better stimulate and motivate the associative capabilities of college students.

METHOD

Subjects

The 16 Ss again were volunteers from an undergraduate educational psychology course at the University of Wisconsin.

Task and Procedure

The seven Ss in the Checklist Group and the nine subjects in the Control Group were allowed 10 minutes to list physical changes for each of two problem objects, a thumb tack and a kitchen sink. Both groups were instructed to "Use your imagination. Do not hesitate listing ideas which seem wild or unusual to you."

The subjects in the Checklist Group received a brief checklist, entitled "Aids in Thinking of Physical Changes" (Table 7), and a brief explanation of the meaning of the checklist items and how these items could be applied to changing or improving practically any object.

Table 7

Brief Checklist
(Experiment V)

"Aids in Thinking of Physical Changes"
1. Add and/or subtract something
2. Change color
3. Change the materials
4. Change by rearranging the parts
5. Change shape
6. Change size
7. Change design or style

All Ss were provided with a two-page scoresheet containing 37 blanks for each of their two problems, with a recommendation to use the back of the sheets if they ran out of blanks. The instructions at the top of the scoresheet simply read, "List as many physical changes as you can for a thumb tack/kitchen sink." The dependent measures were (1) total number of ideas listed, (2) mean ratings on a seven-point "creativity" scale by two judges, (3) number of ideas rated above the midpoint ("4") on the creativity scale, and (4) per cent of ideas rated above the midpoint of the scale.

RESULTS AND DISCUSSION

All experimental data, along with the results of statistical tests (Mann-Whitney U;

Winer, 1962), are summarized in Table 8. First, Ss in the Checklist Group produced no fewer than two and one-half times the number of ideas generated by subjects in the Control Group. Second, while the mean "creativity" ratings were not especially high for either group, those ideas produced by the Checklist Group were judged as generally more "creative" than were ideas produced by Control subjects. Third, compared with Ss in the Control Group, Ss in the Checklist Group produced almost five times as many ideas rated above the midpoint of the seven-point creativity scale, a finding which is further reflected in the higher percentage of ideas rated above the scale midpoint for the Checklist Ss.

The outcome of Experiment V is very clear. The Control Group produced about the same number and quality of ideas produced by the Checklist and Control subjects in the four earlier experiments. In contrast, the present Checklist Group, provided only with the seven-item checklist, generated a strikingly large number of comparatively more "creative" ideas.

Table 8

Summary of Dependent Measures
(Experiment V)

Dependent Measures		Treatment: Checklist (n = 7)	Treatment: Control (n = 9)	U	p <
Mean No. of Ideas	Thumb Tack	38.14	17.11	1	.001
	Kitchen Sink	44.29	16.44	3	.001
	Average	41.21	16.78	1	.001
*Mean Creativity Rating	Thumb Tack	3.53	3.13	13	.05
	Kitchen Sink	3.47	3.07	7	.001
	Average	3.50	3.10	12	.025
Mean No. Ideas Above Midpoint	Thumb Tack	12.00	2.22	4	.01
	Kitchen Sink	8.68	2.22	8	.01
	Average	10.43	2.22	3	.001
Per cent Ideas Above Midpoint	Thumb Tack	31.5	12.9	10	.025
	Kitchen Sink	20.0	13.5	18	NS
	Average	25.3	13.2	13	.05

* 7-point scale

VII
EXPERIMENT VI

In the final experiment in this series, the authors sought to replicate the results of Experiment V, which showed that the short, seven-item checklist very effectively stimulated idea production, plus examine the effectiveness of another creative thinking procedure, the morphological synthesis method (Allen, 1962). This latter procedure requires the thinker to list specific ideas for improving one aspect (or dimension) of a problem along one axis of a two-dimensional diagram, and specific ideas for another aspect of the problem along the other axis; novel idea combinations are found in the intersecting squares of the matrix. For example, the problem of "inventing new kinds of vehicles" could be approached by creating a matrix with ideas for vehicle bodies listed along one axis and ideas for power sources listed along the other axis; some of the large number of idea combinations could be valuable.[1]

Experiment VI included an important procedural change. Instead of allowing a fixed 10- or 20-minute problem-solving period as in Experiments I to V, Ss in Experiment VI were self-paced. Much has been written regarding the disrupting effects of time pressure upon the natural flow of creative behavior (Wallach &

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[1] In practice, one may consider three or more dimensions of a problem when using the morphological synthesis procedure.

TYPE OF BODY

POWER	Bicycles	Cars	Busses	Trucks	Boats	Trains	Airplanes	Grocery carts	Helicopters	Flying Saucer	Tin-Can Shaped Vehicle	Bubble Shaped	Very Small Auto	Small Collapsible Auto
Gas Motor														
Pedals														
Underground Vacuum Tube														
Diesel														
Gas-Turbine														
Electric - Sun Power														
Electric - Catch Radio Waves														
Steam														
Sails														
Atomic														
Propellers														
Ocean Tides and Currents														
Gravity														

Fig. 1. Example of a Morphological Synthesis (from Davis & Houtman, 1968).

Kogan, 1965) and the improvement in idea quality with extended effort (Osborn, 1963; Parnes, 1961). It seemed reasonable, therefore, to investigate the effects of unlimited time upon idea generation, using the two different problem-solving techniques.

METHOD

Subjects

The Ss were 30 undergraduate educational psychology students at the University of Wisconsin.

Task and Procedure

Four training conditions, with 7 or 8 Ss randomly assigned to each group, were incorporated: Ss in the Long Checklist Group were instructed in the use of Osborn's (1963) "73 idea-spurring questions" (see Appendix D) and were provided with a copy of this checklist; a second group of Ss (Short Checklist Group) used the 7-item checklist described in Experiment V; a third group (the Morphological Synthesis Group) received instruction in the use of Allen's morphological synthesis technique; and the fourth group (Control Group) consisted of untrained Ss. Verbal instructions advised Ss that they would be asked to think of ideas for changing and improving a particular object and that unlimited time was available to work on the problem (30 minutes was suggested, but not required as a minimum). All Ss worked on the Door Knob Improvement problem.

Eight dependent measures were available: (1) Time spent working, (2) total number of ideas produced, (3) number of ideas per minute, (4) mean idea "originality" (uniqueness) as rated by two judges, (5) mean "practicality" (usefulness or feasibility) as rated by two judges,[2] (6) number of ideas rated in the upper half of the "originality" scale by both judges, (7) number of ideas rated in the upper half of the "pr ctically" scale by both judges, and (8) number of ideas rated above the scale midpoint on both "originality" and "practicality" by both judges.

[2] A 10-point decile ranking system was used, described in detail in Warren & Davis (1969a, b).

RESULTS

Mean group performance scores for all eight dependent measures are summarized in Table 9. For measures showing a $p < .05$, subsequent Newman-Kuels tests (Winer, 1962) were used to determine significant pairwise differences.

The Ss in the Short Checklist Group tended to work longer on the problem than Ss in the Morphological Synthesis Group who, in turn, spent more time than Ss in the Long Checklist Group or Control Group. While these results tend to support the results of Experiment V, which showed the short checklist to be intrinsically motivating, the overall F did not reach acceptable levels of statistical significance.

With the idea frequency measure, Ss in the Morphological Synthesis Group produced a significantly larger number of ideas than did Ss in the Control or Long Checklist Groups. While Ss in the Short Checklist Group produced roughly double the number of ideas generated by Ss in the Long Checklist or Control Groups, these pairwise differences did not reach statistical significance.

The derived measure of ideas-per-minute showed that Ss with instructions in the morphological synthesis procedure did indeed produce ideas significantly faster than Ss under any of the other training conditions. The Ss in the Short Checklist Group produced ideas faster than Ss in either the Control or Long Checklist Groups, but these latter differences were not significant.

There appeared to be no marked differences among the four groups on rated "originality" or "practicality." However, Table 9 shows that the mean number of ideas above the scale midpoint in (1) originality, (2) practicality, and (3) both practicality and originality reflected about the same performance as did the total idea frequency measure.

DISCUSSION

The favorable results with the Morphological Synthesis Group support earlier claims of its effectiveness in producing large quantities of ideas. The Ss trained in this forced-combinations procedure generated the greatest total number of ideas in less than the greatest amount of time, reflecting the finding that these Ss produced more ideas per minute than any other group. While these ideas were not of generally lower quality, which was expected since "morphologized" ideas normally are mechanical permutations of basically fewer ideas, it may be that Ss in this study did not list the

Table 9

Summary of Dependent Measures
(Experiment VI)

Measure	Morphological Synthesis	Short Checklist	Long Checklist	Control	*F	p <
(1) Mean S-Determined Working Time (Min.)	65.63	70.00	63.13	51.43	1.80	
(2) Mean No. Ideas	75.50	55.71	37.88	31.14	5.40	.005
(3) Mean No. Ideas per Minute	1.20	.800	.441	.591	4.06	.02
(4) Mean "Originality" Rating	5.81	5.71	6.17	5.67	0.47	
(5) Mean "Practicality" Rating	4.19	4.74	4.07	4.54	1.57	
(6) Mean No. Ideas Above Scale Midpoint in Originality	20.13	18.71	7.38	9.29	3.08	.05
(7) Mean No. Ideas Above Scale Midpoint in Practicality	43.00	26.14	17.00	16.14	6.84	.002
(8) Mean No. Ideas Above Scale Midpoint in Originality and Practicality	9.00	5.14	3.00	2.86	2.39	.10

* df = 3,26

truly "silly" combinations or else our quality measures were simply insensitive to true differences.

Experiment VI provides support for Osborn's (1963) recommendation that idea quantity leads to quality. Those Ss producing the greatest total number of ideas (Morphological Synthesis and Short Checklist Groups) also produced the greatest frequency of high-quality (original, original and practical) ideas. The proportion of high quality ideas, however, was constant across all four groups (Table 10).

Finally, this experiment essentially replicated the major results of Experiment V. The Ss provided with the short, seven-item checklist worked longer and produced more total and more high quality ideas than Ss in the Long Checklist or Control Groups.

Table 10
Proportion of High Quality Ideas (Experiment VI)

Measure	Morphological Synthesis	Short Checklist	Long Checklist	Control
[1]Proportion Original	.267	.336	.265	.298
[2]Proportion Original and Practical	.119	.092	.108	.092

1. Number of ideas above scale midpoint in "originality" divided by total number of ideas.
2. Number of ideas above scale midpoints in both "originality" and "practicality" divided by total number of ideas.

VIII
GENERAL DISCUSSION

In spite of the great appeal of the checklist technique, the results of the present six experiments suggest several qualifications and precautions. The nature of the problem, the thinkers, and the particular idea checklist must be coordinated. With college students, solutions for simple product-improvement tasks, regardless of duration of problem-solving time or object complexity, are not facilitated by the availability of lengthy, detailed checklists which almost give the students ideas if only they will transfer these ideas to the score sheet. In these studies, college students were successfully stimulated only by our brief, seven-item list of "aids in thinking of physical changes." By providing a few general categories of problem solutions, this short checklist stimulates a large number of specific ideas by allowing Ss to think in their "own" familiar and fluent fashion.

It was perhaps surprising that Ss provided with Osborn's (1963) 73 "idea-spurring questions" performed no better than untrained control Ss (Experiment VI). Since this negative finding replicates the results of Experiments I and II (which tested a very slightly modified version of Osborn's list against no training at all), it would seem that his list is either better suited for problems other than our product-improvement tasks or else Ss simply cannot learn to use it effectively in a short period of time.

Based upon idea frequency measures, the morphological synthesis procedure (Experiment VI) would appear to be the most effective technique examined in these studies. Such a conclusion may be misleading, however, since the larger number of ideas produced by Ss in the Morphological Synthesis Group was likely a product of permuting basically fewer ideas (which, of course, was precisely what these Ss were trained to do).

Object complexity per se did not appear to be an important factor in the present tasks. While various problem objects differed significantly in the number of ideas elicited (Experiments I and V), these differences were not clearly related to judged object complexity (Experiments II and V). In Experiment II, for example, Ss produced as many ideas for a cup as for the more complex kitchen sink. However, it seems very possible that in other problem situations, perhaps given unlimited time and strong motivation, more complex stimulus objects (perhaps interpreted as combinations of simpler objects) may very well stimulate greater numbers of ideas.

Experiment II showed that ideas produced in the last half of the 20-minute period were significantly more original than ideas produced in the first half. This finding is consistent with earlier studies, using the unusual use test, which showed moderate but highly significant correlations between order of emission and rated idea originality (Manske & Davis, 1968). In complete agreement with Parnes' (1961) conclusions regarding the increase in idea quality with extended effort, these findings also are quite in accord with traditional habit-hierarchy interpretations of human problem solving and thinking (see Davis, 1966).

The results of verbal instructions, e.g., to "be original" or "be wild" (Experiment IV) in the present product improvement tasks only partially replicated earlier laboratory research with the unusual uses test (Manske & Davis, 1968). As before, fewest ideas were produced under the most constraining instructions, i.e., when Ss were asked to "be original and be practical." It is quite possible that the various sets of instructions influence performance differently in the two tasks. In the earlier study, for example, the greatest number of "unusual uses" was produced by Ss who, when instructed to "be practical," itemized long lists of very common (but quite practical) ideas. In the present Experiment IV, the greatest numbers of "product improvements"

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were generated when Ss were under no instructional constraints (see Table 6).

As a final note, the authors elsewhere have proposed that creativity profitably may be conceptualized as consisting of three trainable components, (1) appropriate attitudes which predispose an individual to deliberately seek imaginative problem solutions, (2) various cognitive abilities which facilitate whatever mental abstracting, perceiving, associating, and combining contribute to the flow of original ideas, and (3) techniques for the conscious and systematic production of new combinations of ideas (Davis, 1969; Davis, Houtman, Warren, & Roweton, 1969). To be suitable for a given problem, however, a particular idea-finding technique also must stimulate and challenge the associative capabilities of the specific thinkers. Though these techniques reasonably should be considered a supplement, not a replacement, for natural ingenuity, the present experiments clearly support the feasibility of increasing creative output by teaching deliberate methods of generating new combinations of ideas.

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APPENDIX A
FIFTY-FIVE ITEM VERSION OF OSBORN'S "73 IDEA-SPURRING QUESTIONS"
(Experiments I and II)

MODIFY?

New twist?
Change color, motion, sound, odcr, form, shape?
Other changes?

MAGNIFY?

What to add?
Greater frequency?
Stronger?
Higher?
Larger?
Longer?
Thicker?
Extra value?
Plus ingredient?
Duplicate?
Multiply?
Exaggerate?

MINIFY?

What to subtract?
Smaller?
Condensed?
Lower?
Shorter?
Lighter?
Omit?
Split up?
Eliminate?
Divide?
Slower?

SUBSTITUTE?

What else instead?
Other ingredient?
Other material?
Other power?

REARRANGE?

Other layout?
Interchange components?
Other pattern?
Other sequence?

REVERSE?

How about opposites?
Turn it backward?
Upside down?
Inside out?

COMBINE?

How about a blend?
An assortment?
Combine purposes?
Combine units?
Combine appeals?

APPENDIX B
LONG CHECKLIST
(Experiment III)

NEW FORM?

Square, triangle, oval, rectangle, sharp corners, round corners, asymmetrical, doughnut shape, other forms?

CHANGE COLOR?

Silver, gold, copper, bronze, brass, red, purple, green, white, black, grey, blue, plaid, striped, polka-dots, op art, other colors or patterns?

NEW MATERIAL?

Plastic, fiberglass, formica, paper, wood, aluminum, steel, glass, leather, copper, other material?

NEW SIZE?

Longer, wider, fatter, thinner, higher, lower, larger, smaller, shorter, etc.

ADD OR SUBTRACT SOMETHING?

Longer, shorter, stronger, exaggerate something, thicker, thinner, duplicate, eliminate, divide, make lighter, abbreviate, add new do-dad, add new odor, new sound, etc.

REARRANGE?

Interchange components, other pattern, other sequence of operation, split up, turn it backward, upside down, inside out, etc.

NEW COMBINATION?

Combine units, combine purposes, combine appeals, new assortment, new blend, etc.

APPENDIX C
LONG CHECKLIST FROM DAVIS AND HOUTMAN (1968)
(Experiment IV)

CHANGE COLOR?

Blue
Green
Yellow
Orange
Red
Purple
White
Black
Olive Green
Grey
Brown
Tan
Silver
Gold
Copper
Brass
Plaid
Striped
Polka-dotted
Flowers
Speckles
Paisley
Pop Art
Other Colors?
Color Combination?
Other Patterns?

NEW SIZE?

Longer
Shorter
Wider
Fatter
Thinner
Thicker
Higher
Lower
Larger
Smaller
Jumbo
Miniature
Other Size?

CHANGE SHAPE?

Round
Square
Triangle
Oval
Rectangle
5-Sided
6-Sided
8-Sided
10-Sided
Lop-Sided
Sharp Corners
Round Corners
Egg-Shaped
Doughnut-Shaped
"U" Shaped
Other Shapes?

NEW MATERIAL?

Plastic
Glass
Fiberglass
Formica
Paper
Wood
Aluminum
Nylon
Cloth
Gunny Sack (Burlap)
Cardboard
Steel
Leather
Copper
Rubber
Other Material?
Combination of These Materials?

ADD OR SUBTRACT SOMETHING?

Make Stronger
Make Faster
Exaggerate Something
Duplicate Something
Remove Something
Divide
Make Lighter
Abbreviate
Add New Do-Dad
Add New Smell
New Sound
New Lights
New Flavor
New Beep Beep
New Jingle Jingle
Subtract The Thing That Doesn't Do Anything

REARRANGE THINGS?

Switch Parts
Change Pattern
Combine Parts
Other Order of Operation
Split Up
Turn Backward
Upside Down
Inside Out
Combine Purposes
Other Switcheroo?

NEW DESIGN?

From Other Countries?

Oriental design
Swedish design
Mexican design
French design
Eskimo design
Russian design
American design
Indian design
Egyptian design
Spanish design

From Other Time?

Old West
Roaring Twenties
Past Century
Next Century
Middle Ages
Cave Man
Pioneer

From Other Styles?

Hippie
Beatnik
Other Weirdos
Ivy League
Secret Agent
Elves and Fairies
Clown
Football Uniform

APPENDIX D
OSBORN'S "73 IDEA-SPURRING QUESTIONS"
(Experiment VI)

PUT TO OTHER USES?

New ways to use as is? Other uses if modified?

ADAPT?

What else is like this? What other idea does this suggest? Does past offer parallel? What could I copy? Whom could I emulate?

MODIFY?

New twist? Change meaning, color, motion, sound, odor, form, shape? Other changes?

MAGNIFY?

What to add? More time? Greater frequency? Stronger? Higher? Longer? Thicker? Extra value? Plus ingredient? Duplicate? Multiply? Exaggerate?

MINIFY?

What to subtract? Smaller? Condensed? Miniature? Lower? Shorter? Lighter? Omit? Streamline? Split up? Understate?

SUBSTITUTE?

Who else instead? What else instead? Other ingredient? Other material? Other process? Other power? Other place? Other approach? Other tone of voice?

REARRANGE?

Interchange components? Other pattern? Other layout? Other sequence? Transpose cause and effect? Change pace? Change schedule?

REVERSE

Transpose positive and negative? How about opposites? Turn it backward? Turn it upside down? Reverse roles? Change shoes? Turn tables? Turn other cheek?

COMBINE?

How about a blend, an alloy, an assortment, an ensemble? Combine units? Combine purposes? Combine appeals? Combine ideas?

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