

*SOCIAL CONTROL OF FORM DIVERSITY AND THE EMERGENCE
OF NEW FORMS IN CHILDREN'S BLOCKBUILDING¹*

ELIZABETH M. GOETZ AND DONALD M. BAER²

UNIVERSITY OF KANSAS

The blockbuilding behavior of three preschool girls was analyzed in terms of the forms manifest in any completed block construction, and found to contain few different forms in baseline sessions. Social reinforcement, given contingent on the production of any form not previously constructed within the current session (*i.e.*, every first appearance of any form within a session was reinforced but no subsequent appearances of that form within that session were), increased the number of different forms built per sessions. Social reinforcement, given for all second and later appearances within the session, decreased the number of different forms built per session. Furthermore, it was found that new forms (forms never seen before in the child's total prior sequence of blockbuilding sessions) emerged at higher rates during periods of reinforcement of different forms (first appearances) than during periods of baseline or reinforcement of same forms (second and later appearances).

Virtually every nursery, preschool, and day care center is equipped with a collection of blocks, usually incorporating a variety of shapes and sizes. Use of these blocks is ordinarily a frequent activity of the majority of preschool children, and such play is widely believed to be educational, contributing to the child's concepts of space, form, mathematics (*cf.* Cuisenaire rods), balance, leverage, and visual esthetics. The possibility of such a contribution does not appear to have been subjected to experimental analysis and verification, probably because the

outcomes are not well specified in objectively measurable behavioral terms. Even without an empirical basis, though, it might well be guessed that if blockbuilding were to yield such a contribution, the block play itself would need to be diverse rather than limited, repetitive, or stereotyped. If the guess is a good one, then diverse block play becomes a behavioral goal in itself. Significantly, it is one that can readily be given behavioral definition and thereby be subjected to experimental programming, such as by external reinforcement contingencies. If the guess is not a good one, the deliberate development of diverse blockbuilding may nevertheless be taken as an experimental goal, so as to ask, if it is developed, what else results? The present study was undertaken to demonstrate the possibility of reinforcing an objectively specifiable aspect of children's blockbuilding that would yield results that might readily be labelled diverse or (less readily, no doubt) even creative. To the extent that such behavior is valued in itself, these procedures then contribute to an educational technology capable of producing it; to the extent that the value of such behavior is questioned, these procedures contribute to the

¹A preliminary version of this study has been published in *A New Direction for Education: Behavior Analysis, Vol. 1*, edited by E. A. Ramp and B. L. Hopkins, (Lawrence: University of Kansas Printing Service, 1971). Supported in part by the University of Kansas Center for Research in Early Childhood Education, in association with the National Program for Research in Early Childhood Education, CEMREL, Inc., and the U. S. Office of Education. (Grant numbers OEC 3-7-070706-3118 and OEC 0-70-4152[607]). We thank Ms. Susan Young, Mr. Charles Burns, and Mr. Lawrence Russell for assistance in obtaining the measurements.

²Reprints may be obtained from either author, Department of Human Development, University of Kansas, Lawrence, Kansas 66044.

possibility of experimental examination of any other results of its deliberate development.

METHOD

Setting

The study took place in a university preschool classroom, specifically in the blockbuilding area of the classroom (characterized by a clear expanse of flat floor bordered by shelves containing the blocks). Each subject was invited by the teacher to play with the blocks in this area, alone with her and an observer, stationed a few feet away. These invitations were made every few days, and were invariably accepted. The blockbuilding session took place during a time of day when the block area was free of all other children (who were engaged in curricular activity outdoors). The session continued until the child said she was finished or until all the blocks available had been used and their rearrangement had stopped, and the child agreed when the teacher asked, "Are you finished?". Usually, the child made a single construction per session; occasionally, several separate constructions were made in a session, in which case all were considered in the data analysis of that session.

Subjects

Three girls, each 4-yr old, had little else in common apart from an absence of well-developed blockbuilding skills. This deficit had been remarked on informally by the classroom staff during the months of school preceding the study, and was formally examined in a baseline period at the outset of the study. Staff comments emphasized that these girls' blockbuilding efforts were either devoid of construction (the blocks merely being laid out in like-shaped or like-sized groups), or primitive (characterized by repetition of the same structure—*e.g.*, the same "castle"—in every successive construction). One subject came from a low-income family; the other two represented highly enriched, intellectually and culturally stimulating family situations.

Behavior Definitions and Recording

Child behaviors. The basic child behaviors of blockbuilding were defined according to their products, block *forms*. In general, *form* referred to various uses of two or more blocks to create a specified shape or function. Specifically, an arbitrary but frequently seen 20 such forms were defined, as listed in Table 1. Most of these forms could be constructed from a wide variety of blocks; only a few are defined in terms of specific pieces ("circles", "S", "X", and "inter-face"). Note that some of these definitions require that the block collection contain rectangular solids of various length-width-thickness ratios and arc-shaped and V-shaped pieces, as well as the more familiar cubes.

A *form diversity* score was defined as the number of these 20 forms appearing at least once in any session's construction(s).

A *new forms* score was defined as the number of these 20 forms appearing in a given session's construction that had not appeared in *any* prior construction by that child (in previous sessions of blockbuilding) recorded within the study. The *new forms* measure was not scored for the child's first block construction(s) in the first session of the study, in that all forms appearing in that session would have to be considered new. Instead, the number of forms appearing in the first construction(s) of the first session of the study was taken as the child's baseline of forms; new forms were then considered forms other than those and were scored from the second session's construction(s) on.

Recording of each construction was done photographically with a Polaroid camera. A series of photographs was taken of each session's construction(s), from all sides and angles necessary for complete display of its structure. (The use of a Polaroid camera was considered important, in that each photograph could be examined for adequacy of exposure, focusing, scope, and clarity almost immediately; deficient ones then could be replaced or augmented by additional photographs before the construction

Table 1

Definition of 20 Block Forms

<p>FENCE: any two or more blocks placed side by side in contiguity; if not contiguous, then any three or more blocks placed at regularly spaced intervals in a straight line.</p> <p>STORY: any two or more blocks placed one atop another, the upper block(s) resting solely upon the lower.</p> <p>RAMP: a block leaned against another, or a triangular block placed contiguous to another, to simulate a ramp.</p> <p>PILLAR: any story in which the lowest block is at least twice as tall as it is wide.</p> <p>POST: any story in which the lowest block is at least twice as wide and half as tall as the upper block(s).</p> <p>TOWER: any story of two or more blocks, each of which is at least twice as tall as it is wide.</p> <p>ROOF: two or more slat-shaped blocks placed flat and side by side atop at least two supports.</p> <p>FLOOR: an inverted roof.</p> <p>BALANCE: any story in which the upper block is at least four times as wide as the lower.</p> <p>ELABORATED BALANCE: any balance in which both ends of the upper block contain additional blocks.</p>	<p>ENCLOSURE: any arrangement of fences which encloses an open area, with or without "gate".</p> <p>SUBDIVISION: two or more enclosures in contiguity with at least one common fence.</p> <p>ARCH: any placement of a block atop two lower blocks not in contiguity.</p> <p>STORIED ARCH: an arch built atop another arch.</p> <p>ADJUNCT: two or more forms connected by a fence; at least one of the forms must be an enclosure, subdivision, or roof.</p> <p>CIRCLE: arrangement of four arc-shaped blocks in contiguity to form a circle.</p> <p>"S": arrangement of four arc-shaped blocks in contiguity as two half-circles to simulate an s.</p> <p>"X": arrangement of two V-shaped blocks in contiguity to simulate an X.</p> <p>INTERFACE: arrangement of any two blocks with curved contours to fit precisely together, such as circle into hole of doughnut-shaped block, or half-circle into arc-shaped block.</p> <p>SIMULATION: a construction of blocks which resembles a real-life object and is explicitly labelled by child as such, usually a building, boat, or swimming pool.</p>
--	---

was dismantled). These photographs were taken after the child had left the setting; the camera was not in evidence during the blockbuilding, and the child was presumably unaware of the fact of photographic recording.

Two judges independently examined each series of photographs, counting the number of forms appearing at least once in the series representing the session's construction. Their agreement in this counting of form diversity was compared and found to be 100% over all sessions of the study. In that the new forms score was derived directly from these counts (comparing the identities of the forms found in a given construction to those found in all previous constructions), there was similarly 100% agreement between the judges on that score as well.

The *duration* of each session was recorded by the observer with a stopwatch. The session was defined as beginning when the first block was set down, and as ending either when the child

said it was or when the child replied affirmatively to a teacher question about completion.

Teacher behaviors. An observer silently watched the blockbuilding interaction from a few feet away and recorded teacher behavior and its contingency with the child's production of forms. Specifically, the observer recorded each successive new form built by the child in that day's construction, whether the teacher attended to that form production or not, whether the attention was enthusiastic and approving, and the duration of the session. These records were used primarily as a check on the teacher's efficiency in carrying out the social contingencies required by the experimental design, rather than as a direct measure of the child's behaviors in producing forms. (The photographs were preferred as likely to yield higher accuracy, in that they could be examined at leisure many times over, whereas the observer was required to judge all blockbuilding behaviors immediately as they occurred). In addition, the teacher herself main-

tained similar records, as the blockbuilding proceeded. Comparison of the teacher's records and the observer's showed agreement on 95% of the events recorded, over the study, and also showed that 95% of the teacher's attention was supplied in the contingencies required by the experimental design, across the study.

Procedures

Baseline: no reinforcement. During the first three to five sessions (varying with the subject), the teacher sat by the child as she built with the blocks, watching closely but quietly, displaying neither criticism nor enthusiasm about any particular use of the blocks. At the end of each baseline session, the teacher expressed her appreciation of the child's total effort and conducted her back to the rest of the classroom group (usually in the play yard outside), and then returned to photograph the construction(s). Baseline sessions were continued until inspection of the child's daily form diversity scores showed a stable enough level to justify experimental programming. (The new forms score was not considered).

Reinforcement of different forms. After the baseline sessions, the teacher began a program of social reinforcement of new forms. In these sessions, the teacher remarked with interest, enthusiasm, and delight every time that the child placed and/or rearranged blocks so as to create a form that had not appeared previously in that session's construction(s). (The form might well have appeared in any previous session's construction(s), but it would be reinforced in this session nevertheless). In other words, the teacher reinforced every first appearance of any form within the current session but no subsequent appearances of that form within that session. The content of the teacher's remarks was designed to accomplish descriptive reinforcement: that is, they often indicated the dimension to be reinforced, such as, "Oh, that's very nice—that's different!". These procedures were continued for four or five sessions until clear evidence of increasing form diversity was

obtained, at which point the next experimental condition was implemented. (The new forms score was not considered).

Reinforcement of same forms. Experimental control of the increasing form diversity score was attempted by reversal of the direction of the social reinforcement contingency employed. Thus, for the next two to four sessions, the teacher continued to display interest, enthusiasm, and delight, but only at those times when the child placed and/or rearranged a block so as to create a repetition of a form already apparent in that session's construction(s). (This form need not have appeared in any previous session's construction(s); so long as it had appeared earlier in this session's construction(s), it would be reinforced.) Thus, no first usage of a form in a session was reinforced, but every second usage of that form and every usage thereafter within the session was. Again the content of praise was descriptive: it specified the dimensions (sameness) being reinforced (e.g., "How nice—another arch!"). These sessions were continued until a clear decrease in form diversity was seen. (As ever, the new forms score was not considered).

Resumption of reinforcement of different forms. To conclude the experimental analysis and leave each child with the desired high level of diversity, reinforcement of different forms was resumed and continued for three to five sessions, until high levels of form diversity were seen. Procedures during this condition were identical to those used in the previous condition of reinforcement of different forms, i.e., only first appearances of any form within the current session were reinforced.

Number of blocks to be used. The first two subjects, Sally and Kathy, were free to use any number of blocks, many or few, for each construction. In fact, each girl tended to use a number of blocks roughly correlated with her form diversity score, across constructions. While the correlation was not high, it did allow the possibility that the increasing form diversity scores associated with reinforcement of different

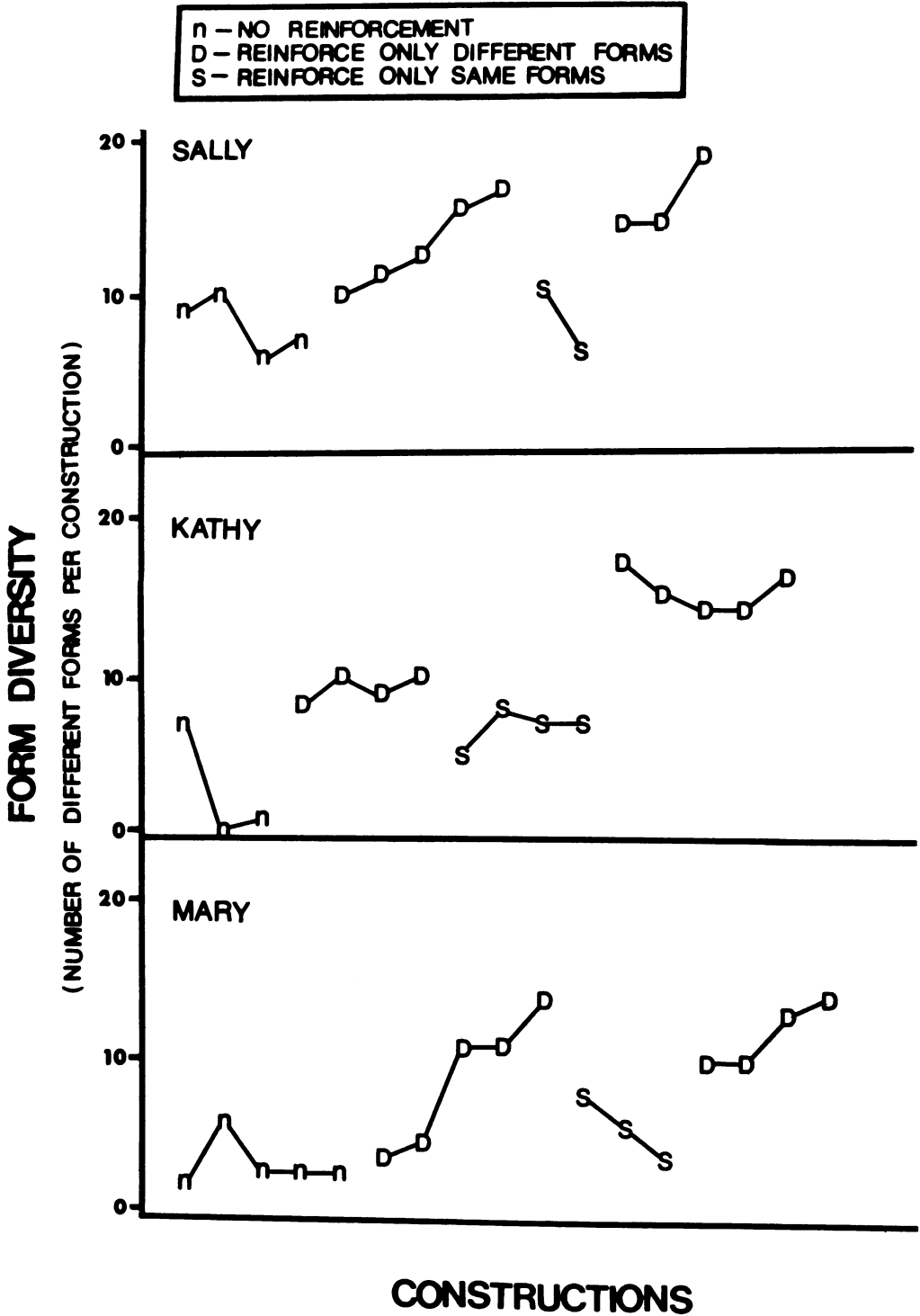


Fig. 1. The form diversity scores of three children in the course of block-building training. Initial points, labelled as n's, represent scores produced when reinforcement was programmed only for different (non-repetitive) forms; and points labelled as S's represent scores produced when reinforcement was programmed only for repetition of the same forms used previously that session.

forms could represent a chance outcome of the increased opportunity to display different forms when using many blocks. Consequently, Mary's procedures were conducted as described above, but with one added element: Mary was told that she must use all of the blocks (53 in number) each session. Invariably she did.

RESULTS

Form diversity. Each child's form diversity score, for each experimental session, is shown in Figure 1. It is apparent that the social contingencies applied effectively controlled the development of form diversity: each child showed appreciable increases from her baseline (no reinforcement) levels during the two periods of reinforcement of different forms; and during the interpolated condition of reinforcement of same forms, each child's form diversity decreased toward her baseline range.

New forms. Each child's new forms score, for all sessions after the first (which was used to define old forms for all later sessions), is shown in Figure 2, cumulatively. That is, each bar represents the number of new forms displayed by the child so far in her sessions, since the first session. (The number of "new" forms seen in her first session was of course identical to the first point in each graph of Figure 1.) The increment each bar shows over the immediately preceding bar is thus the number of new forms that emerged in that session. Figure 2 shows that the emergence of new forms was largely restricted to periods in which different forms were being reinforced. Only three exceptions appear: Sally, in her second baseline session (first bar in Figure 2), showed one new form, and in her third session, another new form; Mary in her second baseline session (first bar in Figure 2), showed four. By contrast, Sally showed nine new forms during periods of reinforcement of different forms, and Mary displayed 14 during these periods. In Kathy's case, her 16 new forms emerged only during periods of reinforcement of different forms. In no child's

study did new forms appear during the period of reinforcement of same forms. On the average, across the three children, the rate of emergence of new forms during periods of reinforcement of different forms was 1.5 new forms per session; the rate of emergence of new forms during periods of baseline or reinforcement of same forms was 0.33 per session. These figures exclude the first baseline session, as required by the definition of the new forms score.

Session durations. The mean duration of blockbuilding sessions was 16 min in Sally's case, 19 min in Kathy's, and 9 min in Mary's. However, when Sally was receiving reinforcement for different forms, her mean duration was 23 min; in conditions of baseline and reinforcement of same forms, her mean duration was 9 min. The comparable mean durations for Kathy were 22 min and 12 min, respectively; and for Mary, 10 min and 8 min. Thus, in general, performance during reinforcement of different forms required more time than during baseline or the reinforcement of same forms.

DISCUSSION

The three children of this study showed increasing form diversity when they received descriptive reinforcement for creating different forms, and decreasing form diversity when repetition of similar forms was descriptively reinforced. Thus, the teacher techniques implicit in descriptive reinforcement were functional in the analysis of this behavior of preschool children, as they have been in many other studies (*e.g.*, Baer and Wolf, 1968).

Sally and Kathy were free to use many blocks or few for each construction, but Mary was required to use all the 53 blocks in each construction. Mary's results thus represent the number of different forms achieved per 53 blocks in each session, and cannot represent simply a better chance to achieve many forms during the condition when different forms were being reinforced. The similarity of Mary's results to Sally's and Kathy's suggests that the same process oper-

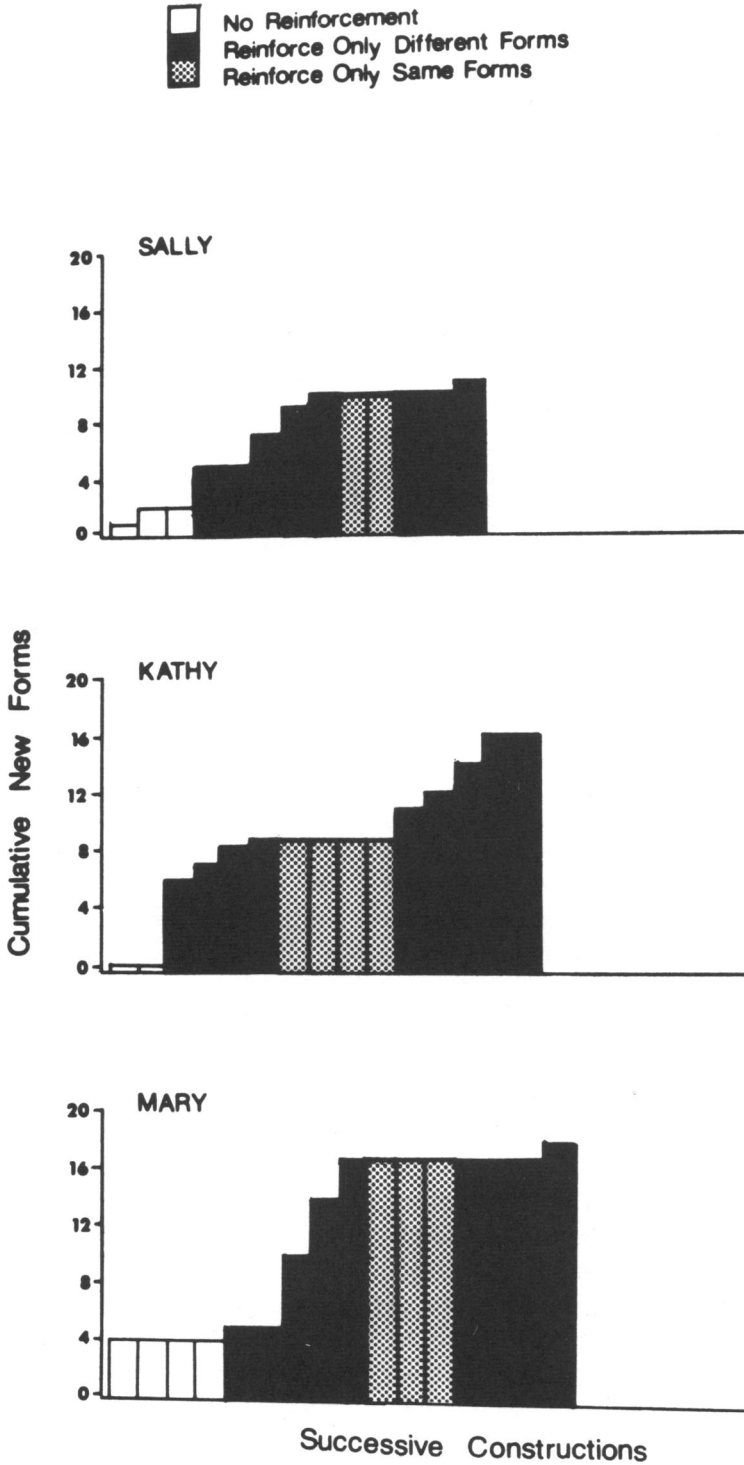


Fig. 2. The cumulative number of new forms (forms never used before) produced by three children in the course of block-building training. All scores represent cumulative increments above the score produced in the first session (not graphed). (The increment each bar shows over the preceding bar is thus the number of new forms produced in that session.)

ated in all three cases, independently of the number of blocks used per construction.

It seems clear that diversity of response, within this delimited sphere of activity, is readily modified by simple, everyday reinforcement contingencies. This is in agreement with the earlier demonstrations by Maltzman (1960), who performed a series of studies using verbal instruction and/or praise to increase original word associations in college students, and by Pryor, Haag, and O'Reilly (1969), who increased never-before-observed body movements in two porpoises, using food reinforcers. However, the Maltzman studies displayed their effects as changes in the mean scores of various subject groups, which is certainly valuable but nevertheless actuarial. Creativity could have its greatest meaning as a description of an individual's behavior. The Pryor *et al.* study showed a deliberate development of novel or original swimming gymnastics in each of its two porpoises, but had difficulty maintaining objective, reliable measurement of these behaviors as they became increasingly original, and did not offer an experimental analysis of the procedures necessary to this development. (Furthermore, creativity in the porpoise, while intriguing, may reasonably be doubted as an analogue of any similar process in man or child).

The generality of the ease of training displayed in the present study of course remains to be seen. Furthermore, whether or not to attribute the effect simply to a reinforcement mechanism remains to be seen as well. In this study, the content of the verbal reinforcement described the dimensions at issue, *i.e.*, diversity as opposed to similarity of forms to be constructed. Analysis of the separate functions of description and reinforcement remains to be accomplished, although its value is more theoretical than applied. It is likely that the functions of description without praise and of praise without description are different in different children. In particular, it may well be supposed that for some children, either will be sufficient without the other, but that for other children, the mix

of the two will be more effective than either alone. If so, then for applied purposes, a package of the two is probably the best technique to apply to children in general. The present study, of course, testifies to the effectiveness of the package, not to its components.

It may be noted that the package was applied to form diversity directly, and only to form diversity; change in the new forms score and in session durations are thus collateral changes, rather than direct results of the descriptive contingencies applied to each new (or each same) form. Nevertheless, these changes, taken together, suggest that children receiving descriptive reinforcement merely for form diversity *within* a session do display an emergence of new forms *across* sessions, and take more time in their blockbuilding as they do so. The descriptive content of teacher praise specified "difference" (or "sameness"), but did not include any instruction in how to construct any form. For these reasons, the total pattern of behavior change seen in these three children might well be labelled "creative", pursuant to a discussion of the definitional problems inherent in the term.

It has never been easy to define creativity (*cf.* Crutchfield, 1965; Ghiselin, 1955; Guilford, 1959; Stein, 1953). However, one definition is attractive on its face and also lends itself to objective measurement and specific environmental programming. This definition equates creativity to novel or original behavior, *i.e.*, behavior that the subject of study has not displayed before in his present setting, or behavior that his group, class, or culture has not displayed before in that setting (Maltzman, 1960; Pryor *et al.*, 1969). The phrase, "not displayed before", implies a criterion of time: not displayed since when? Clearly, this definition of creativity confers maximum creativity on those behaviors that have never been displayed before—meaning never before within the limits of the observer's memory (or within the limits of his recording system, or his culture's recording system). Less creativity is suggested for behaviors

that have not been displayed since more recent times than that, such as "since yesterday". Nevertheless, if the goal is to foster creativity through direct training, a lesser criterion of creativity may be necessary. To reinforce only those responses that have never been displayed before may result in an extremely thin schedule of reinforcement, which will often be an ineffective one. In the present study, the target of training was behavior not displayed previously in that session by the child. This short-term criterion of creativity allowed a realistic reinforcement schedule, and success with the short-term criterion was associated with a modest collateral development of behavior consistent with a long-term criterion, as evidenced by the new forms score. Thus, it may well be that a short-term criterion, important on pragmatic grounds, may result in long-term outcomes of both pragmatic value and theoretical significance. Meanwhile, the definition of "creativity" is no less arbitrary than it has ever been, but one facet of that arbitrariness has been subjected to experimental analysis, within the obvious limits of this study.

REFERENCES

- Baer, D. M. and Wolf, M. M. The reinforcement contingency in preschool and remedial education. In R. D. Hess and R. M. Baer, (Eds.), *Early education: Current theory, research, and practice*. Chicago: Aldine, 1968. Pages 119-130.
- Crutchfield, R. S. Creative thinking in children: its teaching and testing. In H. Brim, R. S. Crutchfield, and W. Holtzman, (Eds.), *Intelligence: Perspectives*. New York: Harcourt Brace and World, 1965. Pages 33-64.
- Ghiselin, B. *The creative process*. New York: New American Library, 1955.
- Guliford, J. P. Traits of creativity. In H. H. Anderson, (Ed.), *Creativity and its cultivation*. New York: Harpers, 1959. Pp. 142-161.
- Stein, M. E. Creativity and culture. *Journal of Psychology*, 1953, **36**, 311-322.
- Maltzman, I. On the training of originality. *Psychological Review*, 1960, **67**, 229-242.
- Pryor, K. W., Haag, R., and O'Reilly, J. The creative porpoise: training for novel behavior. *Journal of the Experimental Analysis of Behavior*, 1969, **12**, 653-661.

Received 29 November 1971

(Revision requested 3 February 1972.)

(Final acceptance 28 November 1972.)