EFFECTS OF A TREATMENT PACKAGE ON THE CREATIVE PLAY BEHAVIOR OF CHILDREN WITH AUTISM

by

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Abstract

EFFECTS OF A TREATMENT PACKAGE ON THE CREATIVE PLAY BEHAVIOR OF CHILDREN WITH AUTISM

by

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The purpose of the present study was to examine the effect of a treatment package comprised of instructions, prompting (manual guidance and modeling), reinforcement (token and behavior-specific praise) and response interruption on the creative play behavior of children with autism. The extent to which creative building behavior would generalize from the original play materials to novel play materials was examined. A pre-test/post-test measure allowed for examination of responding with untrained building materials in the presence of novel instructors in novel settings. The participants were three children with autism ranging in age from 7 to 9 years. A multiple-baseline-across-subjects design was used. During each trial, the participant created a form using the play materials provided. The trial ended when the participant used all 6 pieces of the material provided or when 3 minutes had passed. During baseline trials, reinforcement was provided contingent upon appropriate sitting behavior during each trial. During training trials, tokens and behavior-specific praise were provided contingent upon the production of any form not previously constructed within that same session. A reinforcer was provided upon every first construction of a form within a session, but subsequent constructions of that same form did

not occasion a reinforcer. Data were collected during baseline, training and probe trials on creative responding that occurred within sessions as well as creative responding that occurred across sessions. Results indicated that after the implementation of treatment there was a systematic increase in creative play behavior across participants during training trials. During probe trials, during which untrained materials were used, responding increased systematically from baseline to treatment. Creative responding also increased from pre-test to post-test for all three participants when novels materials, novel teachers and a novel setting were used. The present study demonstrated that a treatment package was effective in increasing creative play behavior in children with autism. In future research, a component analysis could be conducted to determine the components of the treatment package that were necessary and sufficient for skill acquisition and generalization of creative play behavior in children with autism.

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EFFECTS OF A TREATMENT PACKAGE ON THE CREATIVE PLAY BEHAVIOR OF CHILDREN WITH AUTISM

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Children with developmental disabilities often do not display the play skills that their typical peers exhibit, or if they do engage in play, they do not play creatively (Rutter, 1968). The purpose of the present study was to increase the creative building behavior of children with autism as they played with sets of building materials, such as blocks. Boucher (1977), examined the creative behavior of children with autism and of typically-developing peers as they played with cars being driven through mazes. He found that the children with autism did not vary their responding from trial to trial at the same level as did their typical peers; rather, they more often chose the same arm of the maze repeatedly. The children with autism were also less likely to respond to a novel stimulus (a third arm of the maze) when it was introduced compared to the typically developing children.

In behavior-analytic research, creativity has been defined as responding that differs from any other responding that has been produced within a particular time frame (Goetz & Baer, 1973), or within a specified number of previous responses (Page & Neuringer, 1985), or was never a part of the subject or species' repertoire of behavior (Pryor, Haag, & O'Reilly, 1969). The study of creativity has shown that creativity can be observed, measured, and modified. Creativity has been increased through the use of response-contingent reinforcement (Page & Neuringer, 1985). Creative responding may also be temporarily increased when response-contingent reinforcement is terminated or

withdrawn. This initial increase in responding may be an example of extinction-induced variability (Duker & Van Lent, 1991; Lalli, Zanolli & Wohn, 1994), but it may also be referred to as behavioral variability or creativity.

Research on the production of creative behavior or novel responding has been conducted with a variety of species, including: porpoises (Pryor, Haag & O'Reilly, 1969), pigeons (Page & Neuringer, 1985; Machado, 1989) rats (Neuringer, Deiss & Olsen, 2000) and humans (Miller & Neuringer, 2000). Responses that have been selected for investigation with humans have included communicative gestures (Duker & Van Lent, 1991), writing (Glover & Gary, 1976; Maloney & Hopkins, 1973) problem solving (Parsonson & Baer, 1978) and play (Lalli, Zanolli & Wohn, 1994; Goetz & Salmonson, 1972; Haring, 1985; Goetz & Baer, 1973). Goetz & Baer (1973) used reinforcement in the form of behavior-specific praise to modify the block-building behavior of three typically developing preschool children. They found that when reinforcement was provided contingent upon building different forms of block construction (forms that had not yet been built within a given session), there was an increase in creative building behavior. When reinforcement was provided contingent upon building the same form (a form that had been built previously in that same session), there was a decrease in creative building. Miller and Neuringer (2000) also showed that probability of producing novel responses could be influenced by parameters of reinforcement. In their study, the production of various novel computer key press response sequences by children with autism was manipulated by providing reinforcement when a response sequence varied from a prior response sequence. A more extensive review of the research literature on creative responding may

be seen in Appendix A.

The present study used procedures similar to those of Goetz and Baer (1973), and extended their earlier study in six ways: a) children with autism served as subjects rather than typically developing children; b) a treatment package was used consisting of instructions, prompting (manual guidance and modeling), token reinforcement, behavior-specific praise and response interruption; c) generalization was assessed from the play materials used during training to different play materials during probe trials; d) normative data collected by observing the behavior of typical children were used as a basis of comparison; e) social validity data were obtained by having regular education teachers review randomly selected photographs depicting baseline and training sessions to determine if there were habilitative changes in the level of creativity from baseline to training for all participants; and f) pre and post-test sessions were conducted using untrained materials, two novel settings and two novel teachers.

Method

Participants

Three children with autism participated in the study, John, Jeff and Katie ages 7, 8 and 7 years respectively. All attended the same private school for children with autism. John had been enrolled in the school for 2 years at the start of the study; Jeff had been enrolled for 3 years, and Katie had attended the after-school program for 3 years. All participants had received diagnoses of autism by independent agencies prior to the onset of the study. Each of the children had demonstrated little or no creative responding (placing or rotating three or more building pieces differently from one structure to the

next) in their building behavior prior to intervention. To participate in the study the child had to be able to complete an activity independently and sit for at least 15 minutes with a structured activity under adult supervision. This was determined by teacher report as well as by data-based progress notes. Individuals observed to build creative structures (structures in which they rotated or placed differently three or more building pieces from one structure to the next) were not selected to participate in the study.

All of the participants had displayed low levels of stereotypic behavior, including hand movements and non-contextual vocalizations. Each of the participants had used a token board for correct responses and appropriate behavior in their classroom prior to the onset of the study. All of the participants were able to complete a task from beginning to end independently and they each had picture schedules that contained play activities (e.g., puzzles, matching activities) that they used in their classrooms.

John's verbal skills consisted of answering yes and no questions, responding to social questions and initiating his wants and needs using a sentence. John did not vary his responding across occasions when asked to list responses within a category (e.g., "tell me some animals"). On occasion, he drew or created items using play-doh™; however, these creations, once made, were repeated and novel responding was not typically observed.

Jeff's verbal skills consisted of answering yes and no questions, responding to social questions asked of him and reciprocating basic social information with an adult. Jeff did on occasion vary his verbal responses when asked to list responses within a category (e.g., "tell me some animals.")

Katie's verbal skills consisted of answering yes and no questions and responding to social questions asked of her. Reciprocation of social information was also emerging. She used an augmentative communication device to communicate in conjunction with verbalization. Katie did not vary her responding across occasions when asked to list responses within a category (e.g., "Tell me some animals."), and displayed minimal creative building. Katie however did sometimes vary her responding during art-related activities such as drawing or coloring.

Two typically developing peers participated in the study by allowing their building behavior to be recorded and used as a normative level of responding for use during the study. Amy and Mark were both 8 years old. Amy was related to the primary experimenter and was recruited by the primary experimenter to participate in the study. The experimenter recruited Mark as Mark and Amy attended the same elementary school and had frequent play dates at Amy's house. Amy and Mark attended the same elementary school and were both in a regular second grade class. After obtaining consent from both participants' parents, both participants were also independently asked if they would like to build with some building materials and were asked if they minded photos being taken of their structures. Both children agreed to participate and sessions were conducted so that only one child participated at a time and the second child was playing in an area that was not near where the session was being conducted.

Experimenter and Research Assistants

The primary experimenter was a doctoral student in psychology who had received extensive training in applied behavior analysis. The primary experimenter served as the

teacher and conducted most of the baseline and treatment sessions throughout the study. A research assistant conducted the remaining baseline and treatment sessions. The research assistant was an educational coordinator at the school with a Masters degree in Special Education and extensive training in applied behavior analysis. Another two research assistants conducted the pre-test and post-test sessions. These research assistants had B.A. degrees in speech and also had extensive training in applied behavior analysis.

Setting

The study took place at the school attended by the participants, a center-based private school program for children with autism that uses a behavior-analytic approach. The children are educated in all areas of their individualized education plan (IEP) using a behavioral approach to teaching.

Training sessions took place in the meeting room in the school program. The meeting room was 200 square feet and contained 4 tables, 10 chairs, a white wipe off board, two enclosed cabinets, one closet, and two windows. Two long rectangular tables were placed alongside each other to create one larger table and two chairs were placed next to one another on the same side of the table (one for the teacher and one for the participant). A file caddy box containing session materials was kept on one of the remaining tables to store building materials that were not in use at a particular portion of a session.

The pre-test and post-test sessions took place in two settings within the school building that were different from the training setting, specifically: a classroom and a large recreation room. Each room was 800 square feet. The classroom contained 2

tables, 8 student chairs, 6 student desks, one bookcase, and a locked cabinet. The recreation room contained 6 chairs, 2 tables, an air hockey table, exercise equipment (a treadmill and two exercise bicycles), a ping-pong table, and a refrigerator. During pre-test or post-test sessions chairs were situated in the same manner alongside each other facing a table as they were in the meeting room.

Materials

Five types of building materials, described below were used during the course of the study. Four sets of building materials (wooden blocks, Bristle blocks™, Interstars™ and Legos™) were used during baseline, training and probe trials. The fifth material (Magna Tiles ™) was used during the pre-test and post-test sessions only. For each set of building materials there were 6 pieces in total; of the 6 pieces there were 3 different shapes and 3 different colors. The 3 pairs of identically shaped materials in each set were identical in color as well (e.g., 2 green rectangular Legos™, 2 yellow square Legos™, and 2 round red Legos™). None of the building materials was used during the participants' regular programming in his/her classroom. For each participant, three of the building materials were used during baseline and training trials and the fourth set of building materials was used during probe trials. A detailed description of the building materials follows.

Wooden blocks. A set of 6 colored wooden blocks was used. The following shapes were used for Katie and John (two of each form): 3.5" X 1.5" orange rectangle, 1.25" red square and 1.5" X 1.25" green cylinder. The following shapes were used for Jeff (two of each form): 3.5" X 1.5" orange rectangle, 3.25" X .75" blue cylinder and

2.25" X 2.5" X 1" yellow triangle.

Bristle blocks™. A set of 6 Bristle blocks™ were used. The following shapes were used (two of each type) 3" X .75" blue cylinder, 3" X .75" green rectangle, and 5" X .75" red rectangle.

Interstars™. A set of 6 Interstars™ toys were used. The following shapes were used (two of each type): 3.5" X 3.5"yellow H shape, 1.5" X 1.5" orange open cylinder, and 3.65" X .1" pink cylinder.

Legos™. A set of 6 Legos™ were used. The following shapes were used (two of each form): 4" X 1.33" silver v shape, 4" X 1.33"gold rectangle, and 2" X 1.33"pink square.

Magna Tiles™. A set of six Magna Tiles™ were used. The following shapes were used (two of each shape) 5.5" X 5.5" X 3"triangle (green on one side and orange on other side), 2.75" isosceles triangle (green on one side and orange on other side) and 3" square (green on one side and yellow on other side).

Token boards

One token board was used during all phases of the study for each participant. This token board was used only to reinforce appropriate sitting and the participant was allowed to access a break when he/she received all fifteen of these tokens. This token board was constructed from a small 5"X 7" clipboard and pennies served as tokens. A second token board was used during treatment sessions only for all participants. Tokens were placed on this board contingent upon creative building behavior. The board was constructed from an 8.5"X 10" paper that was laminated and chips with colored stickers

served as tokens. Alongside each token was a picture or word depicting a potential reinforcer. If the student earned 4 tokens he/she could access any reinforcer next to the fourth token or any reinforcer below the fourth token. A specific number of tokens were required in order to access specific reinforcers. If all 8 tokens were earned the participant could choose any reinforcer on the board.

Camera and Recording Equipment. A Logitech Smartclick digital camera was used to take photographs of the forms created to determine the number of different forms occurring across sessions. A Compaq Presario 1400 laptop computer and the software program Logitech Quick Cam were used to store the photographs of each structure taken with the Logitech digital camera.

Response Definitions

A piece of building material was *placed* when it was touched and moved or picked up and placed down on the table. It was *rotated* when it was turned or sloped at a different angle. The building material did not need to touch another piece of building material to be recorded as having been placed or rotated.

A *trial* was initiated when the materials were placed on the student's desk, and was terminated upon completion of a form (all six pieces of the play material were placed or rotated by the participant), or when three minutes elapsed.

A *form* was defined as any construction in which all 6 pieces of play material were placed or rotated by the participant. A form was not considered independent if prompting (manual guidance and modeling) or response interruption (described below) was used. A building piece was *independently placed differently* when the material

differed by placement or rotation from its placement or orientation in any previous form within that same session.

A *different form (within session)* was defined as a form that varied from any prior form completed within the same session by the placement or rotation of a minimum of three pieces of material. A form that was a reverse (mirror) image of another form built during the session was recorded as a different form if the form was created as a reverse image; rather than by rotation of the entire structure after construction was completed.

A *different form (across sessions)* was defined as a form that varied from any prior form to date during any prior session according to the criteria for a different form within sessions (see above).

An *error or not different response* was defined as moving or rotating fewer than 3 building pieces, building the same structure as was built on any prior trial, or building the same structure as one already built during a session, and then rotating the entire structure.

Appropriate sitting was defined as sitting on the chair with feet on floor (not on chair) and hands on table or lap, holding materials or building with materials. If any instances of maladaptive behavior occurred, such as; hand flapping appropriate sitting was not scored and the behavior was non-verbally interrupted (e.g., by touching the child's hand).

Design

A multiple-baseline-across-participants experimental design was used. A pre-test and post-test measure was obtained using a novel set of building materials, two novel teachers and two novel settings.

Data collection

Data were collected on the following dependent variables throughout the duration of the study during baseline, training and probe sessions: the number of pieces placed differently, the percentage of different forms and the cumulative number of different forms across sessions. Photographs were taken of each form and stored on the laptop computer. Photographs of all forms completed within a session were displayed on the computer monitor during the session. The inter-observers used the computer monitor display to compare current forms to forms built previously within the same session, to determine whether the current form differed from other forms created within that session.

Data were also collected on the procedures used during baseline and treatment including: the correct use of instructions, the correct use of prompting (manual guidance and modeling), the accurate delivery of tokens, the use of behavior-specific praise, and the use of response interruption. Data were also collected during token delivery for appropriate sitting, presentation of the correct materials on each trial and correct placement of materials on each trial.

Procedure

General Procedure. Fifteen trials were conducted per session; each session lasted approximately 15 minutes. During each session, 10 baseline or training trials were conducted and 5 probe trials were conducted. Each material was presented in a block of 5 trials before another material was presented. Probe trials were not interspersed with training trials. During each trial, the participant was seated next to the teacher. The teacher then placed the play materials on the table in front of the participant. Initial

placement of the materials was identical for each trial. For example, the teacher placed the rectangle Legos™ on the table lengthwise next to one another and the pink squares were placed directly behind the rectangles and then the V shape Legos™ were placed inverted directly behind each pink square. Each set of materials had its own initial placement as shown in Appendix B. Three sets of materials were used during each session (2 sets training materials and 1 set of probe material). A controlled-randomization procedure was used for material-presentation order per session. The order in which the three different sets of material were presented in each session was randomized. The same sequence and ordinal placement of the materials was never repeated in two consecutive sessions. For example, if during session 1 the presentation sequence of the materials was: Legos™, wooden blocks, and then Interstars™, then during the next session, the order of the material presentation might be Interstars™, Bristle blocks™, and then Legos™. At the beginning of each session, the teacher told the participant to build, using all of the materials on the table (i.e., "Use all the (name of material) when you build."). The participant then began to engage with the building materials. If the participant did not use all 6 pieces of the play materials within a one-minute period, the teacher provided a prompt to him/her to continue building, using a least to most prompting method. The teacher first verbally reminded the participant to "Use all of the (name of material)." If the participant did not resume creating the form the teacher then used a gestural prompt by pointing to the materials and if the participant still did not resume creating a form, the teacher used hand-over-hand manual guidance to physically prompt the participant's hand onto the play materials. Each trial continued

until the participant either used all 6 pieces of the play material or until a total of 3 minutes had elapsed, at which point the trial ended. The duration of building a form did not exceed the 3- minute time allotted per trial for any of the participants. A mean building duration for each participant during his/her last baseline session prior to intervention is indicated in Table 1. At the end of each session the participant exchanged his/her tokens for a backup reinforcer (a pre-selected reinforcer).

Baseline sessions. Baseline sessions included two types of trials: baseline trials and probe trials. The procedure used during baseline and probe trials was exactly the same. For each participant, three materials were assigned to baseline trials and 1 was assigned to probe trials. As shown in Table 2, assignment of materials to baseline and probe trials differed across participants, as each of the participants was assigned a different material for use on probe trials. During baseline sessions, one token was provided per trial contingent upon appropriate behavior such as sitting. Tokens were provided during the trial, but not within 5-10 seconds of the completion of a form, to avoid inadvertently reinforcing the creation of a different form. The teacher provided a behavior-specific praise statement with the presentation of each token such as, "that's nice sitting." The participant had the opportunity to receive a total of 15 tokens for appropriate sitting during each session. At the end of each baseline session the participant exchanged the tokens for a reinforcer (i.e., playtime).

Treatment sessions. Treatment sessions included two types of trials: training trials and probe trials. The materials assigned to baseline trials during the baseline phase were assigned to training trials in this phase. During training trials, token delivery paired

with behavior-specific-praise was contingent upon the creation of different forms and was provided at the end of each trial. The teacher provided tokens and behavior-specific praise contingent upon every first appearance of a form within a session. Tokens and behavior-specific praise were not provided contingent upon subsequent appearances of the same form within a session. The content of the teacher's descriptive praise was directly related to the behavior of the participant (e.g., "that's nice, that's different").

During the first two treatment sessions, tokens were provided for appropriate sitting during the trial and the instruction to "Use all the _____ when you build." was used. If the participant did build something different, a token was provided contingent upon that response and behavior-specific praise was provided (e.g., "Wow, that's different"). If the participant did not build a different form, token reinforcement was not provided for building different. During all subsequent sessions of this phase, a treatment package was implemented that included specific instructions to build different forms, reinforcement for building different forms, prompting (manual guidance and modeling) and response interruption. These procedures, which are described in the following paragraphs, were used during training trials, but not during probe trials.

Instructions. Instructions were presented at the onset of each trial (e.g., "Use all the (name of material) when you build. Build something different.").

Reinforcement. Behavior-specific praise and tokens were provided contingent upon the different placement or rotation of three or more building materials within a trial. Tokens were provided within 3 seconds of completion of a different structure. Behavior specific praise was paired with token delivery and was specific to building something

different (e.g., "Wow, that's different."). Eight tokens were available per session and were traded for a back up reinforcer indicated on a token menu that was included on the token board. Dependent on the number of tokens received, the participant was able to access different reinforcers. Reinforcers were selected through the use of teacher interview, student observation and a forced-choice preference assessment.

During probe trials, tokens were provided only one time during each trial, contingent upon appropriate sitting behavior. Tokens were not presented within 5-10 seconds of the completion of a form.

Prompting was provided using a most-to-least prompting hierarchy and was faded out according to the criteria listed in Appendix C. Three levels of prompting were used. Level 1 was a full physical prompt, level 2 was a faded physical prompt and level 3 was a model prompt. Once prompting (i.e., modeling) was faded, only response interruption was used. Prompting (manual guidance and modeling) was provided only during trials 2-4 for each material during a session. For John, all 3 levels of prompting were used (i.e., full and faded physical prompting and modeling) and faded out during training. For Jeff and Katie, only the level 3 prompting (i.e., modeling) was used. The decision to use only level 3 prompting with Jeff and Katie was based on the slow skill acquisition exhibited by John after the implementation of treatment. It was speculated that the full and faded physical prompts actually may have hindered John's independent responding. It is possible that prompts came to function as discriminative stimuli and that John's responding was therefore dependent upon the prompt. To avoid this problem with Jeff and Katie, a visual prompt that required attending to the materials was used and the full

and faded physical prompts were not used.

Response interruption. Response interruption consisted of the teacher interrupting an incorrect response by separating the building pieces and placing them back in their original placement, and starting the trial over. Response interruption was implemented after the 3 levels of prompting were completely faded. During response interruption, if the participant began building the same structure as s/he had on a previous trial within the same session, the teacher interrupted the response by separating the building materials and placing them again in their initial placement on the table in front of the participant. Response interruption was implemented after the first two building pieces were placed in the same position as they had been on a previous trial within the same session. If response interruption was used two times consecutively on the same trial, the prior level of prompting (i.e., a model prompt) was then used. Response interruption continued to be applied throughout treatment any time that an incorrect response occurred.

Pre-and Post-Intervention Sessions. Five pre- and post-intervention sessions were conducted in two settings (a classroom and a recreation setting) that were not used during baseline or training sessions, with two teachers who did not conduct any baseline or training sessions. Magna Tiles ™ (a material not used during baseline or training sessions) were used during all of these sessions. For John and Jeff the first two pre- and post-intervention sessions were conducted in one setting with one novel teacher and the final 3 sessions were conducted in a different setting with a different teacher. For Katie, the first 3 sessions were conducted in one setting with one novel teacher and the final 2

sessions were conducted in a different setting with a different teacher. Specific assignments to locations and novel teachers are listed in Table 3. During the pre-test sessions, the participant was presented with Magna Tiles ™ and was told to "Use all of the shapes." Different from baseline and training sessions during which building pieces were always placed in the same location across trials, Magna Tiles ™ were placed unsystematically on the table in front of the participant during pre-test and post-test sessions. During pre- and post-test session, tokens were provided contingent upon appropriate sitting behavior. Tokens were provided during the construction of a form and tokens were not presented within 5-10 seconds of the completion of a form to avoid inadvertently reinforcing the completed construction of a different form. The teacher provided a behavior-specific praise statement with the presentation of each token such as "that's nice sitting." Each participant was able to earn a total of 5 tokens during pre-test and post-test sessions. At the end of each pre-test session the participant exchanged the tokens for a reinforcer.

Normative Data

Normative data were collected by observing the building behavior of two typical peers, using all of the building materials presented in the study. Amy and Mark, who were both 8 years old, were selected to provide normative data from a male and female child of nearly the same age as the participants with autism. During these sessions, the same procedure was followed that was followed during baseline sessions with the participants with autism. The participant was seated next to the teacher and was presented with an instruction to "Use all of the (material name) when you build." Neither

tokens not behavior-specific praise were provided at any time during the sessions as the objective was to obtain a level of responding that was indicative of typically developing peers behavior in the absence of reinforcement. During these sessions, data were obtained on the number of pieces independently placed differently per session.

Social Validity Measure

To assess social validity of the behavior change, two regular education teachers were presented with 4 sets of 10 randomly selected photographs for a given participant. For each set, 5 photographs were from a baseline session and 5 were from a training session. Random selection of photographs was accomplished by means of a table of random numbers. Photographs depicting forms created during baseline sessions were selected from all baseline sessions. Photographs depicting forms created during treatment were selected from only those sessions during which no prompting (manual guidance or modeling) was provided to the participant. Table 4 shows the specific session numbers selected for this measure for each participant. The experimenter asked each regular education teacher independently to compare the photographs in each set and select the set that appeared to be more "creative". The experimenter told the regular education teacher to "Please look at the two sets of photographs (set A and set B) and tell me which set of structures you think is more creative. Indicate either set A or set B". When the regular education teacher indicated which set was more creative it was recorded as either set A or set B for each set. The percentage of photographs depicting structures built during treatment that were selected as creative by each teacher was calculated for each session and participant.

A second measure of social validity was produced by comparing the number of pieces independently placed differently by the participants with autism to their age-matched peers (as determined through the normative levels of creative responding recorded).

Data Analysis

During all experimental sessions, data were collected on the number of pieces independently placed differently, the percentage of different forms built within a session and the cumulative number of different forms built across sessions.

The number of building pieces independently placed differently was determined by recording the number of pieces that were independently placed differently on each trial during a session. If a prompt was provided for the first building piece and the participant then placed 5 pieces independently and placed them in a different location, the number of pieces recorded as having been moved independently would be recorded as 5. The first trial with each set of materials was not included as there was no prior form to compare it to within the session. To ensure accurate measurement of the number of pieces moved or a different form within a session, a digital photograph was taken of each construction. The photograph was then stored on the laptop computer so the photograph could be then be viewed immediately on the screen along with photographs of structures from previous trials within the same session. This allowed for comparison of the current form to a form that was created previously within the same session. To ensure accurate measurement of different forms across sessions, the experimenter printed out a copy of each form that was recorded during the session for comparison purposes.

The percentage of different forms was calculated by dividing the number of different forms that were created without prompting (manual guidance or modeling) by the total number of opportunities to build a different form per session. For example, given that there were 8 possible training trials per session, if the participant built 4 different forms, then 50% of her forms for that session would have been scored as different. A different form was scored by observing the forms as they were constructed as well as by using the computer monitor to view the forms built previously within that session.

The cumulative number of forms across sessions was determined by recording the number of independently built forms that had never been built previously. When prompting (manual guidance or modeling) or response interruption was used during a trial, the resulting form was not scored as a different form because it was not built independently. For purposes of data analysis, it was not necessary to eliminate the first trial in each session for each set of building materials, as it was possible to compare a given form to the forms built during prior sessions. Therefore, the cumulative number of different forms across sessions was measured during all 10 trials during baseline and training sessions and during all 5 trials during probe trials.

Data were collected also on the number of times instructions, prompting (manual guidance or modeling) (manual guidance and modeling), reinforcement (tokens and behavior-specific praise) and response interruption were used. During pre-test and post-test sessions data were recorded on the number of pieces independently placed differently within each session.

For the social validity measure, data were recorded as a percentage of photographs (depicting forms built during treatment) selected as more creative as determined by two regular education teachers. In addition, the selections made by the two regular education teachers who evaluated the photographs were compared to obtain an inter-observer agreement measure of creative structures.

Inter-observer agreement

Prior to the onset of the study, observers practiced scoring different forms and number of pieces moved per structure. Two independent observers scored pairs of photographs of forms as being different or not different from each other, as well as indicating the number of pieces moved per structure. The independent observers practiced until they achieved a minimal level of 80% inter-observer agreement across two days. The level of inter-observer agreement was calculated by dividing the number of agreements by the number of agreements plus the number of disagreements and multiplying it by 100.

Inter-observer agreement (IOA) data were obtained from two independent observers during a minimum of 50% of sessions under each experimental condition. As seen in Table 5, measures of inter-observer agreement were obtained for the number of pieces moved, the cumulative number of different forms built across sessions, the percentage of not different forms built within a session and the percentage of different forms built within a session. Inter-observer agreement data were also recorded on the accuracy of the presentation of the instructions, prompting (manual guidance or modeling) and on the use of behavior-specific praise, and token delivery for pieces

placed differently or for different forms (see Table 6). Inter-observer agreement data were recorded on the implementation of the remaining procedural variables: the use of behavior-specific praise for sitting, the accuracy of the materials used on each trial and the accuracy of the placement of the materials on each trial (see Table 7). Inter-observer agreement data were recorded on the number of pieces independently placed differentlywithin session and across sessions. Photographs were taken to aid the observers. Two independent observers compared the photographs to the photographs from all of the previous sessions to determine if a different form across sessions had occurred. It was expected that using the photographs would produce higher rates of inter-observer agreement than attempting to score them only in-vivo as the permanent products would be available for more lengthy review. Inter-observer agreement was calculated for all dependent measures for at least 50% of the sessions for each participant. Mean percentage on inter-observer agreement for each participant across all experimental sessions can be seen in Table 5. In Table 5, a dashed line indicates that there was no opportunity to obtain inter-observer agreement data (e.g., a different form did not occur during baseline, therefore inter-observer agreement data was not obtained on a percentage different measure during baseline). The mean percentage of inter-observer agreement for number of pieces moved was 99% and ranged from 96% to 100% across participants. The mean percentage of inter-observer agreement for cumulative number of different forms across sessions was 99.75% and ranged from 97% to 100%. The mean percentage of inter-observer agreement for percentage of not different forms was 98% and ranged from 83%-100%. The mean percentage for baseline/training trials

was 96% and 99% for probe trials throughout the duration of the study across all participants. For percentage of different forms, the mean percentage of inter-observer agreement was 92% and ranged from 67% to 100%. The mean percentage for baseline/training trials was 93% and 91% for probe trials throughout the duration of the study across all participants. The mean percentage of inter-observer agreement for pre-test and post-test sessions was 100% for number of pieces moved and for percentage of not different forms and percentage of different forms within session.

Procedural reliability measures

To assess reliability of the implementation of the independent variables, the following variables were measured for accuracy: a) the presentation of the instruction to the participant, b) the use of prompting (manual guidance and modeling), c) the delivery of a token for creative responding, e) the use of behavior-specific praise, f) the use of materials and g) the placement of materials at the onset of each trial. These data are presented in Tables 8 and 9.

Table 8 shows the percentage of trials during which components of the treatment package were applied correctly: the use of instructions, the accurate use of prompts, the delivery of tokens contingent upon correct responding and the delivery of behavior-specific praise contingent upon creative responding. Data are presented on baseline, training and probe trials as well as responding during pre and post-intervention sessions. Table 9 shows the percentage of trials during which tokens were provided contingent upon appropriate sitting behavior for each participant, accurate materials were presented and material placement was accurate. Data are presented for baseline, training and probe

trials as well as during pre-test and post-test sessions.

Results

Overall, creative building behavior increased systematically with the introduction of treatment for all three participants. There was a systematic increase in the number of building pieces independently placed differently across participants. More detailed results are provided for each of the following six measures: a) the total number of building pieces independently placed differently within session, b) the percentage of different forms within session c) the cumulative frequency of different forms across sessions, d) responding during probe trials, e) the pre and post-intervention sessions represented as a total number of building pieces independently placed differently and f) social validity data.

Total number of building pieces independently placed differently

As can be seen in Figure 1, there was a systematic increase from baseline to treatment in the number of pieces placed differently during training trials. The y-axis indicates the number of pieces placed differently, and the x-axis indicates sessions. A total of 6 pieces could be moved per trial. There were 15 trials per session. Ten trials were either baseline or training trials and five trials were probe trials. However only eight of the ten trials were scored for the number of building pieces independently placed differently, as the first trial for each material could not be included. Six pieces of building materials were used and could be placed differently during the 8 trials, therefore a maximum of 48 building pieces could be placed differently during baseline or training trials. The arrows labeled 1, 2 and 3, in Figure 1, indicate the session during which each

prompt fading level was faded out (see Appendix C). For John, prompt levels 1,2 and 3 are indicated, whereas for Jeff and Katie only level 3 is indicated. The horizontal line indicates the mean number of building pieces placed independently by the typically developing peers.

During baseline, John's mean number of building pieces independently placed was 1.6 for baseline trials. The mean number of building pieces placed independently during the 2 training sessions prior to introduction of the treatment package (reinforcement only) was 2.After introduction of the treatment package consisting of instructions, prompting (manual guidance and modeling), reinforcement and response interruption, the mean number of building pieces placed independently increased to 28.6. During baseline, Jeff's mean number of building pieces independently placed was 4.2 for training trials. The mean number of building pieces placed independently during the reinforcement only phase of training was 9 for training trials. After introduction of the treatment package, the mean number of building pieces independently placed increased to 29.5 during training trials and 3.4 during probe trials. The increase from baseline to training during probe trials was inconsistent for Jeff; there was a slight increase in responding during sessions 33-35, but responding then decreased again to near zero levels. Another increase up to session 47 was followed by a decrease and another increase. Katie's mean number of independently placed pieces during baseline was 0.5. During the reinforcement only phase, Katie did not independently placed any pieces during training and probe trials. After introduction of the treatment package, Katie's mean number of building pieces placed independently increased to 36.60 during training

trials. Katie's responding increased rapidly from baseline to training upon introduction of the treatment package.

The percentage of different forms within session

Figure 2 indicates that the percentage of different forms per session increased from baseline to training for both training and probe trials across participants. Presented on the y-axis is the percentage of trials during which each participant created a different form within each session. The percentage of different forms indicates the percentage of trials in which an entire structure was built in the absence of prompting (manual guidance or modeling) or response interruption and resulted in a different form defined as the different rotation or placement of a minimum of three building pieces. The arrows labeled 1, 2 and 3, in Figure 2, indicate the session during which each prompt fading level was faded. For John arrows 1,2 and 3 are indicated, whereas for Jeff and Katie only arrow 3 is indicated.

During baseline John built a different form during a mean of 3.57% of the baseline trials with a range of 0%-25%.John's responding increased during treatment to a mean of 35.53% during training trials with a range of 0%-100%.

During baseline, Jeff's percentage of different forms was a mean of 8.17% during baseline trials with a range of 0%-25%. During treatment, Jeff's percentage of different forms increased to a mean of 54.32% during training trials with a range of 0%-100%.

For Katie, responding increased from a mean of 0.69% with a range of 0%-12.5% during baseline trials to a mean of 64.16% with a range of 0%-100% during training trials.

Cumulative number of different forms across sessions

Figure 3 shows the cumulative number of different forms across sessions produced by each participant during baseline and training and probe trials. The cumulative number of different forms was measured to determine if different forms would be produced across sessions in the absence of direct reinforcement for this response. The arrows labeled 1, 2 and 3 indicate the session during which the prompt level was faded. For John arrows 1, 2 and 3 are indicated, whereas for Jeff and Katie only arrow 3 is indicated. As can be seen in Figure 3, there was an increase in the cumulative number of different forms across sessions for all participants. For each participant, the rate of producing different forms was higher after implementation of the treatment package. No different forms across sessions were produced during the reinforcement only phase for the 3 participants. The cumulative number of different forms produced during training trials by John, Jeff, and Katie were 88, 73, and 56, respectively. For the cumulative number of different forms the first trial within each set of trials was included as each form was compared to all of the forms built previously within the study (across all prior sessions). The number of different forms built (across sessions) during the first trial within a session for each set of materials can be seen in Table 10.

Creative responding during probe trials

After implementation of the treatment package, there was a systematic increase in responding during probe trials across all participants (see Figure 1). During the 5 probe trials conducted per session, 4 trials could be scored with 6 pieces of building materials each trial, therefore a maximum of 24 pieces could be placed differently.

During baseline, John's mean number of building pieces independently placed differently during probe trials was 2 with a range of 0-4. The mean number of building pieces placed independently during the 2 training sessions prior to introduction of the treatment package (reinforcement only) was .5 for probe trials. Responding increased to 4.2 with a range of 0-18 after the implementation of the treatment package. During probe trials, the increase from baseline to treatment ultimately showed a stable level that exceeded the baseline level.

During probe trials, Jeff's number of building pieces that he independently placed differently increased from a mean of 0 to a mean of 3.4 with a range of 0-15 after treatment was implemented. Jeff did not place any pieces differently during the reinforcement only phase.

For Katie, responding increased from a mean of 0.16 with a range of 0-6 building pieces independently placed differently during baseline to a mean number of 10.13 with a range of 0-22 after treatment was introduced. Katie did not place any pieces differently during the reinforcement only phase during probe trials.

As can be seen in Figure 2, there was a systematic increase in the percentage of different forms across all participants during probe trials. The percentage of different forms was calculated by dividing the number of trials during which a different form was created by the total number of opportunities to build a different form.

During baseline, John built a different form during a mean of 3.57% of the probe trials with a range of 0%- 25%. John's responding increased to a mean percentage of 16.76 and a range of 0%-100% after implementation of the treatment package.

Jeff's percentage of different forms during probe trials increased from a mean of 0% during baseline to a mean of 13% during treatment with a range of 0%-75%.

For Katie, responding during probe trials increased from a mean of 0.69% with a range of 0%-25% during baseline to a mean of 41.66% with a range of 0%-100% during training.

As can be seen in Figure 3, cumulative responding occurred throughout the duration of the study across all 3 participants. Cumulative different forms were recorded by recording a new form each time it occurred throughout the study. No different forms across sessions were produced during the reinforcement only phase for the 3 participants. The cumulative number of different forms produced during probe trials by John, Jeff, and Katie were 25, 15 and 20 respectively. For the cumulative number of different forms the first trial within each set of trials was included as each form was compared to all of the forms built previously within the study (across all prior sessions). The number of different forms built (across sessions) during the first trial within a session for each set of materials can be seen in Table 10.

Pre and post-intervention sessions

Figure 4 shows the total number of building pieces independently placed differently during pre and post-test sessions for all three participants. The pre-tests and post-tests were conducted to determine the extent to which building behavior that occurred during training would occur in the in the presence of two novel teachers, two novel settings and a novel set of building materials. As seen in Figure 4, responding increased from pre-test to post-test for all 3 participants. For John responding increased

from a mean of 0 during the pre-test sessions to a mean of 15 and a range of 10-18 pieces placed differently during the post-test. Jeff's responding showed the smallest increase, with an increase from a mean of 0 during the pre-test sessions to a mean of 6 during the post- test with a range of 2-8 pieces placed differently. Katie's responding showed the most dramatic increase from pre-test to post-test. Katie placed a mean of 2 pieces differently during the pre–test with a range of 0-6, and she placed a mean of 22 pieces differently during the post-test sessions with a range of 20-24.

Social validity measure

In order to measure social validity, two regular education teachers were independently asked to compare two sets of photographs (depicting forms built during baseline and training) and select the set that appeared to be more "creative". The percentage of treatment photographs that were selected as creative by each teacher was calculated for each session and participant. As seen in Table 11, both Teacher 1 and Teacher 2 chose the photographs depicting forms built during treatment during a mean of 92% of the trials across participants. More specifically, they selected photographs depicting forms created during training sessions during 75% of the trials for John, and 100% of the trials for Jeff and Katie. The agreement measure calculated across the responses of the two regular education teachers showed 100% agreement across all participants.

The second social validity measure was a comparison of performance of the participants with autism to their age-matched peers. The horizontal line in Figure 1, indicates that the normative mean level for the number of pieces independently placed

was 40. Although John's average number of pieces placed differently fell below the normative mean, during treatment John did place 40 or more pieces differently during 3 sessions, specifically sessions 31, 42 and 47. Jeff's average number of pieces placed differently fell below the normative mean and he did place 40 or more pieces differently during one session in treatment session 51. For Katie, the mean number of building pieces also falls below the mean normative number placed differently, however she did place 40 or more pieces differently during 5 treatment sessions.

Discussion

The purpose of the present study was to determine the extent to which a treatment package consisting of instructions to build something different, prompting (manual guidance and modeling), token reinforcement contingent upon building something different, behavior-specific praise and response interruption would result in an increase in the creative building behavior of children with autism. This study extended Goetz and Baer's (1973) similar study in six ways: a) children with autism served as subjects rather than typically developing children; b) a treatment package was used consisting of instructions, prompting (manual guidance and modeling), token reinforcement, behavior-specific praise and response interruption; c) generalization was assessed from the play materials, used during training to different play materials during probe trials; d) normative data collected by observing the behavior of typical children were used as a basis of comparison ; e) social validity data were obtained by having regular education teachers review randomly selected photographs depicting baseline and training sessions and by comparing the building behavior of participants with autism to those of their

typical peers; and f) pre and post-test sessions were conducted using untrained materials, two novel settings and two novel teachers

The present study resulted in a number of important findings. The participants with autism built very few different forms during baseline sessions when building a different form did not result in reinforcement. This finding supports Boucher's 1977 study that indicated that children with autism did not vary their responding to the same degree as their typical peers in the absence of response-contingent reinforcement. Boucher found that children with autism did not vary their responding from trial to trial as compared to the behavior of typical peers and more often chose the same maze of the arm repeatedly. In the current study, children with autism did not vary their building behavior when compared to their age-matched peers, in the absence of the treatment package.

When the treatment package was introduced, creative responding increased systematically across all participants. These findings are consistent with those of Goetz and Baer (1973) who showed that when reinforcement was provided contingent upon creative building behavior, creative building behavior increased in frequency. Neuringer & Miller (2000) demonstrated similarly that children with autism varied their responding when reinforcement was provided for this response. In the current study, reinforcement was only one component of a treatment package; therefore, it is not possible to determine the extent to which reinforcement controlled the building behavior of each of the participants. If however, the reinforcement only phase had been carried out longer this may have provided valuable information. This would have been most important for Jeff

whose behavior did increase slightly during the reinforcement only phase. Nonetheless, it is important to know that creative responding was increased in the participants with autism using a treatment package that included reinforcement contingent upon creative responding. It is likely that reinforcement would have been insufficient to increase creative responding in these participants, as their low level of producing different forms during baseline would have resulted in minimal opportunity to contact the reinforcement contingency. It is unlikely that instructions alone would have controlled the participants' creative responding as the participants did not appear to have a creative building response in their repertoire. Rather, the participants apparently needed to be shown what "different" was through the use of prompting (manual guidance and modeling), prior to emitting different responses. It is also possible that the specific prompting strategy used affected skill acquisition as well. For John, three prompt levels were used and faded out throughout training (i.e., full and faded physical prompts and modeling), whereas for Jeff and Katie only level 3 prompting was used (i.e., modeling). There appears to be a difference in the skill acquisition exhibited by John as compared to that of Jeff and Katie after the implementation of the treatment package. John's skill acquisition was gradual, whereas for Jeff and Katie there was a much more rapid increase in responding upon the implementation of the treatment package. It is therefore possible that the difference between participants' responding upon implementation of the treatment package may be related to the type of prompting strategy used. A possible basis for this effect is that physical guidance may have acquired a discriminative stimulus function for John, resulting in prompt-dependency. This effect would have been minimized for Jeff and

Katie, who received only modeled prompts that directed their attention to the building material.

The present study used probe trials to assess generalization from the original building materials to untrained materials never associated with reinforcement. It was found that responding did increase during probe trials, although acquisition was gradual and did not occur immediately upon the implementation of treatment. There are a number of possible bases for the increase in responding during probe trials. First, the materials used during probe trials were similar to those used during training trials in that they were all building materials and required similar response topographies, such as stacking. Second, mediating stimuli or functional mediators may have assisted in the generalization from the original training materials to the probe materials (Stokes & Baer, 1977). Mediating stimuli are stimuli that are present during training and present during generalization and may enhance the likelihood that generalization will occur. Mediating stimuli that were present during both training and probe trials in the present study would include stimuli such as, the stimuli (e.g., tables, chairs) in the setting in which the trials took place, the teacher who presented the instructions and reinforcement during training trials, and the token board used for appropriate sitting behavior. In addition, the probe trials were conducted during the same session as the training trials. Prior research has indicated that the more similar the probe materials are to the training materials the more likely that generalization from training trials to probe trials would be achieved. In particular Holman, Goetz and Baer (1977) showed that responding would generalize from felt pen drawing to easel painting, but did not generalize to Legos™ or

wooden block building. The current study supports the findings that generalization occurs to materials that are more similar to one another and require a similar response topography.

Unlike the present study, Holman, Goetz and Baer (1977) found that even when one participant received reinforcement for creating a different form with Legos™, generalization still did not occur from building with Legos™ to building with wooden blocks. The contrasting finding of the current study may be attributable to the use of multiple exemplars in this, but not Holman, Goetz and Baer's study (Hughes, Harmer, Killian, & Niarhos (1995). The present study used four exemplars throughout the duration of the study, whereas, Holman, Goetz and Baer (1977) originally used a felt pen and reinforced creative drawing and attempted to generalize responding to wooden blocks. It was only after generalization did not occur in the presence of the wooden blocks that they then provided reinforcement for building creatively with Legos™ to promote generalization of creative building with wooden blocks.

A significant finding of the present study is that different forms continued to emerge throughout training, as shown by cumulative frequency of different forms across sessions. As children with autism are typically described as behaving in a rote or ritualistic manner, it was expected that the participants might alternate between two forms within sessions, a strategy that would lead to reinforcement at least once per session. Alternately, it was possible that participants would alternate among five forms during each session, thereby earning more reinforcers, but would not continue to add different forms to their repertoire across sessions, as there was no contingency for doing

so. In the present study different forms did emerge across sessions throughout the duration of the study.

The pre and post-intervention measure used in the present study showed that responding increased from pre-test to post-test for all participants. There were zero or near zero levels of creative responding during the pre-test for all 3 participants, followed by an increase in responding during the post-test. Responding during the post-test was more similar to responding observed at the end of training for John and Katie. Jeff's responding did increase from pre-test to post-test although the increase was not as substantial. This finding is important because during the pre and post-intervention sessions, performance was assessed using an untrained set of materials, two novel settings and two novel teachers. It is quite remarkable that the participants with autism responded creatively during the post-test, given the number of variables (settings, materials and teachers) that were changed from pre-test to post-test.

Social validity data collected during the present study showed that regular education teachers identified photographs depicting forms built during training sessions versus baseline sessions 92% of the time as more creative.

The comparison of the building behavior of participants with autism to that of their typical peers also indicated social validity of the present results. Previous studies have used behavioral observation normative data as a standard for evaluating the practicality of treatment effects produced by a particular intervention (Walker & Hops 1976; Van den Pol, Iwata, Ivancic, Page, Neef, & Whitley, 1981). In the present study, after implementation of the treatment package, the participants with autism engaged in

responding that was similar to that of the typically developing peers (in the absence of the treatment package). Level of creative behavior was generally lower for the participants with autism; however, it did reach the normative mean level on some occasions.

A future extension of the current research might address several questions, including determination of the treatment components that are necessary and sufficient to increase creative responding and generalization of this response. For example, it would have been interesting to determine if response interruption alone would have been sufficient for the participants to build differently.

In addition, the effect of instructions might be further evaluated in relation to behavioral variability or creativity. It is possible that by simply instructing someone to be more creative, s/he might behave more creatively. However, use of instruction without additional procedures may not be an effective treatment for children with autism, whose repertoire may not include the response being requested, and who therefore, might not have the skill to behave as instructed. For children with autism, instruction in conjunction with reinforcement or prompting would potentially have a greater effect on responding as in the present study. However, if further research attempted to use the procedures set forth in the current study with a different population, the use of instructions might have a large impact on behavior. For example in a typical preschool classroom if an instruction was given to build all different structures, it is likely that the children would vary their building behavior. Similarly, if the instruction was to build the same structure each time, it is likely that the children would also follow that rule.

In relation to contingency-shaped behavior it is possible that typically developing peers would respond to reinforcement alone for creative behavior, or even for non-creative behavior. This was demonstrated with preschool children in Goetz and Baer's 1973 study in which they showed that reinforcement alone in the form of behavior-specific praise was enough to control creative and non-creative responding.

In conclusion, it is clear that there is a need for continued research in the area of behavioral variability. Research should continue to examine specific procedures that may be useful in increasing variable responding in all organisms so that these procedures may continue to be applied to specific populations who may engage in less variable behavior than their typical peers without the application of intervention. Such intervention may be helpful not only to individuals with autism who often exhibit less variable levels of responding in the absence of reinforcement (Miller & Neuringer, 2000), but to other individuals who may exhibit deficient levels of variable responding, such as individuals with mild depression (Hopkinson & Neuringer, 2003).

Table 1

Mean Duration and Duration Range of Building during Last Baseline Session Sampled Prior to Intervention for each Set of Materials for Each Participant. Probe Materials for each Participant are Indicated in Italics

Participant	Building Material	Mean	Range
John	*Interstars*™	24.5 sec	23-26 sec
	Bristle blocks™	17.5 sec	14-21 sec
	Wooden blocks	14.5 sec	13-16 sec
	Legos™	16.5 sec	11-22 sec
Jeff	Interstars™	62 sec	35-90 sec
	Bristle blocks™	80 sec	49-111 sec
	Wooden blocks	27 sec	25-29 sec
	Legos™	24 sec	17-31 sec
Katie	Interstars™	26.5 sec	18-35 sec
	Bristle blocks™	17.5 sec	17-18 sec
	Wooden blocks	35 sec	13-57 sec
	Legos™	14 sec	12-16 sec

Table 2

Assignment of Materials to Baseline, Training and Probe Trials for Each Participant

	Baseline and training Materials				Probe material			
	Wooden blocks	Legos™	Interstars™	Bristle blocks™	Wooden blocks	Legos™	Interstars™	Bristle blocks™
John	X	X		X			X	
Jeff	X		X	X		X		
Katie		X	X	X	X			

Table 3

Assignment of Location for Pre and Post-intervention Sessions for Each Participant

	Pre and post-intervention sessions				
Participant	Session 1	Session 2	Session 3	Session 4	Session 5
John	Classroom Novel teacher 1	Classroom Novel teacher 1	Recreation Novel teacher 2	Recreation Novel teacher 2	Recreation Novel teacher 2
Jeff	Classroom Novel teacher 1	Classroom Novel teacher 1	Recreation Novel teacher 2	Recreation Novel teacher 2	Recreation Novel teacher 2
Katie	Recreation Novel teacher 2	Recreation Novel teacher 2	Recreation Novel teacher 2	Classroom Novel teacher 1	Classroom Novel teacher 1

Table 4

Baseline and Training Sessions Selected for Presentation to Regular Education Teachers to Assess Social Validity

	Sessions							
Participant	Baseline session number				Training session number			
John	1	3	4	6	37	38	47	50
Jeff	3	11	12	20	47	48	50	51
Katie	4	9	13	35	49	50	52	53

Table 5

Mean Percentage of Inter-observer Agreement for Number of Pieces Placed Differently, Cumulative Number of Different Forms across Sessions, Percentage of Not Different and Different Forms within Session during Baseline, Training and Probe Trials for Each Participant and during All Pre-test and Post-test Sessions for Each Participant

		Experimental Condition					
Participant	Response type	Baseline		Treatment		Pre- & Post-Intervention Measures	
		Training	Probe	Training	Probe	Pre-tests	Post-tests
John	Number placed differently	100	100	100	98	100	100
	Cumulative across sessions	100	97	100	100	-	-
	Percentage not different	100	95	96	100	100	100
	Percentage different	100	75	100	89	-	100
Jeff	Number placed differently	100	100	97	97	100	100
	Cumulative across sessions	100	100	100	100	-	-
	Percentage not different	88	100	83	100	-	100
	Percentage different	67	-	96	-	100	100
Katie	Number placed differently	99	100	96	100	100	100
	Cumulative across sessions	100	100	100	100	-	-
	Percentage not different	100	100	100	100	100	100
	Percentage different	-	100	100	100	100	100

Table 6

Mean Percentage of Inter-observer Agreement for Instructions, Use of Prompts, Token Delivery for Different Form, and Behavior-specific Praise during Baseline, Training and Probe Trials for Each Participant and during All Pre-test and Post-test Sessions for Each Participant

		Experimental Condition					
Participant	Response type	Baseline		Treatment		Pre- & Post-Intervention Measures	
		Training	Probe	Training	Probe	Pre-tests	Post-tests
John	Instruction	100	100	99	100	100	100
	Prompt	100	100	99	100	100	100
	Token for different	100	100	98	100	100	100
	Behavior-specific praise	100	100	98	100	100	100
Jeff	Instruction	100	98	98	97	100	100
	Prompt	100	100	95	100	100	100
	Token for different	100	100	97	100	100	100
	Behavior-specific praise	100	100	100	100	100	100
Katie	Instruction	99	100	100	96	100	100
	Prompt	99	100	96	100	100	100
	Token for different	100	100	100	100	100	100
	Behavior-specific praise	100	100	100	100	100	100

Table 7

Mean Percentage of Inter-observer Agreement for Token Delivery for Appropriate Sitting, Use of Correct Materials, and Correct Placement of Materials during Baseline, Training and Probe Trials and during Pre-test and Post-test Sessions for Each Participant

		Experimental Condition					
Participant	Response type	Baseline		Treatment		Pre- & Post-Intervention Measures	
		Training	Probe	Training	Probe	Pre-tests	Post-tests
John	Token-appropriate sitting	100	100	99	96	100	100
	Correct materials	100	100	100	100	100	100
	Correct material placement	100	100	100	100	100	100
Jeff	Token-appropriate sitting	100	100	98	97	100	100
	Correct materials	100	100	98	100	100	100
	Correct material placement	100	100	98	100	100	100
Katie	Token-appropriate sitting	98	100	94	96	100	100
	Correct materials	100	100	100	100	100	100
	Correct material placement	100	100	100	100	100	100

Table 8

Mean Percentage of Trials during which the Instructions, Prompting (manual guidance and modeling), Token Reinforcement and Behavior-Specific Praise were Presented Accurately across Baseline, Training, and Probe Trials and during Pre-Test and Post-Test Trials for All Participants

		Experimental Condition					
Participant	Response type	Baseline		Treatment		Pre- & Post-Intervention Measures	
		Training	Probe	Training	Probe	Pre-tests	Post-tests
John	Instructions	98.50	100	98.60	99.50	100	100
	Prompting	100	100	100	100	100	100
	Token different	100	100	99.72	100	100	100
	Behavior-specific praise	100	100	99.72	100	100	100
Jeff	Instructions	99.23	96.23	100	99.25	100	100
	Prompting	98.46	100	100	100	100	100
	Token different	100	100	100	100	100	100
	Behavior-specific praise	100	100	99.25	99.25	100	100
Katie	Instructions	99.70	100	98.75	95	100	100
	Prompting	100	100	100	100	100	100
	Token different	100	100	100	100	100	100
	Behavior-specific praise	100	100	100	100	100	100

Table 9

Mean Percentage of Trials during which the Token Reinforcement for Appropriate Sitting, Material Use and Placement of Materials were Accurate across Baseline, Training, and Probe Trials and during Pre-Test and Post-Test Trials for All Participants

		Experimental Condition					
Participant	Response type	Baseline		Treatment		Pre- & Post-Intervention Measures	
		Training	Probe	Training	Probe	Pre-tests	Post-tests
John	Token-sitting	95.70	97.14	95	97.60	100	100
	Material	100	100	100	100	100	100
	Material placement	100	100	100	100	100	100
Jeff	Token-sitting	99.23	98.46	98.14	98.51	100	100
	Material	100	100	100	100	100	100
	Material placement	100	100	100	100	100	100
Katie	Token-sitting	98.12	98.30	96.25	98.75	100	100
	Material	100	100	100	100	100	100
	Material placement	100	100	100	100	100	100

Table 10

Number of Different Forms (across sessions) that Occurred during the First Trial (with each material) within a Session

Participant	Baseline trials	Training trials	Probe trials
John	1	17	6
Jeff	2	1	1
Katie	4	2	2

Table 11

Mean Percentage of Trials during which a Regular Education Teacher Selected Photographs Depicting a Set of Forms Created during Treatment as More Creative than the Set Depicting Forms Created during Baseline for Each of the Participants

	Participants			
Teacher	John	Jeff	Katie	Mean Percentage
Teacher 1	75%	100%	100%	92%
Teacher 2	75%	100%	100%	92%

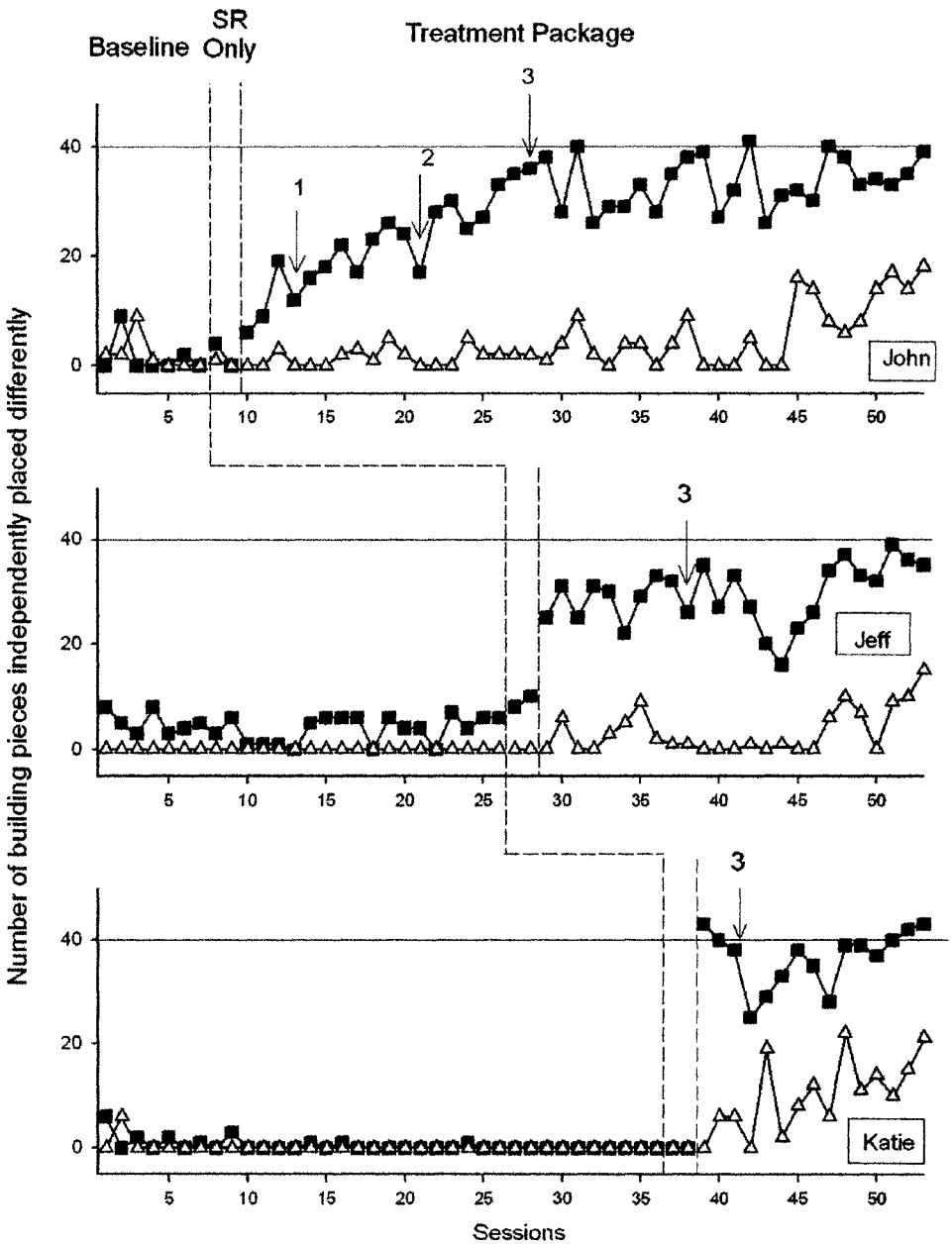


Figure 1. Number of trials in which each participant placed a building material differently within a structure, plotted as a function of sessions. Responding during baseline and training trials is represented by the closed squares and responding during probe trials is represented by the open triangles. Horizontal line indicates normative mean level. The arrows labeled 1, 2 and 3 indicate the session during which each prompt level was faded out.

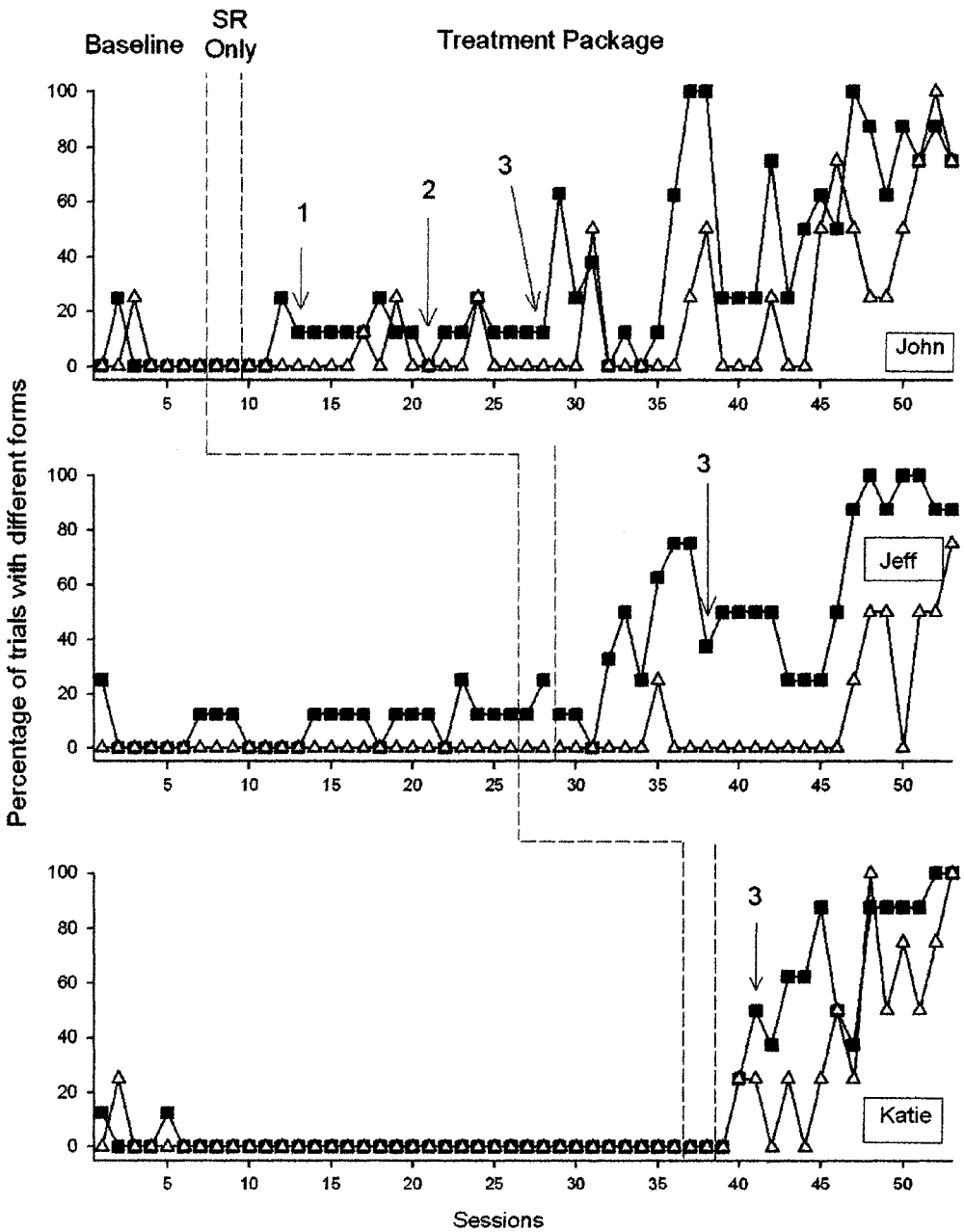


Figure 2. Percentage of trials in which each participant built a different form. Responding during baseline and training trials is represented by the closed squares and responding during probe trials is represented by the open triangles. Arrows labeled 1, 2 and 3 indicate the session during which each prompt level was faded out.

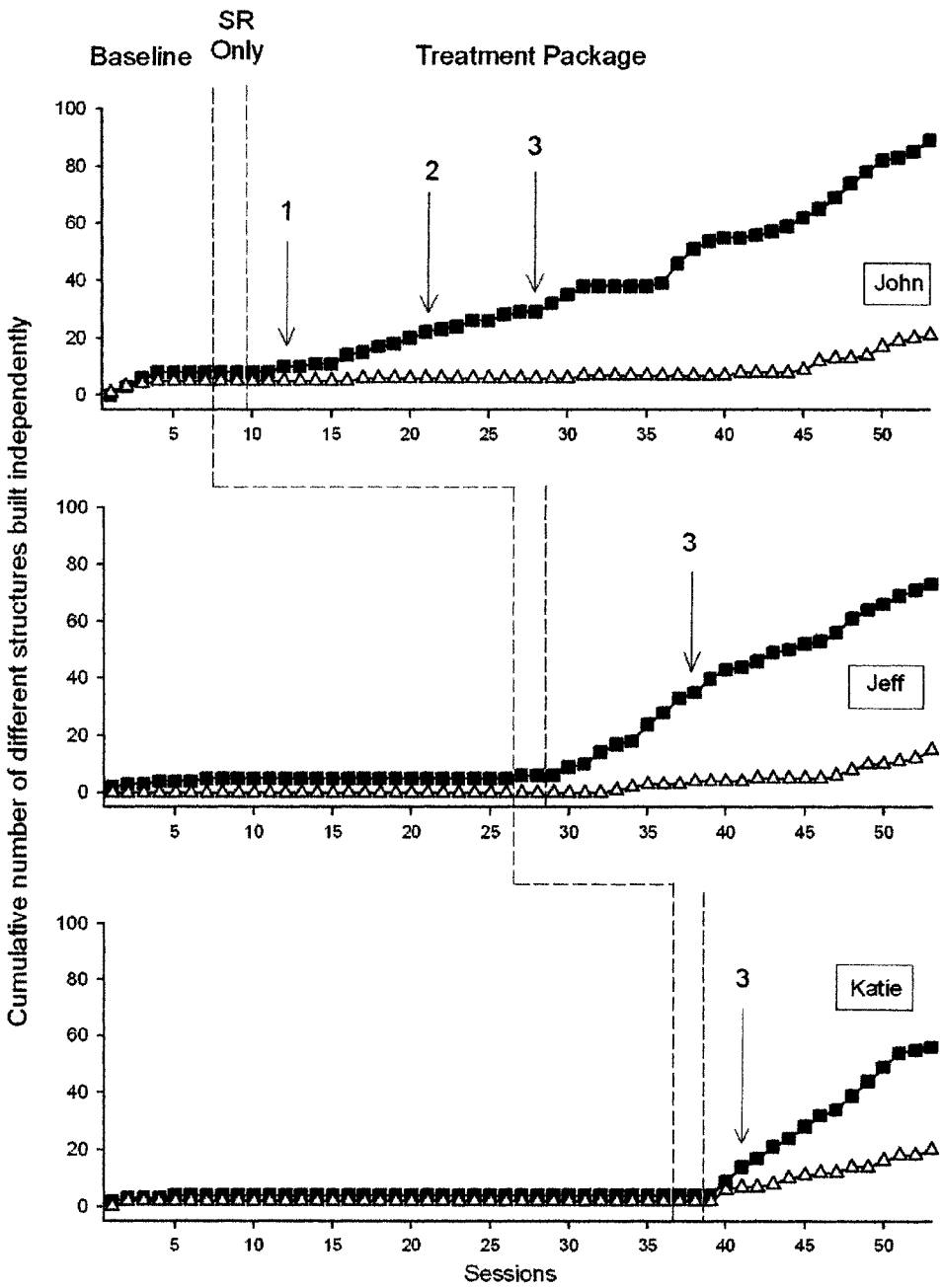


Figure 3. Cumulative number of different forms built across sessions during training and probe trials by John, Jeff and Katie. Closed squares represent training trials and open triangles represent probe trials. The arrows labeled 1, 2 and 3 indicate the session during which each prompt level was faded out.

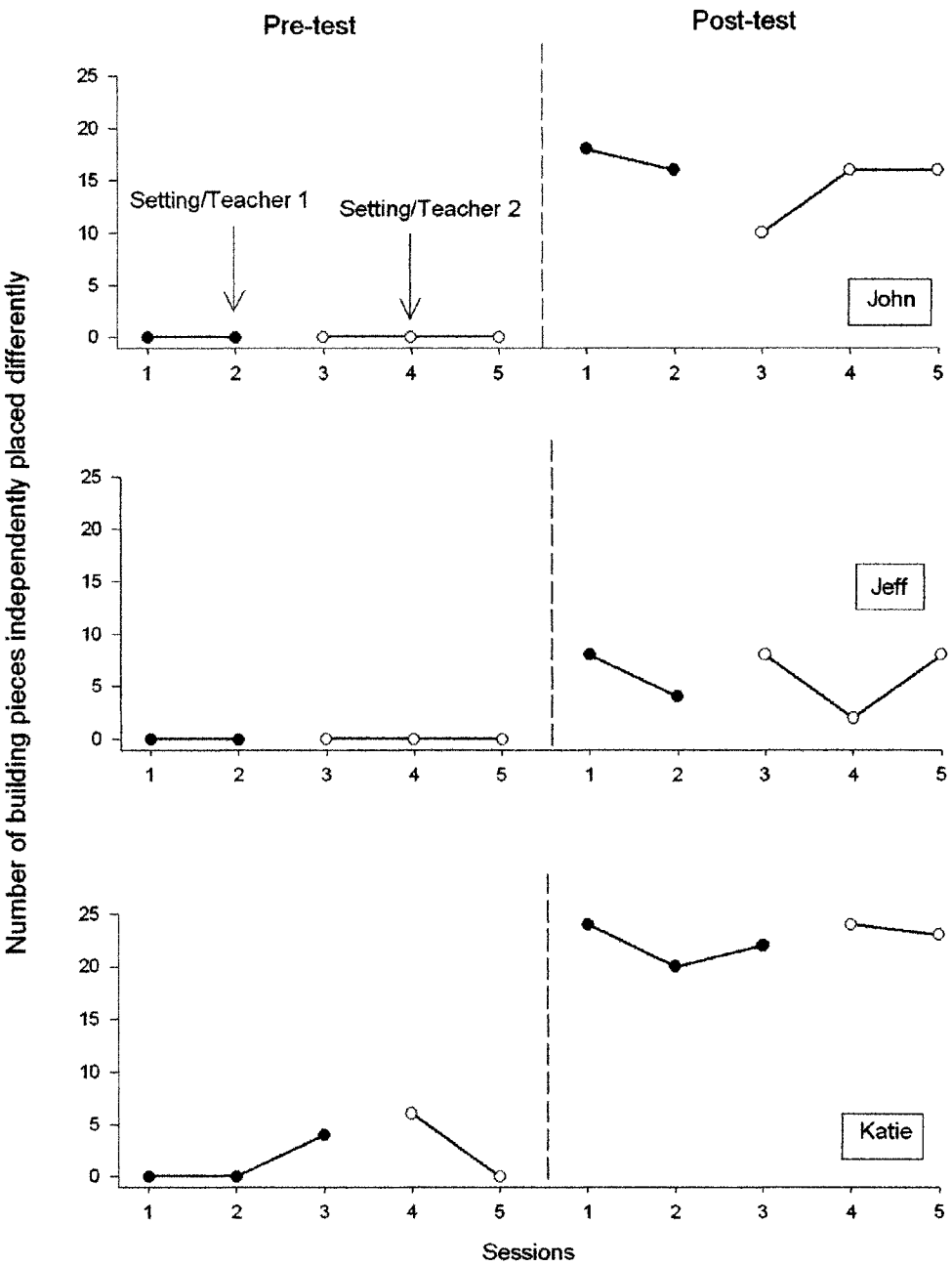


Figure 4. Number of pre-test and post-test trials during which each participant placed a building material differently within a structure, plotted as a function of sessions. Responding during pre-test and post-test is represented by the closed circles.

Appendix A

A Review of Creativity Research

The current paper reviews both basic and applied behavioral research on changing the level of creative responding. The *Psychlit Search Engine* was used to research both basic and applied research articles in which in which reinforcement strategies were used to increase creative responding. Applied studies were identified as those in which creative responding for a socially significant behavior such as: writing, language, problem solving was targeted. No restrictions were placed on the year of publication during this search. Specific keywords were included during the search including: different, diversity, novel, variability, new and original. All forms of the aforementioned keywords were included (e.g., variability, variable, novel, novelty). In addition, any article that contained any form of the word creative was also searched for potential inclusion. Publications that were excluded from this review included: bibliographies, articles of a non-behavior analytic nature and theoretical papers on creativity. The review is not exhaustive; however, articles were selected across a number of different responses in order to be representative of the research literature. Based on this literature review areas for future research on creativity were identified and discussed.

A single, consistent definition of creative behavior did not emerge from this review. Shahan & Chase (2002) state that all behavior could potentially be considered novel because behavior varies in topography from one instance to the next. In addition,

behavior occurs in response to stimulus conditions that may vary from moment to moment. It is however clear that it is not possible for every instance of behavior to be considered novel; therefore, the description of a behavior as being novel will depend on the behavior of the organism and the observer's level of analysis, including the observer's knowledge of the organism's history. Researchers have used more specific definitions to describe novelty. For example, Pryor, Haag, & O'Reilly (1969) defined creativity as responding that was never a part of the individual's or of the specie's repertoire. Goetz and Baer (1973) defined creative behavior as any response that differed from any other response that had been produced within a particular time frame. Glover (1979) defined creativity by the statistical infrequency of a response. Page and Neuringer (1985) defined creativity as a response that differed from another response within a specified number of previous responses; more specifically a particular number of responses would need to occur before a response could be considered novel again. Although the definitions regarding creative behavior have varied from researcher to researcher, the definitions have in common a requirement for a "different" response. That response may differ over time from a previous response or from all responses within a particular species. The studies reviewed in the present paper are consistent with at least one of these definitions.

Basic Research on Creative Behavior

A large portion of the research in the area of creativity has been conducted in attempt to demonstrate that creativity is operant behavior and to determine what contingencies of reinforcement maintain creative responding. Researchers have studied variability in responding by measuring a subject's ability to vary responses, to alternate

between responses, and to vary sequences of responses. The following articles focus on basic research questions in that the responses studied are not of a socially significant nature; they include responses such as word naming, swimming movements, key pecking and lever pressing.

One of the earlier studies that examined creativity from a behavioral perspective was conducted by Maltzman, Bogartz and Bregar (1958). They attempted to increase novel verbalization in college students. They gave the students instructions and provided reinforcement contingent upon the use of novel verbalizations. A novel verbalization was a verbalization that did not occur during any of the trials. The results showed that the treatment package produced significant increases in the students' novel verbalizations. Maltzman (1960) developed and used a standardized word-association training procedure in which he presented subjects with twenty-five stimulus words, one at a time, and asked them to respond as quickly as possible with the first word that came to mind. He then repeated the entire list five times with instructions to respond with a new word each time. Maltzman's word association technique has been subjected to a number of experimental investigations since its development (Maltzman, Bogartz, & Breger, 1958; Maltzman, Simon, Raskin, & Licht, 1960; Penney & McCann, 1962; Rosenbaum, Arenson, & Panman, 1964). When the procedure was used and accompanied by instructions to "be original," results obtained have been similar to the results achieved by Maltzman.

In 1960, Maltzman reviewed a series of his previous experiments in which he used his standardized word association procedure to increase creativity in responding. He

demonstrated that participants who were exposed to this training and were then presented with new stimulus materials provided more original responses more reliably than participants who were not exposed to the training. Maltzman conceptualized originality or creativity as an operant that is uncommon but that is relevant to a given situation. He suggested that an original or creative operant responds to the same principles of learning as any other operant. He stated that the occurrence of an original operant may be sufficient to access reinforcement, but that the amount of reinforcement may varying dependent upon the probability of the response. Therefore if a response is common it may not access a reinforcer, if it is uncommon it may access a reinforcer and if it extremely uncommon it may access a larger reinforcer. He suggests that each individual's learning history includes situations in which a creative response was reinforced. He also stated that if reinforcement is provided contingent upon creative responding, it would be expected that the individual would be likely to produce more creative responding in the future.

In 1969, Pryor, Haag and O'Reilly also attempted to produce an "original" response. To determine the extent to which they could produce original responses in porpoises, the researchers provided reinforcement contingent upon responses that had not been reinforced previously, and specifically for movements that did not appear to be "normal swimming motions." They found that in addition to the original responses, the porpoises also produced responses that had never been observed in that species before.

Although many studies thus far have shown that variability can be reinforced, there are two issues that need to be explored. First, although the terms "variability" or

"originality" have been operationalized in each of the studies that have been conducted, it appears that in some of the studies the actual determinant of when to provide a reinforcer may lie in the hand of the observer. It appears that there may be a subjective nature to the definition of creativity in some cases. In particular, Pryor, Haag, and O'Reilly (1969) stated that the trainer provided a reinforcer if he/she believed that the motion did not constitute a normal swimming motion. The second issue relates to the use of contingent reinforcement to increase variability, as opposed to the possible effects of extinction on variability in responding. Because variability does increase as an effect of extinction, it may be that when variability has occurred it is because of an extinction effect rather than the use of reinforcement.

Schwartz (1980, 1982) conducted a study using pigeons to determine if variability could be increased by providing reinforcement contingent upon varied patterns of responding. During a preliminary training phase, the subjects were required to move a light from the upper left to the lower right (by pecking left to move the light one column to the right and by pecking right to move the light down one row). During this phase there was no requirement to engage in variable responding, however if a key was pecked more than four times (either left or right),n the trial was terminated and no reinforcer was provided for that trial. Results showed that during this phase the subjects obtained between 70% and 90% of the reinforcers available. The subjects typically generated repetitive response sequences such as LLLLRRRR. An additional requirement was then added such that that each response sequence of eight key pecks was required to vary from the previous response sequence (variability constraint condition). Under this condition

the pigeons only obtained 40% of the available reinforcers. Schwartz's findings showed that even when variable response sequences were required for reinforcement, variable responding did not increase substantially. Schwartz's findings differ from previous findings showing that reinforcement contingent upon variable responding increases response variability (Pryor, et. al, 1969; Blough, 1966).

There are a few possible explanations as to why Schwartz's pigeon's did not respond variably. First, during Schwartz's study all pigeons were given extensive preliminary training on a sequencing task in which the only requirement was to move the light from the upper left to the lower right. During the sequencing training, patterns of responding did not have to differ from prior patterns, and the pigeons exhibited stereotyped patterns of responding. Secondly, the phases during Schwartz's study were carried out longer than during the study conducted by Page and Neuringer and it is possible that response stereotypies may have developed over time. In experiment 2, Schwartz (1980) examined the use of an extinction procedure to increase variability in sequences of responses. When reinforcement was no longer provided (an extinction procedure was implemented) that there was a substantial increase in the level of variable response sequences emitted.

Page and Neuringer (1985) further evaluated Schwartz's findings, and noted that if a random number generator were responding in place of the pigeons used in Schwartz's studies (1980, 1982), reinforcement would be provided during 29% of the trials. The pigeons in Schwartz's studies produced the response sequences (required for reinforcement) slightly more often than the random number generator used by Page and

Neuringer (1985). Page and Neuringer (1985) exposed pigeons to a procedure similar to Schwartz's (1980, 1982) in which no more than four key pecks were permitted. Under this variability constraint condition, only 42% of the trials resulted in reinforcement (similar to the 40% in Schwartz's study); when there was no constraint on key pecking, reinforcement was earned during 90% of the trials. The researchers further analyzed the last five sessions of the variability constraint condition and they determined that for 3 of the 4 pigeons, 99% of the errors (trials during which no access to reinforcement was provided) were due to a fifth peck on the same key rather than an actual repetitive sequence. Therefore it was not that the pigeons were responding in a repetitive sequence but were pecking a fifth time on a particular key. All that can be concluded is that for 3 out of the 4 pigeons, responding occurred a fifth time on the same key.

Neuringer, Deiss and Olsen (2000) also attempted to increase variability of response sequences using contingencies of reinforcement with rats serving as subjects. This study differs from Page and Neuringer (1985) in that in addition to providing reinforcement contingent upon a variable response sequence, concurrent schedules of reinforcement were used. It was expected that the rats would emit more "creative" sequences if provided reinforcement contingent upon variable responding. The rats were quasi-randomly assigned to three groups, VAR (variability-contingent reinforcement group), ANY (reinforcement of any sequences group) and CON (Control group). All subjects in all groups received reinforcement on a continuous schedule when a target sequence was produced. There were 5 phases and each phase had a target sequence of left (L) and right (R) responses assigned. The five target responses consisted of: RLL,

LLR, RRLR, LR, RLLRL. The VAR and ANY group received reinforcement on a continuous schedule for correct target sequences. A concurrent schedule of reinforcement was in effect for the VAR group and the ANY group. The VAR group received reinforcement on an intermittent schedule (VI-1 minute) for producing a variable response sequence. The criterion for a variable sequence was met if the relative frequency of the current sequence was equal to or less than the level of an even distribution of all possible sequences. The same contingencies were in place for the ANY group, except that the VI-1 minute schedule of reinforcement was provided contingent upon any response sequence other than the target sequence (a DRO schedule of reinforcement). The ANY group was provided the concurrent reinforcer independent of sequence patterns. The CON group only received reinforcement for the targeted responses and concurrent reinforcers were not available. They found that the VAR group learned the target sequences more rapidly than the ANY group and the CON group animals' responding extinguished. In addition, responding that did occur by the ANY group animals did maintain but the animals did not learn the target sequence. The results suggest that when a complex response (e.g., five-letter sequence) was being learned, concurrent reinforcers may have maintained responding, regardless of whether the concurrent schedule was contingent on response variations or independent of response variations. This was demonstrated by the decline in responding in the CON group and the high rates of responding in the VAR and ANY groups. Further, variability-contingent reinforcers facilitated the learning of more complex responses, because only the VAR group learned the complex responses.

Applied Research on Creative Behavior

Although basic research has demonstrated that creativity is operant behavior (Page & Neuringer, 1985), there are few analogous demonstrations in applied research. The remainder of this paper will review applied research studies that have attempted to increase creativity in socially significant behavior. As stated earlier there are two issues to be addressed in relation to operationalizing creativity. The first issue relates to the potential for subjectiveness in the definition of creative behavior. In most of the applied studies this issue is addressed as responses are only reinforced the first time they occur (Maloney & Hopkins, 1973), or the first time they occur within a particular time frame (Goetz & Baer, 1973) The second issue relates to the use of contingent reinforcement to increase variability (as opposed to the use of extinction to increase variable responding). Applied research has examined the use of extinction to increase creative behavior in the area of play (Lalli, Zanolli, and Wohn, 1994) but often may use reinforcement and extinction procedures simultaneously (Duker and Van Lent, 1991).

Creativity in the Area of Writing

In the field of education, there are a number of skills that require creativity including academic skills such as story writing or sentence building. Maloney & Hopkins (1973) attempted to determine if points provided contingent upon creative writing would increase creative writing of short stories in 4th, 5th and 6th graders. They adapted their study from the good behavior game (Barrish, Saunders, & Wolf, 1969) and called it the good writing game. The purpose of their study was to increase the use of "different" words within 10-sentence short stories written by the students. The authors

defined "different" as a word used for the first time in a story (for action verbs and adjectives) or as a word used only once (to begin a sentence). During baseline, no specific words or parts of speech were targeted and the students all received 100% on their papers for good work. During treatment, specific words/parts of speech (e.g., adjectives) were targeted. During the first phase of treatment, adjectives were targeted. Data were recorded throughout the study on the number of different adjectives used as well as the number of different action verbs, the number of different beginning words, the number of different adverbs, the number of different prepositional phrases and the number of sentences with more than eight words. The latter three were not targeted during the study, they were measures of generalization from the targeted areas of composition (e.g., parts of speech or number of words or sentences used) to novel areas of composition. During the second phase of treatment, action verbs were targeted; and during the third phase, adjectives, action verbs and beginning words were targeted. The results showed that as each composition variable was targeted there was a significant increase in the use of different words related to the composition variable that was targeted. When the next composition variable was targeted the composition variable from the previous phase then decreased to baseline levels. It appears that the use of reinforcement in the form of points was effective in increasing creative writing in the students. In addition when adjectives, action verbs and beginning words were targeted, all three remained above baseline levels. The researchers also measured generalization to non-targeted composition variables (i.e., prepositions, adverbs and the number of words used in a sentence). The data showed that the only significant effect on a non-targeted

composition variable occurred during the action verb condition. During the action verb condition, there was a significant increase in the use of adverbs. Adverbs were never directly targeted during the duration of the study. The researchers suggest that the adverbs and action verbs may have made up a response class. Typically a response class is defined a set of responses that meet the requirement for reinforcement (in this case the adverbs were probe items and did not produce a reinforcer). Nevertheless, it is possible that the participants did not differentiate between action verbs and adverbs; and when they used adverbs, they believed they were using action verbs because they would receive points for the use of action verbs. These research findings support findings by Goetz & Baer (1973) and Goetz & Salmonson (1972) showing that a variety of responses can be increased using reinforcement procedures.

To increase creative writing skills in fourth and fifth grade students, Glover and Gary (1976) used a treatment package consisting of instructions and reinforcement (point system). The procedure was similar to that used by Maloney & Hopkins (1973) with exception that Glover and Gary defined specific areas to target creativity that were based on components of a standardized creativity test. They also gave students a standardized pre-test and post-test to determine if changes occurred in the participants' levels of creativity. During baseline, the teacher wrote a noun (common objects only) on the board and each participant was then instructed to create a list of uses for that object. When the teacher scored the papers each student received their sheet with the word "good" written on top. During treatment, the noun was written on the board and the students were told to create a list of uses of the object. Points were awarded based on the

condition of the study. There were four conditions during treatment: number of different responses, number of verb forms, number of words per response, and statistical infrequency of verb forms. For example, if the student used a different verb form during the different verb form condition they would be awarded a point. The target behavior in each condition increased when instructions were presented and contingent reinforcement was provided. After completion of the four conditions, the Torrance's Tests, Thinking Creatively with Words (form b) was administered to all of the participants. The results showed that all of the participants' performances improved on the creativity test. It is difficult to determine the cause for the improvement in scores as they directly related to the creativity test and there may have been practice effects. The importance of this study is that it attempted to define creative responding behaviorally by modifying sections of a standardized test. This study suggest that it may be possible to adapt the measures used in this test within a classroom setting and to modify a variety of responses such as problem solving or oral presentation.

In a second study, Glover (1979) further examined the effectiveness of reinforcement and practice on the creative writing of fifth graders. Reinforcement (points) and practice were applied to the written work of fifth graders on three operationally defined components of creative writing: fluency, flexibility, and originality. Each of these components was assessed using five response measures. Fluency was defined as the number of different ideas each student listed in an idea list prepared prior to writing an essay. Flexibility was measured by an idea list (the number of different ideas in each list) and by story flexibility (the number of different approaches

to the topic that the child used in the story). Originality was measured by idea list originality (statistical infrequency of ideas in the children's lists of ideas) and story originality was determined by blind, subjective ratings of stories conducted by independent raters. All of the participants increased their creative writing when reinforcement was provided contingent upon creative responding. Further, there was an increase in the participants' scores on Torrance's Tests of Thinking Creatively with Words on three variables, fluency, flexibility, and originality. As stated earlier, it is possible that the increase in scores on the standardized tests is due to the practice effects of the treatment used. These results further support Glover & Gary's (1976) findings that the use of reinforcement procedures and repeated practice increase creative writing skills. The procedures used and the definitions created might be easily incorporated within a regular education classroom curriculum to promote creative writing skills. Glover and Gary (1976) and Glover (1979) support prior research that has shown that a reinforcement-based point system can not only increase creative responding but may also change creativity scores on standardized tests that are used to measure creativity (Halpin & Halpin, 1973).

Rousseau, Krantz, Poulson, Kitson and McClannahan (1984) attempted to increase creative writing in children with autism. They used a sentence combining technique to increase adjective use in writing form. Daily sessions were divided into two 20-minute periods: a 20minute-worksheet period followed by a 20-minute writing period. Initially, baseline sessions consisted of non-reinforced sessions during which reinforcement was not provided for new adjective use and on sessions 6, 11 and 13

respectively a reinforced baseline session was implemented. During the reinforced baseline session, students were awarded pennies for the use of new adjectives during the writing period. During treatment, there were two 20-minutes periods, the first was sentence-combining exercise and the second was a writing period. During the sentence-combining procedure students were provided with two sentences that could be combined into one sentence. Visual prompts were used such as underlining the adjective in the second sentence and carets that indicated where to place the adjective in the first sentence. They found that reinforcement alone did not increase adjective use in any of the subjects in the study. When the sentence-combining exercises were introduced there was a slight increase in adjective use across two subjects. When the visual prompts (underlining and carets) were no longer present, and subjects received reinforcement for using adjectives in their writing samples, a systematic increase in adjective use was observed across subjects. In addition, an increase occurred in new adjectives across sessions. Adjectives were used that had never been presented during any of the sentence-combining exercises. It is not clear why the students increased their use of adjectives when the visual prompts were no longer provided. It is possible that the students with autism had become dependent on the visual prompts (under line and carets), in addition, the visual prompts may have been serving as discriminative stimuli as responding occurred only in their presence. When the prompts were no longer present the subjects then began to use adjectives that had never been presented before.

Creativity in the Areas of Communication and Language

Henson (1975) investigated the effects of token reinforcement on divergent verbal

responding in 6 children. The participants consisted of two gifted, two average, and two children with learning disabilities in a public-school setting. Divergent verbal responding to verbal stimulus items from three measures of the Wallach-Kogan Creativity test was examined across participants. The design used both an intra-subject and inter-subject multiple-baseline design with a reversal design. Tokens were provided contingent upon the number of appropriate verbal responses to each stimulus item presented. The participant received one token per appropriate response. The tokens were then exchanged for items using a token menu (e. g., ball and jacks - 100 tokens). After implementation of the token system there was a systematic increase in divergent verbal responding across all participants. The results support Goetz and Baer (1973); Goetz and Salmonson (1972), and Maloney and Hopkins (1973) showing that reinforcement provided contingent upon creative responding increased creative behavior.

Carr & Kologinsky (1983) demonstrated that non-vocal language in the form of gestures could also be modified by using reinforcement procedures. They reinforced only the first two gestural requests made by a child with autism and then withheld reinforcement on the third gesture, in order to produce variability in gestural responding. Although the participants showed increases in the number of gestures used, it is probable that the results were due to a treatment package rather than simply the use of extinction. In addition to the extinction procedure they concurrently taught the children to use spontaneous gestures. Spontaneous gesture use was taught by prompting, prompt-fading and the use of differential reinforcement. It is difficult to determine which components of the treatment caused the change in behavior without an actual component analysis or

systematic application and withdrawal of the treatment components.

Duker and Van Lent (1991) attempted to determine if the use of extinction-induced variability alone (without the use of prompting, fading and differential reinforcement) would promote varied use of communicative gestures in individuals with mental retardation. To select target gestures, all gestures were recorded and then ranked according to the frequency of their use. The high frequency gestures were then selected for the extinction procedure. A reversal design was implemented in conjunction with a multiple-baseline design across subjects. During baseline, when the same gesture was used three times consecutively, the participant was told "No, now something else." and the item requested was not provided. In order for a gesture to be reinforced, two dissimilar gestures must be used first and then the other gesture would be reinforced again. During treatment, reinforcement was withheld for all high-frequency requests (specific gestures that were pre-selected during the ranking of gestures based on frequency of use). All other requests (low-frequency) continued to access reinforcement on a continuous schedule of reinforcement. A return to baseline phase was conducted followed by a second treatment phase. Results indicated that gestures did increase in frequency from baseline to treatment, although results did not reverse during the return to baseline phase. It appears that the treatment had a lasting effect on the student's use of gestures and that, although the contingency was not in effect, gestures still continued at a high frequency. Differences between baseline and treatment may have been more significant if reinforcement was provided for spontaneous requests during baseline rather than only for dissimilar requests that followed two similar requests. In addition, if

reinforcement was withheld for more than 2 or 3 high frequency requests there may have been a greater difference between baseline and treatment. The research design was compromised as the reversal did not occur leaving only a multiple baseline design across subjects, that design was further confounded by the lack of systematic application of treatment to each participant. Stable baselines were not achieved for all of the participants before treatment was implemented. In addition, no measures of generalization were provided across settings or people.

Future research in the area of creativity in gestural communication should examine whether increasing creativity or variability in gestural responding is clinically and socially significant. If a high frequency request is denied (e.g., juice) and the child then engages in a different request (e.g., cookie) and the child then accesses cookie, has the child "communicated?" If the child was thirsty and received a cookie then we would not think that that was effective communication. It is possible that requests may need to be taught within categories so that a child can learn to vary their specific request but stay with a category so that they still receive what it is they requested. Alternately, perhaps if the request could be reinforced if it varied only slightly from the original request (e.g., add "please" or a descriptor word to the original request). For example, If the child asked for a toy and that request response was not reinforced (the child might be given a toy that he/she did not want) and then he/she asked for the "red toy" and was more specific in his/her request this would be appropriate as the child would still receive what he/she requested. Requesting and elaboration of language is often described when referring to a method a teaching referred to as incidental teaching. Incidental teaching

has been shown to be an effective method for increasing initiations in children by providing a functional reinforcer contingent upon an elaboration of language (Hart & Risley, 1974, 1975).

Future research in the area of expressive language might include, applying the techniques used in prior studies to increase gestural language (Duker & Van Lent, 1991). If an expressive request or comment was no longer reinforced, it is likely that variability of responding would be produced as a result of the extinction procedure. This might then in turn lead to the use of novel language production. Henson (1975) showed that novel verbalizations could be produced in college students through the use of direct reinforcement. It is possible that future research might compare providing direct reinforcement as opposed to the use of extinction to increase creative use of language.

Creativity in the Area of Problem Solving

Parsonson & Baer (1978) measured the use of improvisational problem solving skills in typical preschool children using a variety of tools in a within-subject multiple baseline design. Three tasks were required of the participant throughout the study: hammering a peg into a wooden bench, putting 80 marbles into a container and threading a shoe (at least two eyelets). During baseline, only one exemplar was presented for each task (i.e., a wooden hammer, a paper bag and a shoelace respectively). The experimenter modeled the task and the child was then asked to do the same. If the child completed the task, verbal praise was provided. Following completion of the task with the original exemplar, a tray containing a variety of probe exemplars was presented and the child was asked to perform the same task with these materials. The child did not receive verbal

praise; he/she only received descriptive feedback related to the item used. If an item was used a second time, descriptive feedback was provided.

During training, a total of 10 exemplars were provided that could achieve the same results as the original material provided (i.e., a tack hammer, a plastic bag, and a string respectively) for each task. A different exemplar was presented during each session. Contingent praise and descriptive feedback were given contingent upon the first novel improvisation of a probe item (e.g., "Good boy, you hit the peg all the way down with that brick. That's great!"). If an item was used more than once within session, verbal praise or descriptive feedback was not provided. If the same item was used in a different session it was again responded to once and only with descriptive feedback and then not thereafter.

Probe items were present that could potentially be used to complete the task (i.e., a film canister, a glove, and a pipe cleaner respectively). In addition, distractor probe items were present during training that were not sufficient to complete the task (i.e., sytrofoam claw hammer, a tissue, and a drinking straw respectively). The probe items were measured based on three response classes: pick ups- defined as removal of an item without an attempt made to use it as a tool, attempt- defined as any item used in a manner appropriate to the relevant tool but failed to meet successful performance criteria and an improvisation- defined as an item or combination of items was used so that the relevant performance criteria were met. Two classes of improvisation were identified: simple which involved use of an item in its original form to perform the task and complex in which an effective tool was produced by combining tools or by adapting an

item to make it useful. Distractor probe items that were initially expected to be ineffective could be reclassified as an improvisational tool if they were able to modified and used.

After training, follow-up probes were conducted. During the follow-up phase, the exemplars were not present; only probe trials were conducted. As during training, the first occurrence of any improvisation within session was acknowledged with descriptive feedback and any completely novel improvisation (never completed before in a session) was provided with descriptive feedback and verbal praise.

Data were reported both within and across tool classes. Results for Elsie (who received training on hammers only) showed an increase in the number of new improvisations of hammers. In addition to the increase in frequency, there was also a change in the complexity of improvisations from baseline to treatment. During baseline, Elsie made no complex improvisations and during treatment she made 3 complex improvisations. Although improvisations increased for Elsie within hammers, there was no generalization across tool classes of containers and shoelaces.

Jerry and Jimmy received training in two tool classes (i.e., hammers and containers and hammers and shoelaces respectively). Improvisations increased systematically across participants in the hammer tool class from baseline to treatment. As generalization did not occur across tool classes, a second tool class was introduced into training for these two participants. A small effect was obtained across participants for the second tool class. After completion of training on the second tool class for each participant, there was still no generalization effect to the third untreated tool class.

Luther and Ronnie received training on all three-tool classes in the order of containers, hammers and shoelaces. Both participants increased improvisations across tool classes from baseline to treatment for all three-tool classes; however, generalization across tool classes was never obtained for either participant. It is concluded that generalized improvisation within tool class was a function of exposure to the training exemplars within the same tool class. Overall, generalized responding within tool class was better for hammers and containers than for shoelaces; this may be due to the fact that participants initially had difficulty threading the laces and had to be taught this skill before treatment. In addition there were a greater number of potentially effective tools available for the hammer (24 in total) than for the shoelaces (five in total) .

During follow up, at least one novel improvisation was emitted by each participant. This suggests long lasting effects of the treatment protocol and supports the external validity of the study. Although generalization only occurred within tool classes and never occurred across tool classes, it is possible that if generalization was programmed for across tool classes that it may have occurred.

During within-tool-class generalization, exemplars were presented until generalization occurred or the supply of exemplars was exhausted. The authors attempted to balance the diversity of exemplars and a similarity of exemplars in order to promote generalization (Stokes & Baer 1977). In addition, a second generalization training procedure was implemented that consisted of using verbal praise contingent upon the production of successful novel improvisations. This procedure was similar to the procedures used by Goetz and Baer (1973) but differed slightly in the criteria for

reinforcement. Goetz and Baer (1973) reinforced any novel form observed for the first time within a session whereas the authors of this study had a more stringent criterion (Goetz, 1981) and required novel improvisations across sessions. It was possible for the authors to use a novelty criterion across sessions as multiple exemplars were used to increase the likelihood of generalization from the original materials to novel improvisations. The implications of Parsonson et. al., (1978) are that creativity or behavioral diversity can be taught in activities other than those of an artistic nature (Goetz & Salmonson, 1972; Holman, Goetz and Baer, 1977) by programming for generalization. The results are promising in that we may be able to apply similar techniques and promote creativity across an endless number of responses

Creativity in the Area of Play

As cited by Goetz (1984), Figgs, Dunn and Herbert (1971) conducted a study on creativity in block-building behavior. The study used a reversal design with one participant. The intervention included using a prompt before the child built a structure. Prompts were broken down into four categories: suggestions (e.g., "Can you build a farm today?"), differences ("Can you build something different?"), repeats ("Can you build another one like that?"), and use all the blocks ("Let's use all the blocks today.") The results showed that the most effective prompt for increasing form diversity in the participant was the suggestion prompt. Also cited by Goetz (1984), Figgs and Herbert (1971) conducted a similar study on creativity in block-building using a reversal design with two participants. This study implemented a variety of discriminative stimuli (modeling, training and prompts) and possible reinforcing stimuli (descriptive praise) to

compare effects in combination and separately on creative building behavior. The results showed that the prompt for different structures (Can you build something different?) in combination with descriptive praise was most effective in increasing form diversity.

Goetz & Baer (1973) used reinforcement and behavior-specific praise to modify the creativity of block-building behavior of three typically developing preschool children. They found that when reinforcement was provided contingent upon building a block construction form that had not yet been built within that session, there was an increase in creative building. When reinforcement was provided contingent upon building a form that was built previously within the same session, there was a decrease in creative building. This study supports the notion that creative behavior can be systematically taught using reinforcement. Goetz (1981) further investigated the effects of reinforcement on creative block-building behavior. The procedure was similar to the 1973 study with the exception that rather than provide reinforcement for a novel structure for each first appearance within a session, reinforcement was only provided for each novel structure that occurred for the first time across all sessions of the study. Results showed an increase in creative block building behavior within session as well as across session.

Goetz and Salmonson (1972) attempted to increase creativity in three preschool children using easel painting. Different designs were used for each participant, an ABCBC for Sue, an ABCAC for Carrie and an ACAC for Jane. The A condition consisted of no reinforcement, the B condition consisted of the use of general reinforcement and the C condition consisted of the use of descriptive reinforcement.

During the general reinforcement condition painting forms were acknowledged as being "good" but no specific aspect of the painting was commented about. During the descriptive reinforcement condition the teacher's comments were directed toward a specific form. For example, the teacher would comment "that is a very straight horizontal line you have painted." The results showed that the highest number of different forms was produced during the descriptive reinforcement condition across subjects regardless of order of conditions.

Goetz (1984) discusses a study done by Romero, Holt, Stella, Baer and Etzel (1978) in which a multiple baseline across subjects design is used to investigate creativity of shape formation using colored cubes within a square-shaped container. The intervention involved a comparison of treatment methods; descriptive verbal praise was compared to general praise on the creation of shapes. Generalization from original shapes to novel shapes was observed. In addition, the authors state that designs appeared to be more complex, novel and symmetrical during treatment than during baseline sessions.

As cited by Goetz (1984), Holman, Goetz and Baer (1977) conducted experiment 1 of a two-part experiment using two participants to determine if praise provided contingent upon form diversity with one set of materials would increase form diversity with a second set of materials. They used a withdrawal design for task 1 (easel painting) and continued baseline for task 2 (block-building). The intervention consisted of providing descriptive praise contingent upon form diversity in a single product (easel painting). The results indicated that descriptive verbal praise delivered contingent upon

form diversity for easel painting increased form diversity across participants. In addition, form diversity increased in block building when form diversity increased in easel painting. In experiment 2, Holman, Goetz and Baer (1977), conducted a multiple baseline design across three children. Each child received training on one task (felt-pen drawing) while data continued to be recorded on diversity within three other tasks that were not included in intervention (block building, Lego™ building and easel painting). Intervention consisted of providing contingent descriptive praise on form diversity of felt-pen drawings. Results showed that descriptive praise increased form diversity across participants in felt-pen drawing. Generalization from felt-pen drawing to a topographically similar task was observed in two participants and there was a slight increase for the third participant. The generalization occurred in form diversity (novel form within a session) and new forms (a form that was never created previous with the study). Generalization was much less evident to the less topographically similar materials such as the Legos™ or the blocks. Intervention was applied to one participant for Lego™ building and generalization was assessed from Lego™ building to block building and generalization was not achieved.

Lalli, Zanolli and Wohn (1994) implemented a similar procedure to increase toy play in typically developing preschool children. Typically developing preschool children were taught to engage in a particular response with a toy (e.g., make an airplane fly). Once the response was established, that particular topography of response was put on extinction as reinforcement was no longer provided for that topography of response. All participants varied their responding with the toy after the targeted topography of response

was placed on extinction.

This series of research studies in the area of creative play demonstrates that creative play behavior (i.e., building, painting) can be increased by the use of contingent reinforcement in the form of praise and/or by extinction of previously reinforced play responses. More specifically, although general praise was effective in producing an increase in creative play behavior, specific or descriptive praise increased creative behavior to a greater degree or more rapidly. It is possible that the use of instructions, prompts and exemplars may be effective antecedents for promoting creative behavior.

Future research in the area of creative play may profitably focus on areas such as: the use of peers as trainers or as models of creative behavior, maintaining creative behavior through self-monitoring techniques so that the child is able to play with peers without adult intervention and measuring the long-term maintenance and generalization of creative play behavior.

Conclusions

To date, there has been relatively little research on increasing creativity in socially significant behavior (Lalli, 1991; Rousseau, Krantz, Poulson, Kitson & McClannahan, 1994). It is possible that many of the specific reinforcement strategies that have been shown effective in increasing creative responding in a typically developing child or with animal subjects may have promising effects for producing socially significant behavior change. Several reinforcement strategies have been demonstrated to be effective in increasing creative responding across a variety of responses and subject populations (Page & Neuringer, 1985; Pryor, et. al., 1969). These

strategies may be effective in increasing creative responding in children with deficiencies in this area. . These strategies include (a) providing reinforcement contingent upon a creative response (Pryor, et. al., 1969), (b) providing instructions and providing reinforcement contingent upon a creative response (c) the use of behavior-specific praise contingent upon creative responding (Goetz & Baer 1973), (d) providing a continuous schedule of reinforcement and then withholding reinforcement for that same response, thereby producing extinction-induced variability (Duker & Van Lent, 1991; Carr & Kologinsky, 1983), (e) using a percentile or lag schedule of reinforcement (Machado,1989; Lee, McComas, & Jawor, 2002).

The purpose of the current review was to examine research in the area of creativity. It is clear that although there is no one definition for creative behavior, that creative behavior has been operationalized and is being studied. Basic research has examined the parameters in which creative responding occurs such as in response to direct reinforcement and the use of extinction procedures. Applied research has studied creativity across a multitude of socially significant areas such as: written expression (Maloney & Hopkins, 1973), play skills (Lalli, et. al, 1994) and expressive language (Lee, et. al., 2002).

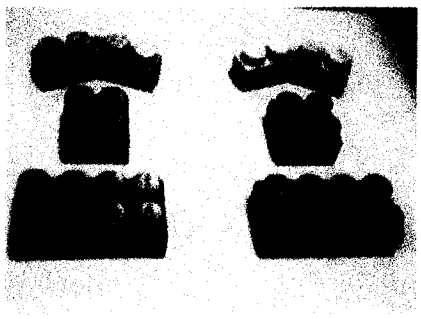
Although researchers have not determined one clear definition of creative behavior, they have each devised their own operational definition. It is expected that if creativity is an operant behavior, then each researcher would be expected to provide a definition of creative behavior, just as would be expected for research on aggression or compliance, for example. The point is that in order to study operant responding, the

researcher must specify the boundaries of the dependent variable under investigation.

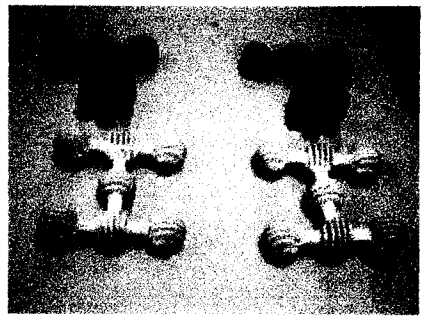
Future research may use definition used in prior research from which they will create their specific operational definitions. Research should continue in the area of creative behavior, as the implications for socially significant behavior are widespread. Much of the behavioral research has only been conducted in the recent years. Behavior analytic researchers will need to continue to conduct research in areas that often appear to fall outside of the traditional areas of behavior analysis such as: artistic creativity (Goetz & Salmonson, 1972) and problem solving (Parsonson & Baer, 1978). Only by conducting research in these areas do behavior analysts further demonstrate the use of principles of behavior across a multitude of response classes. It is particularly important for behavior analysts to demonstrate that behavior that is often thought not to be an operant behavior such as, creativity, can be brought under the control of operant procedures.

Appendix B

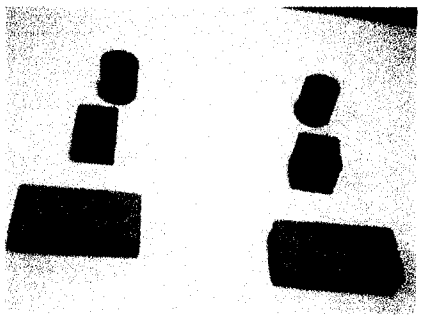
Material placement at onset of each trial during baseline, training and probe trials.



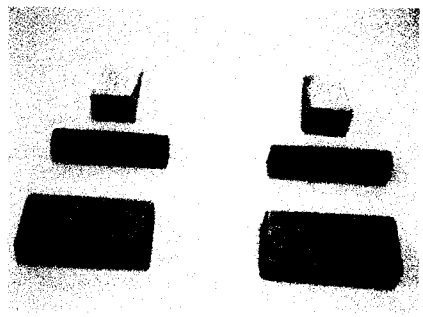
Legos™ placement



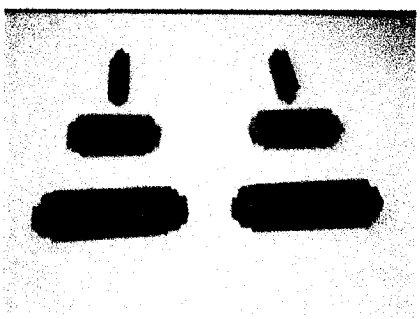
Interstars™ placement



Wooden blocks placement 1



Wooden blocks placement 2



Bristle blocks placement

Appendix C

Prompt levels, response interruption and fading criterion used during training trials.

Prompt level 1

Description: Teacher physically prompted participant to place all 6pieces of building materials.

Fading criterion: Different form (minimum of 3 pieces placed or rotated differently) produced on the last trial for each set of materials for two consecutive days.

Prompt level 2

Description: The teacher provided a prompt for placing only the first piece of building material in the structure. The participant then completed the structure independently.

Fading criterion: A minimum of 24 pieces moved per session for two consecutive days.

Prompt level 3

Description: The teacher modeled the placement of the first piece of building material. The teacher then placed the building material back in starting position on the table in front of the participant.

Fading criterion: A minimum of 32 pieces moved for two consecutive days.

Response interruption

Description: The teacher interrupted an incorrect response by separating the building pieces (after placement of the first two building pieces) and began the trial again.

Fading criterion: Response interruption was implemented after prompting (i.e., modeling) was faded and continued throughout the remainder of the study when an incorrect response occurred.

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