JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1984, 17, 273–278 NUMBER 2 (SUMMER 1984)

THE EFFECTS OF SINGLE INSTANCE, MULTIPLE INSTANCE, AND GENERAL CASE TRAINING ON GENERALIZED VENDING MACHINE USE BY MODERATELY AND SEVERELY HANDICAPPED STUDENTS

JEFFREY R. SPRAGUE AND ROBERT H. HORNER

UNIVERSITY OF OREGON

This report provides an experimental analysis of generalized vending machine use by six moderately or severely retarded high school students. Dependent variables were training trials to criterion and performance on 10 nontrained "generalization" vending machines. A multiple-baseline design across subjects was used to compare three strategies for teaching generalized vending machine use. Training occurred with (a) a single vending machine, (b) three similar machines, or (c) three machines that sampled the range of stimulus and response variation in a defined class of vending machines. Results indicated that the third approach was the most effective method of obtaining generalized responding. Methodological implications for the experimental analysis of generalization and programmatic implications for teaching generalized behaviors are discussed.

DESCRIPTORS: generalization, retarded adolescents, research methodology, response class, community setting, mentally retarded, single-subject design

Increasing attention is being directed at identifying variables that affect generalized responding (Drabman, Hammer, & Rosenbaum, 1979; Sanders & James, 1983; Stokes & Baer, 1977). This attention is of particular significance for teachers working with severely handicapped students. The education of students with severe handicaps is moving from an emphasis on academic skill sequences to the development of functional, community-based activities (Brown, Nietupski, & Hamre-Nietupski, 1976; Neef, Iwata, & Page, 1978; Wilcox & Bellamy, 1982). This new emphasis brings with it a growing need for an applied technology of generalization.

The activity which is the subject of this report was supported in whole or in part by the U.S. Department of Education, Contract 300-82-0362. However, the opinions expressed herein do not necessarily reflect the position or policy of the U.S. Department of Education, and no official endorsement by the Department should be inferred.

We gratefully acknowledge the assistance of G. Thomas Bellamy, Julie A. Williams, and Shawn M. Boles in the development and critical review of this study. Appreciation is also extended to John McDonnell, Marv Wilkerson, and Ellen Adler, whose support within the public school system made this research possible.

Reprints may be obtained from Robert H. Horner, College of Education, University of Oregon, Eugene, Oregon 97403.

Responses that are functional in community settings typically occur across nontrained as well as trained stimulus conditions. There is a lack of consensus on how instructional objectives targeting such generalized responding are best achieved. Engelmann and Carnine (1982) argued that a central variable in obtaining generalized responding is the selection of teaching examples. The relationship between example selection and generalization is supported by infrahuman research (Honig & Urcuioli, 1981; Reynolds, 1961; Terrace, 1966) and recent experimental analyses of generalized responding with handicapped learners (Colvin & Horner, 1983; Horner & McDonald, 1982; Hupp & Mervis, 1981). Stokes and Baer (1977) further support the importance of example selection for teaching generalized responses in at least three of their nine intervention "categories": Train Sufficient Exemplars, Train Loosely, and Program for Common Stimuli.

Applied researchers have argued that the use of several different teaching examples is superior to instruction with a single teaching example as a method of producing generalized responding (Stokes & Baer, 1977; Walls, Sienicki, & Crist, 1981). Becker, Engelmann, and Carnine agreed with the need to use multiple examples, but as-

serted that simply teaching with more examples will not in itself reliably produce generalized responding (Becker, Engelmann, & Thomas, 1975; Engelmann & Carnine, 1982). They indicated a need to select multiple examples that systematically sample the range of stimulus and response variation in the class of stimulus situations where responding is desired (i.e., the instructional universe). This approach has been adapted for use with severely handicapped learners by Horner, Sprague, and Wilcox (1982) and documented as an effective strategy for teaching generalized behavior (Colvin & Horner, 1983; Horner & McDonald, 1982). The research question addressed in this study is: Does a functional relationship exist between the guidelines used for selecting teaching examples and acquisition of generalized vending machine use by students with severe handicaps?

METHOD

Students and Settings

Six male students (15–19 years old) were selected from integrated classrooms for moderately and severely retarded students in two high schools. None had received formal training in vending machine use prior to the study, and none could discriminate the values and uses of coins. All had IEP objectives to improve competence in community activities or acquisition of vending machine use.

The study was conducted in training and "probe" locations where high school students normally purchase items from vending machines. These sites included hallways in the high schools, community recreational facilities, a hospital lobby, a laundromat, and the lunchroom of a nearby public service building.

Activity

The behavior under analysis was the purchasing of items from vending machines. The specific requirements for purchasing an item were as follows: When presented with (a) a vending machine, (b) a 7.5 cm × 12.5 cm card with an item logo on one side and money management directions on the other, (c) six quarters, and (d) the verbal command "buy a —," the student was to approach the machine and purchase the correct item by performing five observable responses correctly. The responses were: (a) select the correct number of quarters, (b) insert the quarter(s) in the machine, (c) activate the machine, (d) obtain the item, and (e) check the machine for change and obtain any if present. Prosthetic cards used during the study had coin amounts down the left edge and pictures of quarters down the right. To determine the cost of items, students were to match the cost numbers from items on machines with the numbers on the card. The number of quarters pictured on sections of the card defined the number of quarters to be inserted into the machine.

Measurement

Two measures of student behavior were collected: (a) trials to criterion during training and (b) correct performance on nontrained probe machines.

Trials to criterion. A training "trial" consisted of purchasing one item from a vending machine. The trainer recorded on a data sheet which of the five steps in item purchasing were done correctly without trainer support. A trial was considered correct only if all five steps were performed correctly without trainer prompts. The total number of trials to criterion represented the number of vending machine purchases a student completed prior to performing three consecutive correct trials on 2 consecutive days.

Correct performance on nontrained probe items. The purpose of measuring performance across a group of nontrained machines was to assess the generality of the skills learned during training. Probe machines were different from those used in training and were selected to allow performance on the probe items to index performance across all vending machines dispensing food and beverage items costing between 20¢ and 75¢ in Eugene, Oregon. Ten vending machines were selected for use as nontrained probe items. The process for selecting the 10 probe machines followed the "general case analysis" guildelines suggested by

Horner et al. (1982). Application of these guidelines involved (a) defining the five responses required for correct vending machine performance, (b) defining the stimulus (S^D) that should control each response, (c) defining S^D variations across machines, (d) defining how the response demands of each of the five responses varied, and (e) selecting a set of examples that sampled the full range of stimulus and response variation for each S^D and response required for vending machine use. (Copies of the general case analysis of vending machine use, the specific stimulus characteristics of the 10 probe machines, and the stimulus characteristics of all training machines can be obtained from the second author.)

To measure correct performance on the 10 nontrained probe machines, a student and trainer traveled to the community site of each probe machine and used the appropriate prosthetic card to purchase an item. The specific product purchased from a machine and the order of machine presentation remained constant across students and probe sessions. Praise or corrections were not given, and feedback was minimal. If a student made an error, the trial was terminated, and the student was led away from the machine. Students never consumed products purchased during a probe session. During each trial the experimenter recorded the accuracy of each of the five responses required for machine use. A probe trial was considered correct only if all five responses were correct. A probe session yielded a score for the total number of probe machines performed correctly.

Reliability

The reliability of training and probe data throughout the study was assessed via agreement between the trainer and an observer. A total of 25 training sessions were dual coded. Observer agreement was obtained in five sessions for each of Students 2–6, with observer agreement recorded in three sessions for Student 1. In each training session the observer maintained a 3-m distance from the trainer and independently recorded the accuracy of performance of each step on each trial. Agreements were scored if both the observer and the trainer scored all steps in a machine purchase as being completed successfully without assistance, or both scored the same steps as assisted or incorrect. Percent agreement scores were calculated by dividing the total number of agreements within a training session over the total number of trials in the session and multiplying by 100. The percent agreement within training sessions was 100% throughout the study.

Observer agreement data were collected during all probe sessions, except Session 7. Two observers independently scored each step of each probe machine. At the end of a probe session scores were compared and agreements determined using the same definitions for agreement as applied in training trials. Observer agreement across all students and probe sessions for correct machine operation averaged 96.1% with no session producing a reliability score lower than 91%.

Design

A variation of a multiple-baseline design across students was used to compare the effects of single instance, multiple instance, and general case training procedures. Only the multiple instance and general case phases were introduced in the staggered format characteristic of multiple-baseline designs. In addition, all phase-change lines index both the beginning of training and the point at which students met the training criterion (i.e., probe session 3 did not occur until after Student 1 had met the training criterion). Training sessions continued on a daily basis within phases after the training criterion was met.

Procedures

Baseline. The baseline phase consisted of a single probe to document the initial ability of students to use vending machines. Students were individually presented with each of the 10 probe vending machines, given the appropriate prosthetic card, six quarters, and the instruction to buy the designated item.

Single instance. The single instance phase simulated an approach used by many teachers to produce a generalized skill. One machine close to the

classrooms was used as the sole training example. Students received individual, 30-minute training sessions four or five times per week with each session including 3 to 15 trials. Although only one machine was used, different items were purchased from the machine on different trials. Training procedures followed the guidelines provided by Bellamy, Horner, and Inman (1979). Students initially observed the trainer use the prosthetic card and activate a machine. Then they received multiple trials in which verbal and physical prompts were delivered to ensure correct responses. These prompts were faded as rapidly as possible, until prompting occurred only if errors increased. Correct responses were followed immediately by praise. Incorrect responses were corrected, and multiple repetitions of incorrect steps were performed with sufficient prompting to ensure correct responding. All assistance, except for praise at the end of a machine activation, was faded out before the training criterion was met.

Multiple instance. Training procedures in the multiple instance phase exactly replicated those used during single instance training. Instead of receiving training with only one machine, however, students were trained simultaneously with three new machines which were similar to each other. The machines were chosen to ensure that they did not sample the available range of variation.

General case. The general case phase also replicated the single instance phase in all training and format characteristics. The only variable distinguishing the general case phase was the set of rules used for selecting the training machines. Three machines were selected that, when combined with the single instance machine, sampled the available range of stimulus and response variation.

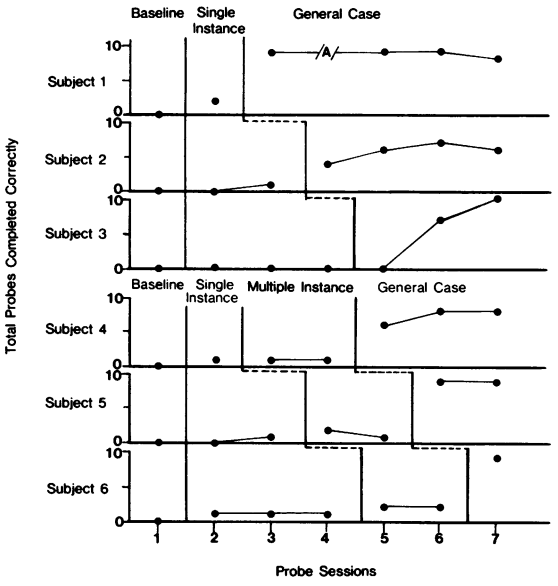

Figure 1. The number of nontrained probe machines completed correctly by students across phases and probe sessions.

RESULTS

Trials to Criterion

Students averaged 14.8, 40.7, and 41.3 trials to criterion for single instance, multiple instance and general case training, respectively. These data translate into a range of 3–7, 30-minute training sessions per student per phase to reach the training criterion.

The costs associated with training involved instructor time and items purchased. Instructor time for training totaled 17.5 hours for all students in all phases. Most items purchased during training were resold, at cost, to the school store. Cans of soda were resold to the local vending machine company, and cups of soda and coffee were purchased outright. The total expenditure to train six students across all phases was $150.00. If no items had been resold the total training cost would have been $255.00 (an average of $42.50 per student).

Probe Performance

Results for each student across probe sessions are shown in Figure 1. Baseline data indicate that all students were unable to operate vending machines prior to training. After receiving training with the single instance machine, students displayed a small improvement in probe performance. The stable, low scores of Students 2, 3, 5, and 6 across probe sessions 2, 3, and 4 indicate that even with additional overlearning on the single instance machine, students did not acquire a skill that was functional across the range of machines. Of addi-

tional interest is the pattern of correct responses that occurred. Eight probe trials were performed correctly by all students in the single instance phase. Seven of these eight trials were with probe machine 1 which was the most similar to the machine used for training during the single instance phase.

Students 4, 5, and 6 each received training with the three multiple instance machines. Across the six probes delivered under the multiple instance phase, only 9 of the possible 60 trials were performed correctly. Six of these nine trials were correct manipulations of probe machine 1. Following general case instruction all students showed substantial increases in their performance across the 10 nontrained, probe machines. With five of the six students this increase was immediate. Student 3's lack of immediate improvement in probe session 5 may have been the result of a ritualistic pattern of coin insertion which he developed during prior probe sessions. Training sessions for Student 3 between probe sessions 5 and 6 emphasized repeated practice on the step of coin insertion during daily training sessions.

Eighteen months after the study was completed, parents and teachers were contacted to determine if the students were continuing to use the skills learned during the study. Five of the six students were reported to be still carrying a prosthetic card and regularly using quarters to purchase items from vending machines. The sixth student was not available for follow-up.

DISCUSSION

We compared a "general case" approach for selecting teaching examples with both a single instance alternative and a multiple instance alternative. The results illustrate that single instance training was not functional for teaching a generalized response. Multiple instance instruction was also dysfunctional. General case instruction, however, was functionally related to acquisition of generalized vending machine use.

We recognize that a modified multiple instance strategy of: (a) randomly selecting examples, (b) training, (c) testing with probe items, and (d) selecting more items if performance is unacceptable would eventually lead to the selection of examples that sample the range of relevant variation and produce acquisition of a generalized response. The guidelines for selecting examples provided by Becker et al. (1975) and Horner et al. (1982) should, however, make this process more efficient. By following the guidelines, teachers can prevent the costly process in which students learn error patterns that must be unlearned, or spend extensive amounts of time relearning information.

Implications for Analysis of Generalization

A major implication for future research arises from the use of a dependent variable that assesses performance across a predefined set of nontrained examples. The focus of our study was not on acquisition of training examples, but whether the competencies acquired from training resulted in performance across a class of nontrained stimulus conditions. Because the 10 probe machines systematically sample the stimulus and response demands, performance across the machines can be used to index performance across all machines. Alternative strategies for selecting probe items would not allow this inference. Future studies addressing generalization should define the class of stimulus conditions across which generalized responding is targeted and document experimental control of responding across this class or a representative subset of examples from the class (Perkins, 1965).

Limitations

Appropriate interpretation of these results requires careful consideration of experimental design limitations. The most serious of these is the effect of multiple intervention interactions (Hersen & Barlow, 1976). Students 1, 2, and 3 received general case instruction only after first completing single instance training. Students 4, 5, and 6 were trained both with the single instance and multiple instance examples before entering general case training. It is impossible within the current design to separate the unique effect of general case instruction from the cumulative effect of multiple phases.

Other research, however, has documented the effectiveness of the general case approach to produce such generalized skills as street crossing (Jones, 1983), table bussing (Horner, Eberhard, & Sheehan, 1983) and telephone use (Horner, Williams, & Stevely, 1983) when multiple intervention interactions were not an issue.

Data from our study point to the need for further research on general case procedures. The efficiency of training with different groups of examples is not addressed in this study and needs examination. Research on rules for how training examples are sequenced for effective instruction is needed. Additional examination of general case instruction with leisure, vocational, and social skills is needed. Of special interest is the potential for using the guidelines of general case instruction to obtain generalized reduction of inappropriate responses (Engelmann & Colvin, 1983). Many avenues for future analysis are available. Our data suggest that these options have a high probability of producing fruitful results both for an improved theory of applied generalization and for specific instructional procedures.

REFERENCES

Becker, W., Engelmann, S., & Thomas, D. (1975). *Teaching 2: Cognitive learning and instruction* (pp. 57–92). Chicago: Science Research Associate.

Bellamy, G. T., Horner, R. H., & Inman, D. (1979). *Vocational habilitation of severely retarded adults: A direct service technology* (pp. 79–174). Baltimore: University Park.

Brown, L., Nietupski, J., & Hamre-Nietupski, S. (1976). The criterion of ultimate functioning. In M. Thomas (Ed.), *Hey, don't forget about me!* (pp. 2–15). Reston, VA: CEC Information Center.

Colvin, G. T., & Horner, R. H. (1983). Experimental analysis of generalization: An evaluation of a general case program for teaching motor skills to severely handicapped learners. In D. Hogg & P. Mittler (Eds.), *Aspects of competence in severely mentally handicapped people* (Vol. 11). Sussex, England: John Wiley & Sons Limited.

Drabman, R. S., Hammer, D., & Rosenbaum, M. S. (1979). Assessing generalization in behavior modification with children: The generalization map. *Behavioral Assessment,* **1,** 203–219.

Engelmann, S., & Carnine, D. (1982). *Theory of instruction: Principles and applications* (pp. 1–54). New York: Irvington.

Engelmann, S., & Colvin, G. T. (1983). *Generalized compliance training* (pp. 1–53). Texas: Pro-Ed.

Hersen, M., & Barlow, D. (1976). *Single case experimental designs: Strategies for studying behavior change* (pp. 198–222). New York: Pergamon.

Honig, W. K., & Urcuioli, P. J. (1981). The legacy of Guttman and Kalish (1956): 25 years of research on stimulus generalization. *Journal of the Experimental Analysis of Behavior,* **36,** 405–445.

Horner, R. H., Eberhard, J., & Sheehan, M. R. (1983). *Generalization of table bussing skills with moderately and severely retarded adolescents.* Unpublished manuscript, University of Oregon, Eugene.

Horner, R. H., & McDonald, R. S. (1982). A comparison of single instance and general case instruction in teaching a generalized vocational skill. *Journal of the Association for the Severely Handicapped,* **7,** 7–20.

Horner, R. H., Sprague, J., & Wilcox, B. (1982). Constructing general case programs for community activities. In B. Wilcox & T. Bellamy (Eds.), *Design of high school for severely handicapped students* (pp. 61–98). Baltimore: Brookes.

Horner, R. H., Williams, J., & Stevely, J. (1983). *Generalized telephone use by moderately retarded high school students: An experimental analysis.* Unpublished manuscript, University of Oregon, Eugene.

Hupp, S. C., & Mervis, C. B. (1981). Development of generalized concepts by severely handicapped students. *Journal of the Association for the Severely Handicapped,* **6,** 14–21.

Jones, D. (1983). *The application of a general case programming strategy to street crossing.* Unpublished manuscript.

Neef, N. A., Iwata, B. A., & Page, T. J. (1978). Public transportation training: In vivo versus classroom instruction. *Journal of Applied Behavior Analysis,* **11,** 331–344.

Perkins, C. C. (1965). A conceptual scheme for studies of stimulus generalization. In D. I. Mostofsky (Ed.), *Stimulus generalization* (pp. 38–54). California: Stanford University Press.

Reynolds, G. S. (1961). Attention in the pigeon. *Journal of the Experimental Analysis of Behavior,* **4,** 203–208.

Sanders, M. R., & James, J. E. (1983). The modification of parent behavior: A review of generalization and maintenance. *Behavior Modification,* **7,** 3–28.

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis,* **10,** 349–367.

Terrace, H. (1966). Stimulus control. In W. Honig (Ed.), *Operation behavior areas of research and application* (pp. 271–344). New York: Appleton-Century-Crofts.

Walls, R. T., Sienicki, A., & Crist, K. (1981). Operations training in vocational skills. *American Journal of Mental Deficiency,* **85**(4), 368–376.

Wilcox, B., & Bellamy, G. T. (1982). *Design of high school programs for severely handicapped students* (pp. 1–60). Baltimore: Brookes.

Received May 20, 1983
Final acceptance November 30, 1983