JOURNAL OF APPLIED BEHAVIOR ANALYSIS 2000, **33,** 97–100 NUMBER 1 (SPRING 2000)

# *READING, EQUIVALENCE, AND RECOMBINATION OF UNITS: A REPLICATION WITH STUDENTS WITH DIFFERENT LEARNING HISTORIES*

LÍGIA EBNER MELCHIORI

UNIVERSIDADE ESTADUAL JULIO DE MESQUITA FILHO (UNESP), BAURU

AND

DEISY G. DE SOUZA AND JÚLIO C. DE ROSE

UNIVERSIDADE FEDERAL DE SÃO CARLOS, BRAZIL

First graders, preschoolers, special education students, and adults received a reading program in which they learned to match printed to dictated words and to construct (copy) printed words. The students not only learned to match the training words but also learned to read them. In addition, most of the students learned to read new words that involved recombinations of the syllables of the training words. The results replicate and extend the generality of a prior analysis of a reading program based on stimulus equivalence and recombination of units.

DESCRIPTORS: reading, stimulus equivalence, recombinatory generalization, exclusion, matching to sample, nonreading adults

The stimulus equivalence paradigm provides economical and effective methods to teach complex repertoires like reading. For example, de Rose, de Souza, and Hanna (1996) taught first-grade children to match pictures and printed words to dictated words. The children also learned to construct (copy) the printed words with letter tiles. Equivalence tests showed that the children matched printed words to pictures and vice versa and that they learned to read the words selected on matching tasks. In addition, most children also read new generalization words that were recombinations of the syllables of training words. For example, after training *bolo*, *vaca*, *mala*, and *pato*, the children could also read the words *boca* and *mapa*. The present study sought to replicate these findings with first graders who were not making progress in reading, and extend them to preschoolers, students with global developmental delay, and nonreading adults.

This research was supported by MCT/FINEP/PRONEX and by Grants 522290/95-7 and 520732/95-2 from CNPq. We thank Adriana B. Pereira, Ana Lidia G. Gama, Domingos S. Coelho, Roberta Rangel, and Vanessa C. Dios for help in conducting the research. We are indebted to Maria Amelia Matos, Elenice Hanna, Olavo Galvão, Tony Cuvo, Lucia Williams, and three anonymous reviewers for valuable contributions to this manuscript.

Requests for additional information about the teaching program or for reprints may be addressed to D. G. de Souza, Departamento de Psicologia, UFSCar, Caixa Postal 676, 13565-905, São Carlos, SP, Brazil (E-mail: ddgs@power.ufscar.br).

## METHOD

### *Participants, Screening, and Settings*

The study included 23 nonreaders: 5 preschoolers, 5 first graders, 5 first graders in special education, and 8 adult women (see Figure 1 for participant characteristics). All children attended school during the study, and those in regular and special education received reading and spelling instruction in their classrooms. The adults did not attend school; 2 never had attended, and 3 had attended when they were children for less than 6 months each.

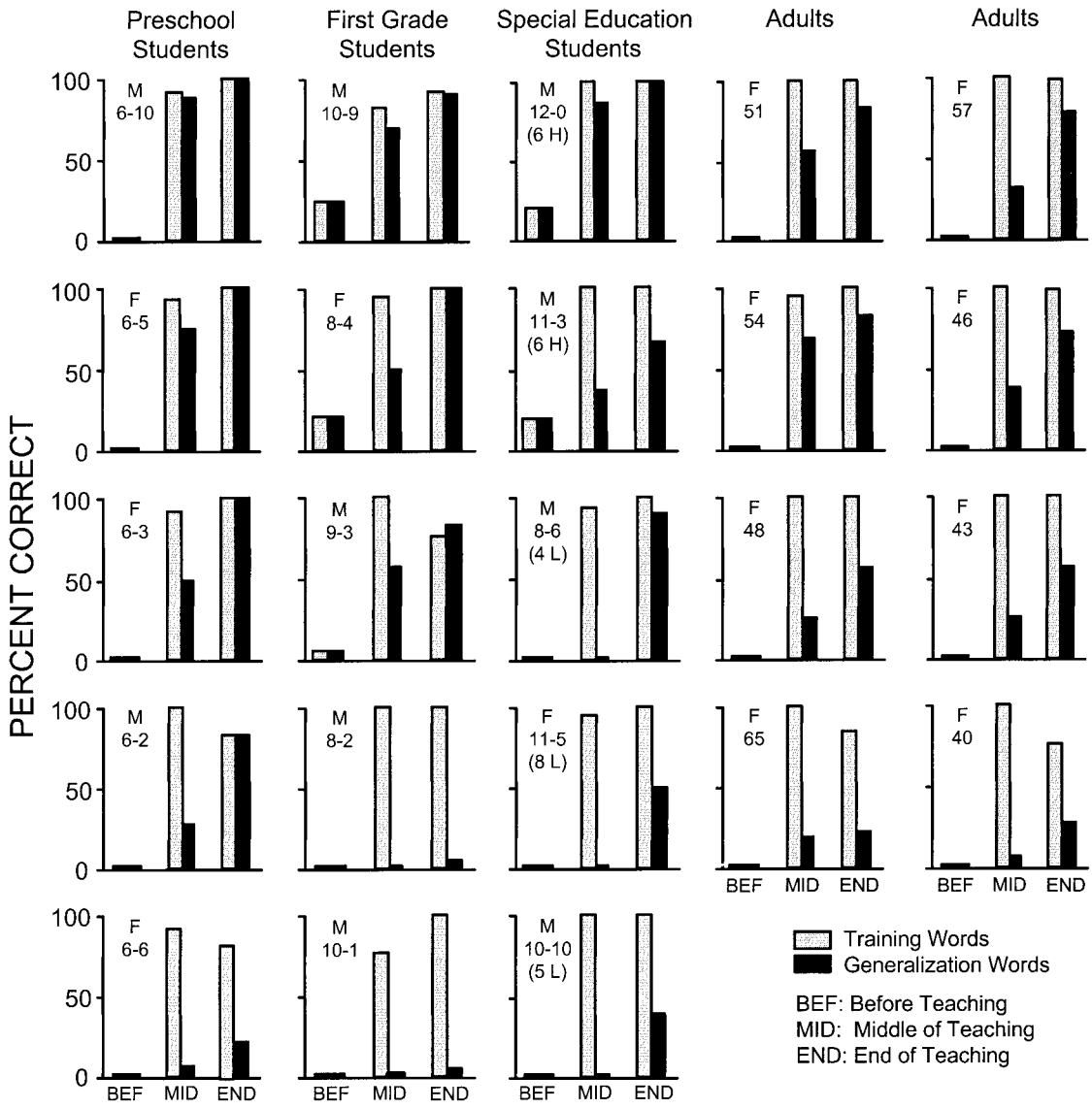


Figure 1. Each panel shows the percentage of the training and generalization words that a student read correctly before, in the middle, and at the end of the teaching program. The four groups of students who were given the program are indicated above the columns. A student's gender (M, F), chronological age (years and months, or years), and mental age equivalent score (in parentheses; H = high end of age range, L = low end of age range) are indicated in the upper left of each panel.

A student was considered a nonreader, and eligible for the study, if no more than 25% of a set of 15 screening words (not used later in the study) were read correctly. These words were presented individually without differential feedback for correct and incorrect responses. These and later teaching sessions occurred in quiet rooms and offices.

*Materials and Procedure*

The materials and procedures were the same as in de Rose et al. (1996). The visual stimuli were Portuguese words (the students' native language), printed in lower case 65-point arial type, and their corresponding pictures. These stimuli appeared on sheets of letter paper, and each sheet displayed stimuli

for one trial. The complete set of trials for one session was contained in a binder for teaching and testing trials. There were 51 two- and three-syllable words in the teaching program, some of which were *vaca* (cow), *mala* (suitcase), *vela* (candle), *pato* (duck), *bule* (coffee pot), *apito* (whistle), *tapete* (rug), *tijolo* (brick), and *menina* (girl).

One-to-one sessions (20 to 30 min) were conducted 5 days per week. There were two teaching activities: matching printed to dictated words, and constructing (copying) printed words. In the matching task, students pointed to one of two printed words, presented side by side on the sheet of paper after a word was dictated. In the constructed-word task, students arranged individual letter tiles to match the word selected in the preceding matching trial. The activities were organized into 25 units (15 teaching and 10 testing). Different sets of words were selected for each unit, and the number of words increased gradually from two to four in early units. Unit 1 established the initial baseline of matching and reading with three words. Unit 2 tested matching of the words to pictures and vice versa to verify the formation of equivalence classes consisting of dictated word, printed word, and picture. Subsequent units used an exclusion procedure to teach matching to dictation (a new word appeared with a baseline word).

Each teaching unit involved a reading pretest, a block of training trials (four matching and two constructed-response trials with each word), and a reading posttest. The pre- and posttests included two to four training words and two generalization words. If the student did not read all training words correctly on the posttest, the unit was repeated the next day. After two exclusion units, the next unit verified the formation of equivalence classes involving the words from the two previous units and the corresponding dictated words and pictures. Midway, and at the end of teaching, tests verified whether the students could read the words trained to that point and new generalization words that were recombinations of the training words. These tests included all the training words from the previous units (19 words in the middle and 51 at the end) and 14 and 45 new words, respectively. Correct responses on all training and test trials were reinforced with confirmation and praise.

Remedial procedures were used when a child failed to meet the reading criterion for a unit (see de Rose et al., 1996, pp. 458–459). Blocks of trials contained baseline words and no more than one word that produced errors (or was not responded to). After criterion was met on a target word, another target word was trained and the unit test was given again. Thus, the training trials included only the words that the student could read plus one not learned in that unit. When that word was learned, the remaining words were added, one by one, in subsequent sessions, until the criterion for the unit was met.

Reliability observations were not conducted. However, the reading data gathered during the test sessions were typically checked against tape recordings of reading made during the sessions. In addition, whether a child's matching and reading responses were correct or not was always unambiguous; and the experimenter was skilled in all aspects of the procedures, which previously yielded high percentages of interobserver agreement (de Rose et al., 1996).

## RESULTS AND DISCUSSION

Accuracy on training tasks was very high for all students (above 90%), and the matching tests demonstrated that dictated words, printed words, and pictures were members of equivalence classes. Each student learned to read the training words, as shown in Figure 1 for tests conducted midway through

(76.4% to 100% correct) and at the end of (75.6% to 100.0% correct) the program. With few exceptions, a student's reading also improved substantially on generalization words. The mean numbers of sessions per teaching unit for preschoolers, adults, first graders, and special education students were 1.1, 1.5, 2.0, and 3.9, respectively. Students in special education required remedial procedures for most units and showed lower levels of reading generalization (midway, 3 students read no new words). The final scores for training and generalization words were, however, comparable to those of the other participants.

First graders in regular and special education also received reading instruction in the classroom. This instruction could have contributed to the children's improved performances. However, further testing partially controlled for the potential problem of history as a threat to internal validity. Compared to their unit pretests, posttest scores for all children were vastly improved (data not shown). The preschoolers and adults did not receive outside reading instruction, suggesting that their results were due to the teaching program and not other influences.

The present data suggest that a teaching package based on equivalence and recombination of units has generality across participants with reading difficulties. Teaching reading at the level of whole words may gradually produce control by smaller units, allowing for recombination and reading of new words (Skinner, 1957). Indeed, without explicit teaching, many of the students in the present study showed this kind of generalized reading. However, the generalized reading scores for other students never reached the accuracy levels achieved on the training words. Better results might have been obtained had the present equivalence methods also involved the explicit teaching of letter–sound correspondences (e.g., Adams, 1990). Such a teaching package might reliably yield recombinatory generalization and also prove to be broadly effective in establishing functional reading skills.

## REFERENCES

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print.* Cambridge, MA: MIT Press.

de Rose, J. C., de Souza, D. G., & Hanna, E. S. (1996). Teaching reading and spelling: Stimulus equivalence and generalization. *Journal of Applied Behavior Analysis, 29,* 451–469.

Skinner, B. F. (1957). *Verbal behavior.* New York: Appleton-Century-Crofts.

*Received April 2, 1999*
*Final acceptance November 16, 1999*
*Action Editor, Robert Stromer*