Teaching generative reading via recombination of minimal textual units: A legacy of Verbal Behavior to children in Brazil

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Abstract

This paper reports results of two studies that sought to teach generative reading skills to a large group of Brazilian children who were exhibiting protracted failure in school. Inspired by Skinner’s analysis of verbal relations and minimal verbal units, the methodology took advantage of certain characteristics of Portuguese. Many words in this language are comprised of two-letter syllabic units (e.g., BO+LA= ball, CA+BO= handle, LA+TA= can) that can be recombined to form new words (e.g., BOCA= mouth, BOTA= boot), thus establishing a route to generative reading via recombinative generalization. Such syllabic units were incorporated within curricular framework that used matching-to-sample and learning by exclusion methods to teach matching relations involving pictures, printed and spoken words, and printed and spoken syllables. Study 1 was conducted within a university-based learning center that maintained certain aspects of laboratory conditions. It showed that teaching textual relations between dictated and printed syllables could control procedurally the inter- and intra-participant variability observed in past studies that lacked this feature - resulting in virtually universally positive teaching outcomes. Study 2 was conducted in a public school programs that applied the same basic training methodology. Positive training outcomes in an experimental group were approximately 3-5 times greater than that in a placebo control group. Together, these studies illustrate that the functional analysis in Verbal Behavior is having a direct impact in educational science in Brazil. It has led to procedures that can be effectively translated from the laboratory to the community via delivery systems that can be implemented in the developing world.

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This paper describes results of a sustained and accelerating effort to develop an effective program for teaching foundations of reading and spelling to Brazilian children, many of them socially disadvantaged and/or intellectually disabled. This program had its roots in Skinner’s (1957) analysis of “minimal units” in verbal relations and in laboratory-derived methods for promoting emergent behavior. The program addressed two key components of reading repertoires identified by behavior analysts (e.g., Skinner 1957): textual/echoic behavior and reading comprehension.

Development of textual and echoic repertoires may be critical to the development of a skilled reading repertoire (Skinner, 1957). Indeed, in calling attention to these functional relationships, Skinner pointed to phonological awareness, the ability to recognize the sounds that constitute words as repeatable units (in behavioral terms, discrimination and abstraction of within-word sound units, cf. Mueller, Olmi & Saunders, 2000) that is now assumed to underlie skilled reading repertoires (Goswani, & Bryant, 1990; Torgensen et al., 1992).

Words within a phrase, sentence, or other word sequence, can function as minimal textual units (recombinative generalization, cf. Goldstein, 1983, 1993). Illustrating the flexible nature of verbal relations, one can extend the recombinative approach to minimal units within individual words. The Portuguese language is especially well-suited to illustrate such minimal unit recombination, because many of its words are composed of combinations of consonant-vowel units. Much research within the Brazilian program has shown, for example, that when direct teaching that establishes appropriate oral naming of words comprised of such separable units (e.g., BOLO (BO+LO), VACA (VA+CA), that learning may be accompanied by emergent naming of recombinations of the constituent units (i.e., BOCA, CABO, LOBO) (de Rose, de Souza, Rossito, & de Rose, 1992).

The failure of much conventional reading instruction is a global problem, especially in developing nations. Our working hypothesis is that this problem can be resolved via a well-defined behavioral technology inspired by key aspects of Skinner’s (1957) analysis of verbal behavior and other advances in behavior analytic science, such as methodology for developing equivalence relations (Sidman & Tailby, 1982). An overarching goal of this research program has been to develop methodology that imbeds within it procedures for establishing the range of functional relations that constitute the basis for a functional reading repertoire. The methodology has evolved over a number of years of research that has progressively refined the techniques (e.g., de Rose, de Souza, & Hanna, 1996; Melchiori, de Souza, & de Rose, 2000; Matos, Avanzi, & McIlvane, 2006).

Overview of Present Study

Our working hypothesis was that contingencies designed in line with the analysis of Skinner (1957) and the procedures of Mackay and Sidman (1984) could prove sufficient to establish generative reading i.e., performances that emerge without direct training. We sought to encourage such behavior by also teaching the children to match printed to dictate syllables and to construct words with syllables – thereby establishing/verifying the necessary discriminations and relations involving syllable sounds and corresponding printed syllable units.

STUDY 1

Method

Participants

Participants were 12 children aged 8-12 years. All were selected based on teacher reports of protracted failure to acquire reading skills in school and a preliminary assessment test. Children were asked to
read orally words presented one by one and to spell those words to dictation. Two response modes were assessed in spelling: constructed response and cursive writing. Ten of these assessment words were included in the teaching program (Training words) and five were used only during tests (Generalization words). No feedback was given.

Setting and Materials. The study was conducted in a laboratory at Universidade Federal de São Carlos, a university-based learning center that maintained certain aspects of laboratory conditions. Experimental operations on the computer were controlled by custom software written for that purpose.

Stimuli. All children were exposed to a computer-based teaching program that was organized in a series of units. The teaching program used common words in Portuguese that could be easily represented by pictures (the same words used by de Rose et al., 1996). Some words were used for training (Training words), while other words were used only for assessing recombinative reading (Generalization words).

Scheduling. Sessions were scheduled five days a week, but the actual number varied. Total length of participation in the study was variable due to factors such as the schedule of academic semesters, but 3-6 months of exposure to the curriculum was typical.

Procedures

The teaching program was a superset of the procedures described by de Rose and colleagues (1996). The main teaching goal was to establish accurate matching of printed word comparison stimuli to dictated-word sample stimuli. To that end, a CRMTS task was implemented to require children to copy printed-word sample stimuli (i.e., CRMTS identity matching), a procedure that verified letter-by-letter discrimination of the printed words. Additions to the program were (1) a requirement that children learn to match printed syllables to dictated syllable names (i.e., the minimal units) and (2) computer-based teaching rather than the tabletop procedure used in previous versions (cf. de Rose et al., 1996; Melchiori et al., 2000). Syllable matching procedures were implemented in each teaching unit only after the child had learned to match the corresponding printed words and dictated words.

General program structure. The program was comprised of 17 teaching units and 11 assessment units. This implementation differed somewhat from previous ones, with the combined objectives of increasing the efficiency of training and testing and rendering the program suitable for automating most tasks. Pretests and Post-tests included behavioral relations BC, CB, and CD, and a new relation AE, spelling words in response to dictation. Post-tests, distributed across two sessions, included (1) all of the words from a given training set, (2) newly introduced common Portuguese words to assess generalization, and (3) pseudo-words having the structure of Portuguese but not defined in that language to assess development of textual responding.

Learning by exclusion. The primary methodology for teaching new relations between dictated words (and later syllables) and corresponding visual stimuli was learning by exclusion (McIlvane & Stoddard, 1981).

Results and Discussion

No child read more than three words correctly during the preliminary assessment. During the training, all children acquired highly accurate performances that were targeted by direct training aspects of the curriculum: (1) matching pictures to corresponding dictated words, (2) matching printed words to dictated words, and (3) matching printed syllables to dictated syllables. All children exhibited accurate emergent matching of printed words with pictures and vice versa, either immediately on initial unit post-tests or after the prerequisite matching relations were reviewed. In doing so, they demonstrated true reading comprehension...
outcomes were due to the curriculum per se and not some other variable correlated with passage of time spent in our instructional environment. For this reason, our group has been endeavoring to assess program efficacy via a group design comparing performances of groups of children who were exposed to our regular program to groups of comparable children who were exposed to a control program that did not teach reading. Our control groups can be considered as “placebo groups” (Wampold, Minami, Tierney, Baskin, & Bhati, 2005) or as non-specific treatment groups (Kazdin, 2003): participants are exposed to the same setting of instruction, but they are required merely to match pictures to dictated words (AB) and to name the pictures (BD). Reis, de Souza, & de Rose (2009), obtained results that were similar to those in the present Study 1 in an experimental group and little or no progress in a matched control group.

Another aspect of this line of research has been to assess whether the methodology that had been implemented in our university-based learning center could be implemented effectively within a public school environment. Study 2 systematically replicated the procedures of Reis and colleagues (2009) using student proctors to supervise the instruction instead of teachers or researchers.

**Methods**

Participants in this study were 17 children aged 8-11 years who had levels of school participation and achievement similar to those of children in Study 1. The primary qualification for participation in the study was failure to read orally or spell words on an initial pretest. In addition, school records were available to characterize these children. The children were assigned either to an Experimental Group (09) or to a Control Group (08) of comparably functioning children.

The setting was a quiet area within the children’s public school program, with the computer equipment necessary to implement the program in that...
environment. Procedures for the Experimental Group systematically replicated those described in Study 1, the primary difference being the change in the setting of instruction. The Control Group was exposed to a similar program except that (1) the tasks included only matching pictures to dictated words (AB) and naming the pictures (BD); (2) each unit taught 9 word-picture relations; there were 30 word sets and these sets did not include the words used with the Experimental Group.

Results and Discussion

Figure 1 presents the most important findings of this study, showing pre- and post-test results for individual participants (isolated points) in the Experimental and Control groups, and the median for the groups (solid lines). Learning outcomes comparable to those in Study 1 were obtained with the Experimental group whereas the Control group made little progress.

![Graph showing percent correct oral reading](image)

**Figure 1.** Individual data: percent correct responses in reading and spelling to dictation before (B) and after (A) the administration of the programs. The medians of the groups’ performances in each task are represented by the solid lines.

Although suggestive, the present findings cannot be taken as definitive proof of the sufficiency of the curriculum, by itself, to establish the performances of interest. One logical possibility is that our curriculum served to potentiate learning in the children’s school programs (many children do learn how to read in school). Nevertheless, longstanding experience and the findings of Study 2, together with the findings of Reis and colleagues (2009) do indicate that exposure to the curriculum was the key factor in allowing initially non-reading children to begin reading – performances that have served as the foundation for extensions of our larger program to teach reading of text passages, the results of which will be featured in a separate report.

**General Discussion**

The present work is very clearly in line with the essential concepts underlying Skinner’s (1968) objective of applying systematic principles of behavioral science to develop a true technology of teaching. Two aspects of Skinner’s analysis seem noteworthy in the present study. First, our addition of explicit teaching of relations between dictated and printed minimal syllabic units in the curriculum is consistent with the concept of fostering progressively evolving, empirically inspired improvements in instructional technology. Regarding oral reading of training words in Study 1, for example, the children averaged about 97% correct and the lowest scoring child exceeded 90%. Overall performance with generalization words in the present studies was far superior to earlier studies, however.

Perhaps even more important than the incremental improvement, however, was the demonstration that improvements in learning outcomes could be made outside the very controlled environment of the university-based learning center. Study 2 showed virtually the same levels of achievement when the curriculum was implemented within a public school environment. This finding shows that protracted failures to acquire reading fundamentals – as exhibited by many children in Brazilian primary grades is potentially correctable via the systematic application of an evidence-based technology of teaching.
REFERENCES


