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# Teaching spelling as a route for reading and writing

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## Abstract

Reading and writing are functionally independent operants, in which the acquisition of one does not necessarily result in the acquisition of the other. However, when the main components of these behaviors become members of equivalence classes, the abilities become interdependent. Several studies have taught matching printed words to dictated words and matching pictures to dictated words, producing the emergence of equivalence classes and the emergence of reading and spelling, although reading scores were systematically higher than spelling scores. The present study taught spelling skills and sought to determine whether it affects reading skills. Four students learned to spell 30 Portuguese words using a computer-based constructed response matching-to-sample task. Simultaneously with presentation of the sample (i.e., a picture and its corresponding printed word or a dictated word), the computer screen showed a pool of 14 letters. The task was to select the letters in the correct order to spell a word that corresponded to the sample. Differential consequences followed correct and incorrect responses. Spelling and reading improved for all of the participants. Spelling performance was as accurate as reading performance for three of the four participants. These results replicate previous data that showed the effectiveness of the constructed response matching-to-sample task in teaching spelling and promoting the emergence of reading. **Keywords:** spelling, reading, constructed response matching-to-sample, recombinative repertoires, stimulus equivalence.

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## Introduction

Reading and writing are different behaviors, and the acquisition of one of these operants does not necessarily result in the emergence of the other (Lee, & Pegler, 1982). However, teaching procedures designed under the conceptual framework of stimulus equivalence have promoted the integration of reading and writing as interrelated repertoires (Aiello, 1995; de Rose, de Souza, & Hanna, 1996; de Souza, de Rose, Faleiros, Bortoloti, Hanna, & McIlvane, 2009; Mackay, 1985; Mackay, & Sidman, 1984; Reis, de Souza, & de Rose, 2009).

The majority of these procedures involve teaching some relations between stimuli, such as matching pictures to dictated words and matching printed words to dictated words. After training, other relations that are not directly taught can be observed: matching pictures to printed words and *vice versa*, reading printed words (textual behavior), and writing upon dictation (e.g., de Rose et al., 1996). A constructed response matching-to-sample (CRMTS) task may be included. In this task, a pool of letters is presented simultaneously with the sample (e.g., a picture, a printed word, a picture and its corresponding printed word, or a dictated word). The learner is required to select the letters in the correct order to spell a word that corresponds to the sample (Dube, McDonald, McIlvane, & Mackay, 1991).

One of these procedures was developed by de Rose and colleagues (de Rose, de Souza, Rossito, & de Rose, 1989; de Rose et al., 1996) and has been extensively tested in both laboratory and applied settings. The results usually show that after the teaching procedure, the participants read the majority of the taught words, spell a high percentage of those words, and show the emergence of relations that were not directly taught between stimuli (de Rose et al., 1989, 1996; de Souza et al., 2009; Melchiori, de Souza, & de Rose, 1992, 2000; Reis et al., 2009).

Despite improvements in both reading and spelling, differences between these repertoires are observed. These procedures focus on reading. Although spelling scores improve, they are usually lower and more variable than reading scores (Reis et al., 2009).

Reis et al. (2009) evaluated the teaching procedure developed by de Rose et al. (1996) using a group design. None of the 38 children in the experimental group could read the words in the pretest, and the initial mean spelling score was 3.4% correct (the highest spelling score was 20% correct). In the posttest, the participants read an average of 96.8% of the words correctly, whereas the mean spelling score was 78.1% correct. The variability between participants should also be considered. Reading scores ranged from 70% to 100% correct, but spelling

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scores ranged from 0% to 100% correct. This pattern has been replicated in other studies (de Rose et al., 1989, 1996; de Souza et al., 2009; Medeiros, Fernandes, Pimentel, & Simone, 2004).

To reconcile these results, some procedures have focused on the spelling instructions (Aiello, 1995; Mackay, 1985; Mackay, & Sidman, 1984). Their goal was to teach the spelling of individual words and evaluate the ability to both spell and read the taught words and establish new relations between stimuli. Variations of the CRMTS task have been used. The results showed that the participants were able to spell most of the taught words by the end of the procedure. They were also able to read many of the words they learned to spell. In the study by Aiello (1995), the participants also showed a recombinative repertoire, meaning that they were able to read and spell words that were not directly taught but were composed of the syllables of the training words. This ability has important implications for effective and efficient teaching.

Considering that most of the procedures designed under the framework of stimulus equivalence effectively establish reading but show less accurate and less stable spelling results and considering that previous studies have shown that spelling instructions can promote reading and equivalence relations, the present study sought to teach the spelling of individual words under the control of dictated words and verify whether the procedure (1) effectively teaches spelling and affects the reading repertoire, (2) promotes the emergence of recombination in spelling and reading (e.g., reading and spelling novel words), and (3) fosters the emergence of untrained relations between the stimuli used in training.

The present study used the CRMTS task as a component of the teaching procedure that differed from those used in previous studies. Additionally, in contrast to other spelling procedures, the present study used computerized tasks and taught a greater number of words (i.e., 30 words, divided into two word sets).

## Methods

### *Participants*

Four elementary school students participated in the study: two girls (Nina and Cissa) and two boys (Cacá and Toni). Their ages at the beginning of the study ranged from 6.9 to 7.8 years. The participants attended a public school in a small town located in southeastern Brazil. They were referred by their teachers because of their low performance on reading and spelling tasks. Assessments conducted prior to the beginning of the study confirmed the participants' difficulties (see *Initial assessments* section below).

### *Setting and materials*

Twenty to 30-min sessions were held 4 days per week with each participant individually. The sessions were conducted in the computer room of the school attended by the participants.

The materials included a computer equipped with the software Aprendendo a ler e a escrever em pequenos passos (Learning to read and spell in small steps; Rosa Filho, de Rose, de Souza, Hanna, & Fonseca, 1998), which presented the tasks and recorded the data. The participants used headphones to clearly listen to the dictated stimuli. Paper, pencils, and erasers were used for the handwriting task.

### *Stimuli*

Thirty two-syllable Portuguese words were taught. The stimuli were selected among the words used in the teaching program developed by de Rose et al. (1996). All of the words had two consonant-vowel (CV) syllables that could be recombined into other meaningful words. The recombination of the syllables resulted in 18 new words that were presented in the test trials to evaluate recombinative spelling and reading.

The training words were arranged in two sets of 15 words each: Set 1 and Set 2. Each set was taught in five training lessons, with three words per lesson. The stimuli used in the study are shown in Table 1.

### *Target task*

To teach and test the spelling of individual words, a computer-based CRMTS task was employed. A sample stimulus could be a dictated word presented through the computer speaker or a compound sample stimulus, including a picture and its corresponding printed word presented at the center of the upper half of the computer screen. The comparison stimuli comprised a pool of 14 letters displayed horizontally across three lines on the bottom half of the computer screen (Figure 1A, B). The letter pool included the letters of the target word plus other letters randomly chosen by the software without replacement (i.e., any letter could be repeated). The task required the selection of the letters in the correct order to spell a word that corresponded to the sample. The selection response included positioning the cursor on a letter and clicking the mouse. Each response produced the displacement of the letter to a construction area located below the window where the visual samples were presented. The constructed response was complete when the participant clicked on a button located on the upper right area of the screen. The button appeared on the screen after the participant selected the first letter. The differential consequences for correct or incorrect responses were contingent on clicking the button (i.e., on the entire sequence of selected letters). No limit hold was used. A trial would remain until a response occurred. Figure 1 shows a schematic representation of the teaching tasks and tasks used only in the probe trials.

### *Study design*

Figure 2 shows the sequence of the procedure, including the assessment phases (or probes) and the training phase. An initial assessment evaluated the

**Table 1.** Training and new words arranged in sets and training lessons.

| Sets of words | Lessons | Training words | New words |
|---|---|---|---|
| Set 1 | 1 | bico (beak), bolo (cake), boca (mouth) | lobo (wolf), tubo (tube) |
| | 2 | faca (knife), vaca (cow), fogo (fire) | figo (fig), gota (drop) |
| | 3 | fita (ribbon), fila (line), tatu (armadillo) | luta (fight), muleta (crutch) |
| | 4 | mula (mule), bule (teapot), vela (candle) | cavalo (horse), fivela (buckle) |
| | 5 | lima (file), luva (glove), lupa (magnifying glass) | tulipa (tulip) |
| Set 2 | 6 | mato (bush), mala (suitcase), lata (can) | mapa (map), saco (bag) |
| | 7 | sapo (frog), pipa (kite), pato (duck) | taco (bat), dado (dice) |
| | 8 | toco (tree stump), gato (cat), galo (cock) | jato (jet), salada (salad) |
| | 9 | caju (cashew), suco (juice), jaca (jackfruit) | sapato (shoe), tomada (socket) macaco (monkey) |
| | 10 | dedo (finger), rede (hammock), fada (fairy) | |

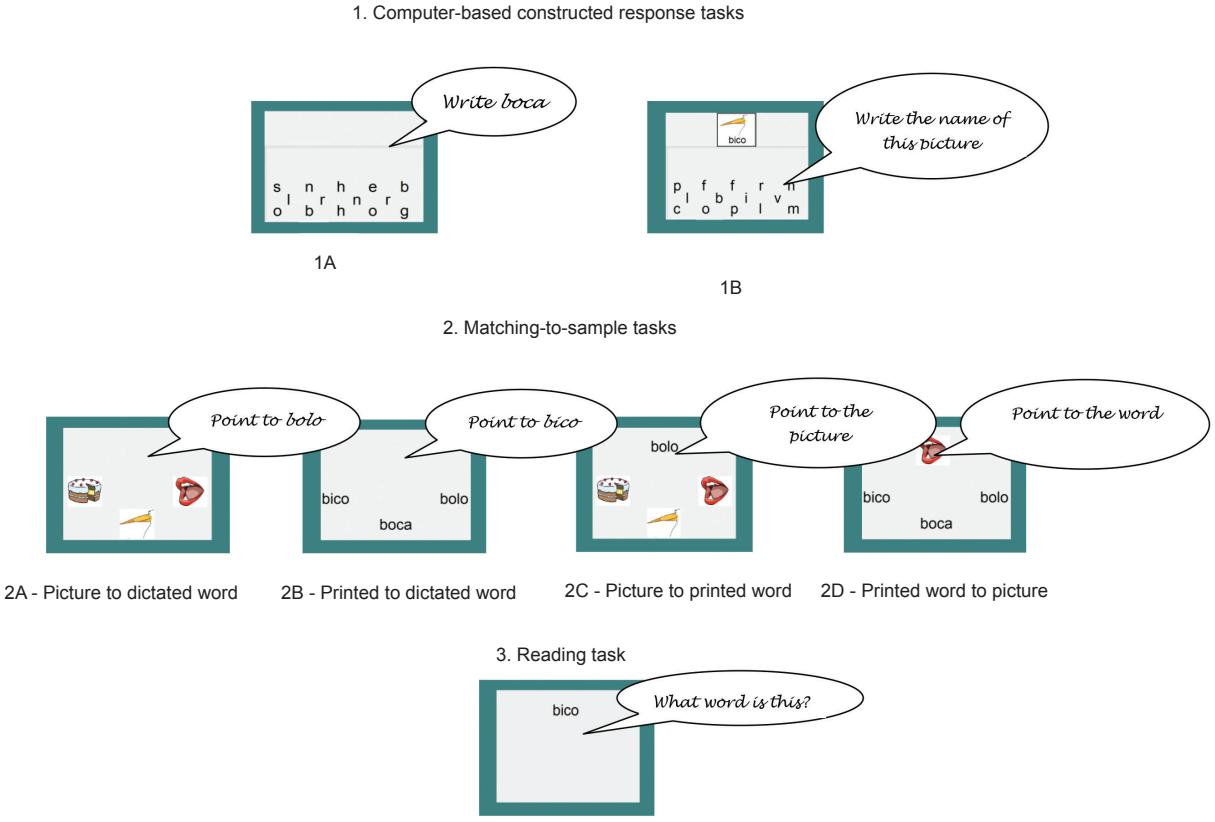


**Figure 1.** Schematic representation of computer-based constructed response tasks (top), matching-to-sample tasks (middle), and reading task (bottom) used in the procedure. The balloons shows the instructions delivered through the computer speakers in each task (the actual instructions were Portuguese phrases). See text for the use of each task type in teaching and assessing the students' skills.

participants' matching, reading, and spelling repertoires. Training phases with each of the two word sets were then conducted, followed by probes. All of the words from Set 1 and Set 2, plus 18 novel words formed by recombining the training words, were probed three times:

I. before the teaching of Set 1, thus, before the beginning of the teaching procedure. Because this assessment was conducted prior to the teaching procedure, it served as a pretest for both sets of words;
II. after the teaching of Set 1 and before the teaching of Set 2. This assessment served as a posttest for Set 1 and second pretest for Set 2;
III. after Set 2 training, thus, after the teaching procedure. Because this assessment was conducted after the teaching procedure, it served as a posttest for both sets of words (second posttest for Set 1 and first posttest for Set 2).

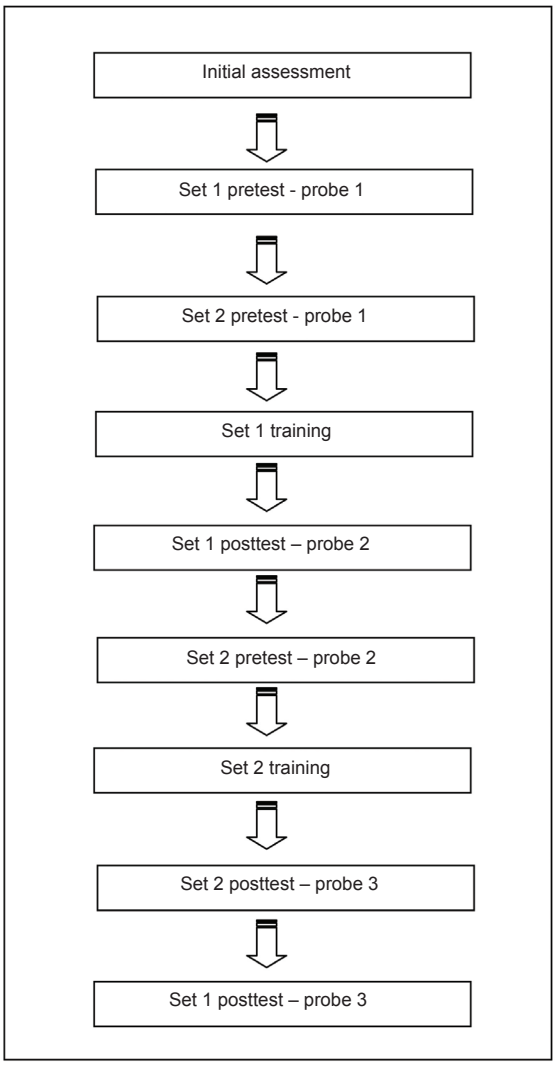


**Figure 2.** General sequence of assessment and training.

### *Initial assessments*

Prior to beginning the study, the students referred by the teachers were subjected to 16 tasks that evaluated reading, spelling, and other components of these target behaviors. Dictated stimuli (spoken words), printed stimuli (words, syllables, and letters), and pictures were presented in the tasks. The assessments were developed by de Souza, de Rose, & Hanna (1996) and evaluated by Fonseca (1997). The tasks included matching dictated, printed, and picture stimuli to each other and reading and spelling tasks. Spelling was evaluated under the control of both printed words (copy) and dictated words.

The words evaluated were also selected among the stimuli used in the teaching program developed by de Rose et al. (1996), but they were not necessarily the same as those selected for the spelling procedure in this study.

### *Pretest or Probe 1: Set 1, Set 2, and novel words*

After the initial assessment, the students were evaluated with the 48 experimental words (i.e., 30 training words and 18 recombined words). Six tasks were tested in the following order: handwriting spelling, computer-based spelling (Section 1A of Figure 1), reading (Section 3 of Figure 1), matching printed to dictated words (Section 2B of Figure 1), matching pictures to printed words (Section 2C of Figure 1), and matching printed words to pictures (Section 2D of Figure 1). Each task presented all of the training and novel words. The 48 trials were arranged in eight blocks with six trials each. Two blocks of each task were presented per session.

Spelling tasks. Spelling was assessed using two tasks: computer-based CRMTS (described above) and handwriting spelling. In the handwriting task, a word was dictated, and the participant was supposed to spell the word using paper and pencil. The consequence for correct responses in the CRMTS task was praise. Incorrect responses received no feedback. Correct and incorrect responses were followed by the next trial.

Reading task. In the reading assessment, a printed word was shown at the center of the upper area of the computer screen. The task consisted of reading the word aloud (Section 3 of Figure 1). A correct response consisted of the emission of a sound pattern that corresponded, point-by-point, to the printed sample (Skinner, 1957). Praise was given after correct responses. Incorrect responses received no feedback. Correct and incorrect responses were followed by the next trial.

Matching-to-sample tasks. The matching-to-sample tasks evaluated three different relations:

1. Matching printed words to dictated words (Section 1B of Figure 1). The sample stimulus was a dictated word presented through the computer speakers and three printed words were presented at the bottom of the computer screen. The task was to select the printed word that corresponded to the dictated word.
2. Matching pictures to printed words (Section 2C of Figure 1). A printed word was presented at the top of the computer screen, and three pictures were shown at the bottom. The task was to select the picture that corresponded to the printed word.
3. Matching printed words to pictures (Section 2D of Figure 1). A picture was presented at the top of the computer screen, and three printed words were shown at the bottom. The task was to select the printed word that corresponded to the picture.

For the matching-to-sample trials, the consequence for correct responses was praise. Incorrect responses received no feedback. Correct and incorrect responses were followed by the next trial.

### *Training lessons: Set 1.*

This phase comprised five lessons. Each lesson taught three of the 15 words from this set. Each training lesson taught target relations with three words. The sequence within a training lesson was the following:

CRMTS to dictated words (pretest), matching pictures to dictated words, constructed response matching letters to compound picture + printed word, CRMTS to dictated words (teaching phase and retention).

CRMTS to dictated words: pretesting the words to be taught. Each lesson began with three trials (one with each target word) of oral dictation with a constructed response. This task was a pretest for the lesson and conducted in extinction. The requirement was to construct the response under the control of a dictated word by selecting individual letters. A correct response consisted of spelling a word according to the dictated sample (i.e., selecting all of the letters that spelled the word in the correct order). No experimental consequences were given. This pretest was conducted to assess the previous spelling of the target words.

Following this specific pretest, the training phase was conducted. Experimental consequences were provided during this phase. The consequence for correct responses was praise that was previously recorded by the computer and delivered at the end of the trial. Incorrect responses received no feedback and were followed by the next trial.

Matching pictures to dictated words. In the first trial block, each trial presented a dictated word (i.e., one of the three words to be trained in the lesson) as the sample and the three pictures that corresponded to the teaching stimuli for that lesson as comparison stimuli (Figure 1, 2A). The task was to select the picture that corresponded to the dictated word. A correct response (i.e., the selection of the picture that corresponded to the dictated word) was followed by praise that was previously recorded by the computer and delivered after the selection. Incorrect responses received no feedback and resulted in repeating the trial until a correct selection was made.

Constructed response matching letters to compound picture + printed word. The next task required the construction of a word under the control of a compound sample stimulus (i.e., picture + corresponding printed word; Figure 1B). The goal of this task was twofold: to prompt the spelling response (the copying response was already well-established in the students' repertoire) and transfer the stimulus control from copying the printed word to spelling the picture name, thus creating a context for the main task (oral dictation). Upon seeing the pictures, the student would have a referent for the words that were dictated in the next task. Three trials were presented, one with each training word. Incorrect responses were followed by repeating the same trial until a correct response occurred.

Constructed response matching letters to dictated words: teaching phase. Twelve trials were initially scheduled, but the number of trials actually conducted could be higher if the participants made mistakes. The number of trials with each target word varied according to the lesson. For each word set in the first lesson, each target word was dictated four times. In the second lesson, the target words were presented three times each, and the words of the preceding lesson were dictated once. From the third lesson onward, each target word was presented twice, and each word of the two preceding lessons was dictated once. Previously taught words continued to be presented in subsequent lessons for maintenance purposes. If an incorrect response occurred, then the procedure backed up to the trial type with the compound sample for that word. After a correct response, the same word was dictated, and the participant was required to spell the word under the control of the dictated word only. The criterion for ending the CRMTS to the dictated words was to correctly spell the words in the 12 trials under the control of the dictated word only. Once this criterion was met, a posttest for that lesson was conducted. The posttest, conducted in extinction, presented three trials, one with each training word. If responding was 100% correct, then the procedure proceeded to the next lesson. Otherwise, the training phase was repeated.

Retention test after each lesson. A retention test was conducted at the beginning of the subsequent lesson. This assessment consisted of three dictation trials, one with each word taught in the previous lesson. Correct responses were followed by praise and led to the next lesson. Incorrect responses received no feedback and resulted in repeating the entire lesson.

### *Probe 2: Set 1, Set 2, and novel words*

After the participant passed the retention test in all five lessons with Set 1, a second probe was conducted (Figure 2). This test served as a posttest for Set 1, a second pretest for Set 2, and a second test for the novel words. The sequence of the tasks and number of trials for each task were the same as in Probe 1, with the exception that the sequence of the trials and position of the correct comparison stimuli within each trial changed.

### *Training lessons: Set 2.*

The sequence of the lessons and sequence of the tasks within each lesson were the same as those described for training with Set 1.

### *Probe 3: posttests*

The procedure was the same as the one described for Probes 1 and 2, with the exception that the sequence of trials for each task and position of the correct comparison stimuli were different from those in prior probes. This time, the probes had the function of assessing the effects of the entire training of the target relations with all of the training and novel words.

### *Interobserver agreement*

Interobserver agreement was sought only for the reading task presented in the pre- and posttest sessions. For each participant, all of the pre- and posttest sessions were video-recorded. Half of these sessions were watched by two independent observers (including the experimenter), who recorded the participants' responses. To obtain interobserver agreement, the number of agreements (i.e., the number of times that the two observers agreed on the participant's response) was divided by the number of agreements plus disagreements

(i.e., number of times that the two observers disagreed on the participant's responses), multiplied by 100. Interobserver agreement was 98.8% (mean range, 96.3% for Nina to 100% for Cissa and Toni).

### *Ethical issues*

The present study was approved by the Ethics Committee of Universidade Federal de São Carlos (process no. CAAE – 0174.0.135.000 – 08). Written informed consent was signed by the principal of the school where the research was conducted and by the participants' parents or responsible guardians.

## Results

All of the participants completed the teaching procedure. Cacá and Toni required 100 days to learn 30 words. The other two participants took longer. Nina completed the teaching procedure in 160 days, and Cissa required 180 days to finish it. The calculation took into account the interval between the first session of the pretest and last session of the posttest.

The number of sessions to reach the criterion of each training lesson varied from one to five, but it was achieved with no more than two repetitions for most of the lessons. Nina and Cissa, however, required five repetitions for some lessons (Lesson 2 for Nina and Lesson 5 for Cissa).

Figure 3 shows the participants' performance on the spelling (both computer-based and handwriting), reading, and matching-to-sample assessments in each of the three evaluations (probes).

### *Spelling*

The bars to the left in Figure 3 show that, except for Cacá, the participants produced no correct spelling before training for Set 1. After training with that word set, taught and novel words that were spelled correctly increased for all of participants in the computer-based task. The number of correct responses with the training words ranged from 10 to 14 of 15. Performance also increased for handwriting spelling. The scores for the training words ranged from seven to 14 words spelled correctly. Cacá, Nina, and Toni correctly spelled some words from Set 2 after teaching Set 1 (i.e., in the second pretest with those words, before they were trained).

After Set 2 training, the participants' performance increased in both spelling tasks. In the computer-based task, all of the participants correctly spelled 14 of the 15 trained words. The performance with words from Set 1 also increased after teaching Set 2. With training words, the scores ranged from 13 to 15 correct responses. Cacá and Cissa had higher scores with the training words from both sets. Nina and Toni had equally high scores with both types of words from both sets.

### *Reading*

With the except of Cacá, who correctly read some words in the pretest (< 15% correct), the participants did not read in the pretest. The bars to the right in Figure 3 show that after Set 1 training, all of the participants read at least 60% of the training words correctly (nine of 15 words). Performance with the training words was slightly higher than performance with novel words for Cacá and Toni. Nina had high scores with both types of words, and Cissa scored very poorly with novel words. Cacá, Nina, and Toni read some words from Set 2 after training Set 1.

After Set 2, Cacá, Nina, and Toni had high scores with both the training and new words. Thirteen to 15 training words were correctly read by these participants. Cissa's performance was high with the training words (i.e., 11 correctly read words), but this participant could not read new words. Scores for the Set 1 words continued to increase after teaching Set 2.

### *Matching-to-sample tasks*

In the pretest, the participants' performance varied, depending on the task. Cacá scored around 70% correct, and Toni scored around 50% correct in all of the tasks. Nina's and Cissa's scores were around chance. Performance increased in all of the tasks after training each set of words. Scores were high with both types of words, although slightly higher for the training words.

## Discussion

Performance in the pretest showed that the participants were unable to spell words. After the teaching procedure, all of the participants could spell the majority of the training words and some new words. Scores in the target task (i.e., computer-based spelling with training words) were high, and variability between participants was small. These data show that the procedure effectively taught the spelling of these target words, extending the results from previous studies that used the CRMTS task to teach spelling skills (Aiello, 1995; Dube et al., 1991; Hanna, de Souza, de Rose, & Fonseca, 2004; Mackay, 1985; Mackay, & Sidman, 1984; Stromer, & Mackay, 1992).

Despite its effectiveness, the fact that only 14 letters were available for construction may be a limitation of the study. In a handwriting task or when someone spells a word using a keyboard, the sample available to them includes all the letters of the alphabet. For Portuguese, this is a total of 26 letters. In the present study, only 14 letters were used because it was the amount allowed by the software in each trial. Although the task was not exactly like the one faced in a natural environment in a specific trial, all of the letters of the alphabet were sampled across trials. The improvement achieved by the four participants with regard to the relations that were directly taught (CRMTS) and the handwriting response mode suggests that the procedure established accurate stimulus control of the target dictated words on written spelling. The participants may have abstracted some of the elementary units of the words (Skinner, 1957) because they also showed some generalized spelling.

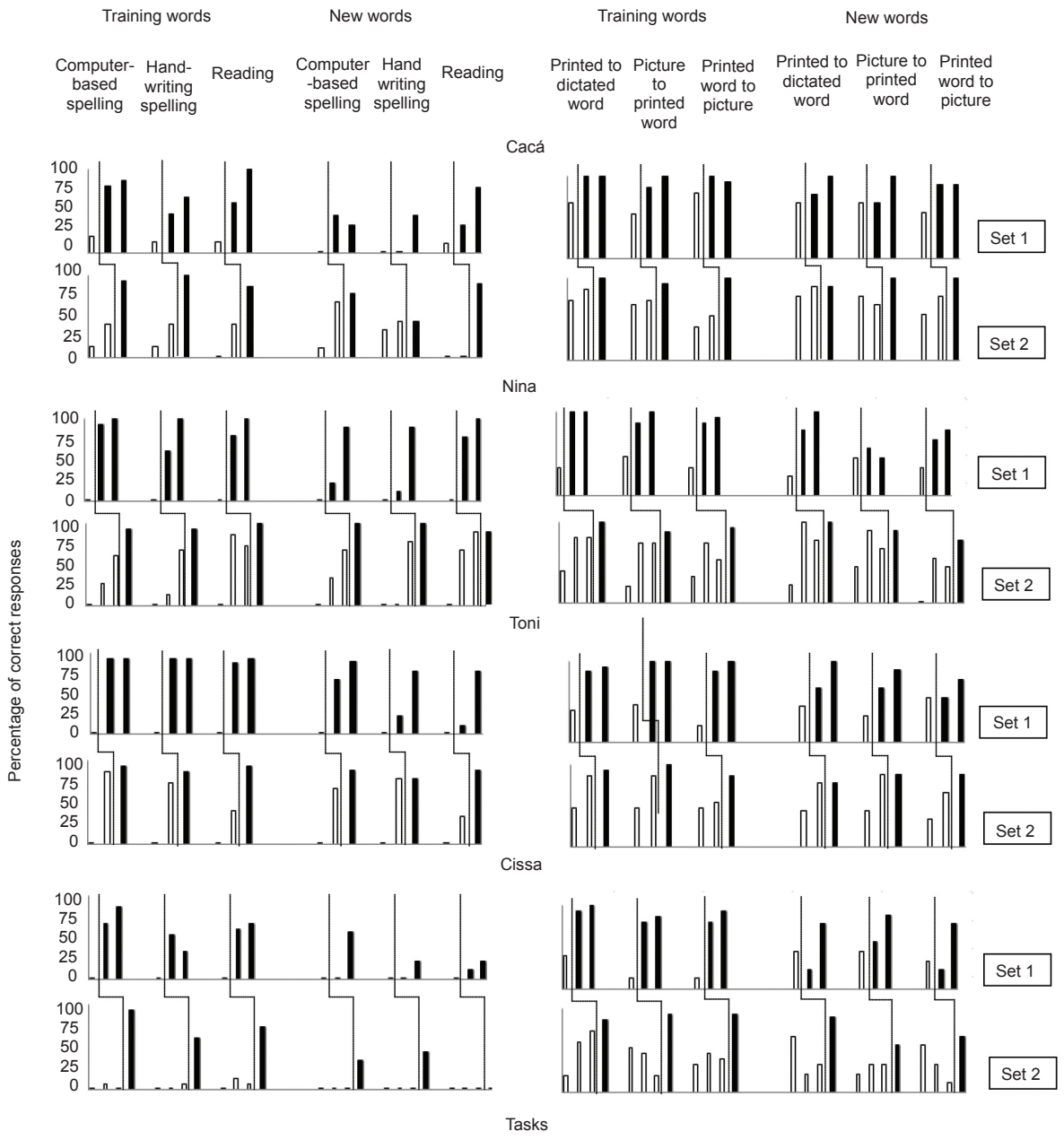


**Figure 3.** Percentage of correct responses on the tasks evaluated in the pretest (white bars) and posttest (black bars) for trained words (left) and novel words (right). The dotted lines indicate training. For each participant, the upper graphic shows the data from Set 1, and the lower graphic shows the data from Set 2. Nina's and Cissa's lower graphic presents four bars because these participants were given an additional assessment of Word Set 2 prior to the teaching phase.

Although more variable than the computer-based spelling scores, handwriting spelling scores were high for most of the participants, at least with training words. Because handwriting spelling was not directly taught, performance on this task suggests generalization from the computer-based to handwriting modes. This might be attributable to a combined effect of the teaching procedure that established the stimulus control to spell a word and the school activities that established the motor responses necessary for handwriting. Previous studies found similar results (Hanna et al., 2004; Reis et al., 2009).

After the teaching procedure, the participants were able to read the words that they learned to spell and that they could not read before the teaching procedure. Reading scores were as accurate as spelling scores with both training and novel words for all of the participants, with the exception of Cissa, although slightly higher variability has been observed for new words. These results replicate and extend previous studies that showed the effectiveness of the CRMTS task in teaching spelling and promoting the joint emergence of reading (Aiello, 1995; Mackay, 1985; Mackay, & Sidman, 1984).

The teaching procedure also affected other untrained relations between stimuli: matching printed to dictated words, matching printed words to pictures, and matching pictures to printed words. Final scores

were high for all of the participants, especially with the training words. These results also replicate previous findings (Aiello, 1995; de Rose et al., 1996; Mackay, 1985; Mackay, & Sidman, 1984; Reis et al., 2009).

Despite of the effectiveness of the spelling task, some concerns may be raised about potential confounding factors that could have influenced the results. Three of the four participants were able to spell and read words from Set 2 prior to training these words. This result could suggest generalization from Set 1 teaching but could also suggest the effect of school activities because the participants attended a school where they were exposed to literacy tasks. A third possibility could be that the results reflect an interaction between the teaching procedure and classroom activities. This was an initial study that tested the teaching procedure, but additional research is necessary to isolate the effects of potentially confounding variables, such as the school experience.

Concerning the possibility of generalization effects, according to Phillips, & Volmer (2012), the term "generalization" could also be used to describe performance with untrained sets of stimuli after some sets have been taught if the amount of training is reduced with subsequent sets. In the present study, Cacá was exposed to nine sessions to reach the criteria for Set 1 and a slightly lower number of sessions (eight) for Set 2. The same was observed for Toni, who required seven sessions to learn the words from Set 1 and five sessions to learn the words from Set 2. Nina needed 13 sessions to reach the criteria for Set 1 but only six sessions to learn the words from Set 2. The argument by Phillips & Volmer (2012) might be used to support the hypothesis that the performance observed with Set 2 was attributable to Set 1 training.

Cissa was the only participant who did not show increased performance related to Set 2 words before teaching. Considering her data only, the procedure appeared to be effective, especially for the target relations. Although handwriting spelling and reading scores for this participant were much lower than the computer-based spelling scores, she learned most of the taught relations, with generalization to untaught skills. However, she did not show the development of recombinative repertoires, given her low scores with novel words.

The scores with novel words were generally less accurate and more variable than the scores with the training words for all of the tasks and for all of the participants. Novel words involved some recombination of the trained syllables, but the possibility of recombination in Portuguese words is not as systematic as the optimal recombination for generating recombinative repertoires (Hanna et al., 2011). The target task required the construction of words with individual letters (i.e., with units smaller than syllables). Perhaps the task requirement (i.e., spelling words using individual letters) was not the best approach to promote recombination. In Aiello (1995), four of the participants who showed spelling recombination were taught to spell the words with syllables instead of individual letters (see also Hanna, Karino, Araújo, & de Souza, 2010).

Studies have shown that to promote recombination, teaching units might be systematically repeated in different positions and with some overlap between them (Hanna et al., 2010, 2011; Mueller, Olmi, & Saunders, 2000; Saunders, O'Donnel, Vaidya, & Williams, 2003). The present study taught 33 syllables, but the majority of them (18) were presented only once. Most of the syllables that were repeated were presented at the same position in different words. Moreover, the repetition of the syllables occurred in particular lessons but not among lessons. Future studies should systematically select the stimuli to be taught, with a focus on maximizing recombinative generalization.

The present study sought to teach spelling skills and determine whether this instruction would result in the emergence of reading and other untrained relations between the stimuli used in training. The results confirmed the hypothesis and extended previous findings that showed that spelling instruction can be as effective as matching printed to dictated words task in promoting reading, spelling, and equivalence relations. In contrast to previous studies that focused on reading, untrained relation scores were as accurate as trained relation scores for the majority of the participants in the present study. Further research is necessary to clarify the variables responsible for this asymmetrical trend. The present results suggest some important variables for the effective promotion of both spelling and reading skills.

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