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Teaching reading and writing to students with intellectual disabilities based on stimulus equivalence instruction

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Abstract

The formation of stimulus equivalence classes has been considered a productive model of symbolic relations – or meaning – for teaching reading and writing. This study aimed to evaluate the effects of one module of a computerized reading and writing program for children with intellectual disabilities enrolled in a regular school. Three students aged between 8 and 10 participated in the study. The program was applied individually to each participant in the school premises across two to three weekly sessions of approximately 35 minutes each. General assessment was applied as a pre and post-test. The results showed that the better the participants' existing repertoires, the faster they advanced in the procedure and improved their reading and writing skills. Conducting this intervention in early school years can contribute to the process of leaning basic reading and writing.

Keywords: reading, spelling, stimulus equivalence, matching-to-sample, intellectual disabilities

ENSINO DE LEITURA E ESCRITA PARA ALUNOS COM DEFICIÊNCIA INTELECTUAL BASEADO NO PARADIGMA DE EQUIVALÊNCIA DE ESTÍMULOS

Resumo

A formação de classes de estímulos equivalentes tem sido considerada um modelo para o estabelecimento de relações simbólicas, ou do significado, contribuindo para o ensino de leitura e escrita. O presente estudo teve como objetivo avaliar os efeitos de um módulo de ensino de um programa informatizado de leitura e escrita em crianças com deficiência intelectual matriculadas em uma escola regular. Participaram três alunos com idades entre 8 e 10 anos. O programa de ensino era aplicado na própria escola, duas a três vezes por semana, individualmente, com sessões de aproximadamente 35 minutos cada. Foi realizada uma avaliação geral de leitura e escrita antes e após o programa. Os resultados mostraram que quanto melhor o repertório de entrada, mais rapidamente os participantes avançaram no módulo e melhoraram seus repertórios de leitura e escrita. A realização dessa intervenção nas séries iniciais pode contribuir para a aprendizagem de repertórios básicos de leitura e escrita.

Palavras-chave: leitura, escrita, equivalência de estímulos, emparelhamento, deficiência intelectual

ENSEÑAR A LEER Y ESCRIBIR A ESTUDIANTES CON DISCAPACIDAD INTELECTUAL BASADO EN EL PARADIGMA DE EQUIVALENCIA DE ESTÍMULOS

Resumen

La formación de clases de estímulo equivalentes se ha considerado un modelo para el establecimiento de relaciones simbólicas, contribuyendo a la enseñanza de la lectura y escritura. El estudio tuvo como objetivo evaluar los efectos de un módulo didáctico de un programa computarizado de lectura y escritura en niños con discapacidad intelectual matriculados en una escuela regular. Participaron tres estu-

diantes de entre 8 y 10 años. El programa de enseñanza se aplicó en la escuela, de dos a tres veces por semana, de manera individual, con sesiones de aproximadamente 35 minutos. Se utilizó una evaluación general de lectura y escritura antes y después del programa. Los resultados mostraron que cuanto mejor era el repertorio de entrada, más rápido avanzaban los participantes en el módulo y mejoraban su repertorio. La realización de esta intervención en los grados iniciales puede contribuir al aprendizaje de los repertorios básicos de lectura y escritura.

Palabras clave: leyendo, escritura, equivalencia de estímulo, emparejamiento, discapacidades intelectuales

The stimulus equivalence paradigm (Sidman, 1994, 2000) has been considered a productive model to establish symbolic or meaning relations, thus it has been adopted in studies on the acquisition of reading with comprehension. In the studies developed by Sidman (1971, 1994), Sidman and Cresson (1973), and Sidman and Tailby (1982), equivalence relations are defined by the emergence of new and predictable analytic units from previously demonstrated units. The pairs of events are directly observable in conditional discrimination tasks for the properties that define an equivalence relation, characterized by symmetry, transitivity, and reflexivity. Thus, after teaching a set of relations among stimuli, untrained relations and stimulus-response relations may also emerge without additional teaching (novel behaviors). For example, when participants learn to match a printed word (C) and picture (B) to the same dictated word (A) through matching-to-sample procedures, they may be able to match picture and printed word (BC and CB) without direct training, and may also be able to read the printed word and write the dictated word.

Based on several studies by Sidman (1971, 1994), Sidman and Cresson (1973), and Sidman and Tailby (1982), de Rose et al. (1992, 1996) developed a curriculum to teach reading and writing of Portuguese words through a network of relations between pictures, printed words, and dictated words called *Aprendendo a Ler e a Escrever em Pequenos Passos* (ALEPP – Learning to Read and Write in Small Steps) for individual application (de Souza et al., 2009a, 2009b).

By creating teaching conditions that promote the learning of skills such as reading and writing, students have an opportunity to develop these repertoires and see themselves as capable of writing and reading, which may increase engagement in these tasks in different environments. These programs are intended to supplement regular classroom teaching (de Rose et al., 1996, 1992). When children have difficulty to learn via regular school instruction and show low age-level reading and writing, they can benefit from the ALEPP curriculum. The goal is to teach entry-level repertoires that will help the students overcome the challenge of the early steps, so they may acquire more complex and refined skills based on accurate reading with comprehension.

Studies on ALEPP have shown to be effective in teaching students with learning difficulties (i.e., who did not master reading and writing with regular classes) to read and write words as well as enable recombinative reading (new words composed by smaller units from previously taught words) (de Rose et al., 1996; de Souza et al., 2009b) with preschool children (Melchiori et al., 2000), illiterate adults (Bandini et al., 2014; Melchiori et al., 2000), individuals with intellectual disabilities (Benitez & Domeniconi, 2016), and children with cochlear implants (Lucchesi et al., 2018).

Benitez and Domeniconi (2016) aimed to assess reading and writing among students with intellectual disabilities exposed to Module 1 of the computerized program, conducted by

family members in their own homes. Six students participated in the study (ages 18 to 49) along with their family members. Five of the six participants who finished Module 1 showed an improved reading performance. In general, the number of teaching sessions ranged from 34 to 94 spread across 13 to 31 weeks. These results demonstrated both the effectiveness of the computerized program to teach reading and writing to individuals with intellectual disabilities and the feasibility of applying the procedure in the students' homes with the aid of family members.

This study consists of a systematic replication of Benitez and Domeniconi's (2016) with younger learners with intellectual disability. This study aimed to evaluate the effectiveness of ALEPP's Module 1 in its computerized version among students with intellectual disabilities enrolled in a regular school.

Method

Participants

Three third-grade students with mild intellectual disabilities enrolled in an elementary school in Brazil were selected to participate in the study after being appointed by the school's special education teacher.

Felipe, male, was 8 years and 5 months old at the beginning of the study. He had diction difficulties and no history of school failure. He received psycho-pedagogical support once a week, speech therapy and occupational therapy every two weeks at school, and special education services in the school's multifunctional resource room once a week during class time. On the Peabody Vocabulary Test – Revised (PPVT-R) (Dunn & Dunn, 1981) – administered by the first author of this article –, Felipe's age equaled 6 years and 1 month old. The Wechsler Intelligence Scale for Children (WISC-IC) test – which shows his intellectual disabilities – was applied in August 2016 by a diagnosis-specialized institution in the city where the study was carried out. According to the report, the participant presented a deficit in verbal comprehension; borderline in perceptual organization and execution activities; difficulty in understanding the meaning of simple words; below-average receptive and expressive vocabulary; and difficulty spelling the first name, vowels, and some consonants.

Lucia, female, was 9 years and 3 months old at the beginning of the study, without history of school failure. She was attending special education classes in the school's multifunctional resource room twice a week during extra-curricular shifts and once a week during school hours. On the PPVT-R – administered by the first author –, her age equaled 3 years and 7 months old. On the WISC-III – administered in March 2015 by the specialized institution of the city –, the participant presented inattention and difficulty to understand instructions, she was able to hold a dialogue in a contextualized manner, she performed well in naming figures from different semantic classes in a poor level of detail – only with background contextual information – and presented difficulty in temporal and spatial orientation.

Roberta, female, was 10 years and 3 months old at the beginning of the study and was attending the third grade for the second time. She received special education services in the multifunctional resource room during school hours once a week. On the PPVT-R – administered by the first author –, her age equaled 7 years and 1 month old. WISC-IV was applied by the same institution as the other participants in January 2016. According to the report, she was able to initiate and maintain a conversation, but sometimes in a decontextualized way with difficulty in comprehension. She also presented difficulty in temporal orientation, wrote simple syllable and trisyllable words with omitted letters and syllables, as well as recognized vowels and most consonants. In reading comprehension, she had difficulty to assimilate the main idea and answer questions.

Experimental setting

After approval by the University's Research Ethics Committee (CAEE 24262713.7.0000.5504), the proposal was submitted to an elementary school in a municipality in São Paulo State that had third grade students with intellectual disabilities who had failed to master reading and writing regular words in Portuguese. Upon parental consent and authorization from the classroom teacher, data collection started.

For the computerized teaching program, we used a notebook connected to the internet, headphones, and a mouse. The procedure was conducted individually by the researcher (first author) in a room that was shared with other teachers.

Data collection was conducted during school hours. The researcher made appointments with the teachers to pick up the child in the classroom and return them to class after the conclusion of the experimental session. Participants performed 35-minute sessions, on average, depending on the task type and the participants' performances. Sessions took place two to three times a week.

The program is available in the LECH-GEIC website (http://geic.ufscar.br/site/), which allows for the remote application of teaching programs. The curriculum is available to researchers of The National Institute of Science and Technology on Behavior, Cognition, and Teaching (https://inctecce.com.br/en/) for basic and applied research.

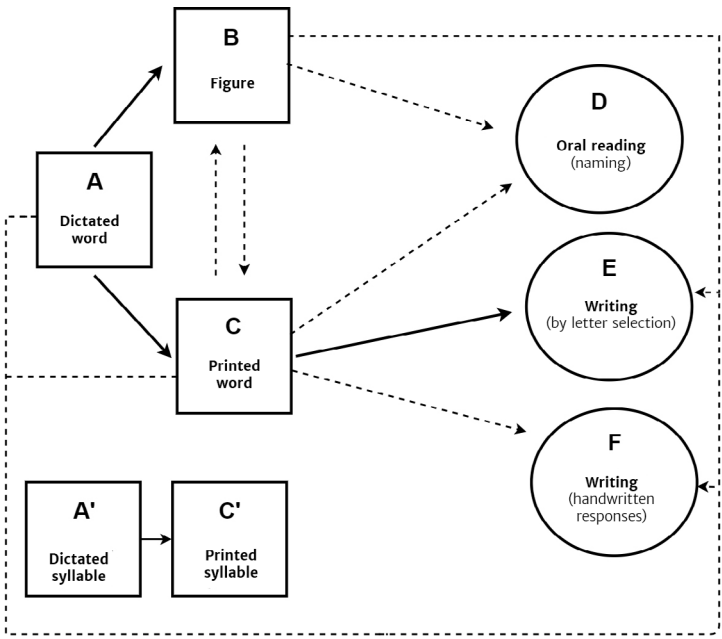
Data collection and analysis procedures

Module 1 of the ALEPP teaching curriculum consists of a general assessment called *Diagnóstico de Leitura e Escrita* 1 (DLE 1 – Reading and Writing Diagnosis 1), in which teaching is divided into four units containing 17 steps with three words each (total of 51 words). Over the years, the program has undergone updates; here, we used version 1 of the DLE and version 2.2 for teaching program. The software allows programmers to configure sessions either in upper

or lower case. The application happened in lower case for Lucia and Roberta and in upper case for Felipe. Figure 1 shows the equivalence relations taught in the program.

Figure 1

Diagram of taught and tested relations in teaching reading and writing



Note. Rectangles show stimuli or selection responses and circles show production responses. Solid arrows show directly taught relations (pointing from sample to comparison stimuli). Dashed arrows show tested relations. Based on de Souza and de Rose (2006) and Benitez and Domeniconi (2016).

Reading and Writing Diagnosis 1 (DLE 1)

The general reading and writing assessment was composed of 15 types of task (see Table 1). Testing was separated into matching-to-sample between printed words (CC), pictures (BB), dictated word to picture (AB), dictated word to printed word (AC), picture to printed word (BC), and printed word to picture (CB). Production tasks – which required participants to name words or pictures – were separated into reading words (CD), syllables (CDs), letters (CDl), vowels (CDv), and naming pictures (BD). Writing tasks (by composition or handwriting) were separated into dictation (AE – writing words by selecting letters on the computer screen, AF – dictated word to handwriting) and copy (CE – printed word to composition using letters,

CF – printed word to handwriting). No programmed consequences followed responses. Most tasks contained 15 trials. Naming letters in the alphabet contained 26 trials (one per letter of the Portuguese alphabet). Naming vowels contained 10 trials – one presentation in sequence (a, e, i, o, u) and one randomized. Naming syllables contained 22 trials. The same test was used in both pre and posttests. Table 1 shows the relations assessed in DLE.

Table 1

Evaluated relations, number of trials, instruction, sample, and comparison stimuli

Type of task	Relation	# of Trials	Instruction	Stimuli	
				Sample	Comparison
Matching-to-sample task	BB	15	Point at the same	Picture	3 Pictures
	CC	15	Point the same	Printed word	3 Printed words
	AB	15	Point at the picture	Dictated word	3 Pictures
	AC	15	Point at the word	Dictated word	3 Printed words
	BC	15	Point at the word	Picture	3 Printed words
	CB	15	Point at the picture	Printed word	3 Pictures
Production task (Reading or Writing)	BD	15	What is the name of this picture?	Picture	–
	CD	15	What word is this?	Printed word	–
	CDl	26	What's written?	Letter	–
	CDv	10	What's written?	Vowel	–
	CDs	22	What's written?	Syllable	–
	AE	15	Write	Dictated word	Letters
	CE	15	Write the same	Printed word	Letters
	AF	15	Write	Dictated word	–
	CF	15	Write the same	Printed word	–

BB = identity picture–picture matching; CC = identity printed word–printed word matching; AB = dictated word–picture matching; AC = dictated word–printed word matching; BC/CB = picture–printed word matching and vice versa; BD = picture naming; CD = word reading; CDl = letter reading; CDv = vowel reading; CDs = syllable reading; AE = dictation with word composition; CE = copy by composition; AF = dictation with cursive handwriting; CF = copy with cursive handwriting

Teaching program

Matching-to-sample and picture-naming training for each unit: divided into matching blocks (AB) and naming blocks (BD). Training was composed of the words to be taught in each teaching unit. Learning criterion in AB was 100% correct responses. After completing this block, participants moved to BD. In case of error, they moved to a new matching block. They could repeat up to five blocks. In the naming block, errors took the student back to the matching block (maximum of five repetitions). If they reached the criterion, they moved to the next

step. If they failed to reach the criterion after five repetitions, the step ended and participants went to the next step (even if they failed to reach 100% in the naming task).

Teaching units pretest and posttest: each test was divided into two steps. In the pretest, the first step evaluated BD, CD, AE, and CC; whereas on the second stage, equivalence tasks (BC and CB) were carried out. All trials provided differential consequences. Correct responses in all relations led to a praise, such as "Very good", "Great", and cheering sounds. Incorrect responses for CC led to a correction procedure – "That's not it" – and the repetition of the same trial. Incorrect responses in the other relations led to the following trial. Learning criterion was set only for BD and CC (if no error, task AB initiated; if error>0, a new block of the same relation initiated). All trials provided differential consequences.

On the posttest, the first step evaluated BC, CB, and CD and the second, CD and AE. All trials provided differential consequences. Reading was evaluated in blocks of three trials with the words taught in the teaching unit. An error in reading led to a review training. The second step evaluated CD and AE. All trials had differential consequences and no learning criterion.

Tasks BC, CB, BD, CD, and AE contained words taught in the unit, generalization words and pseudowords (composed of syllables taught in the unit, with or without meaning in Portuguese).

Teaching steps: consisted of teaching words as well as their syllables. The step started with one retention block of three AC trials (except the first teaching step of Module 1) with the goal of evaluating whether students maintained words they had learned from the previous step. When participants scored below 100%, they underwent the teaching step for the same words. If they answered the three trials correctly, they underwent a teaching step with three new words.

To teach new words, an evaluation block was initially presented, composed of the relation between dictated words and printed words (AC). Next, we presented a teaching block composed of the relations between dictated words and printed words (AC), copy (printed word to composition writing – CE), and dictation (dictated word to composition writing – AE). All teaching trials produced differential consequences. For the matching-to-sample trials, correct responses led to praise and incorrect ones led to a correction procedure and a repetition of the same trial (up to 10 times). For copy and dictation trials, correct responses produced reinforcing consequences (praise) and errors led to the correction procedure.

After teaching the words, we presented test blocks composed of the relation between dictated and printed words. If participants scored 100%, they proceeded to the second part of the teaching step: syllables. If they scored below 100%, the step was terminated after a new exposure to word training (AE, AC, and CE), probe (AC), and posttest (AC), and repeated on the next session.

Teaching syllables included a test block composed of dictation with composition (dictated words to compose using syllables), followed by contextualization (dictated words to

pictures), copy by composition, dictation with picture (picture to compose using syllables), and dictation (dictated word to compose using syllables). The contextualization task had no learning criterion. Then, we taught the syllables that formed the words in each step. Syllables were taught for each word separately (syllabic training – AC'). Thus, participants were taught the syllables of one word and each syllable was presented three times. If the learning criterion was reached, they were taught the syllables for the following word. Otherwise, they would repeat the block up to three times. Learning criterion was 100% correct responses in syllabic posttest. All teaching trials had differential consequences. The syllable teaching block was followed by a dictation test block (dictated word to composition) with the three words taught. If learning criterion was reached, participants moved to the next step. If not, they would repeat the same teaching step on a new session.

Extensive tests halfway and upon completion of the program: were conducted after the conclusion of two teaching units to monitor participants' performances during teaching, making it possible for the researcher to check for difficulties and the need for additional procedures. Each test was divided into four steps. The first and second steps were composed of reading trials using previously taught words (CD) and generalization (new or recombined words). No learning criterion was used and all trials had differential consequences (correct responses led to praise and incorrect ones to the next trial). The third and fourth steps were composed of dictation with composition (AE) and cursive handwriting (AF), respectively. The extensive test was composed of previously taught words and generalization. There were no programmed consequences.

Conclusion criterion for teaching steps: the same teaching step was repeated up to five times. If participants failed to reach the criterion after the fifth repetition, the following teaching step was presented. The first teaching step of the first unit did not contain a retention criterion.

Additional procedures

Throughout the teaching steps, the researcher developed and applied additional strategies to the program. In view of Felipe's difficulty to articulate oral speech, in the dictation step, he was instructed to repeat the word orally (echoic behavior) without the headphones and identify the letters and syllables. In Unit 1, Step 2, words in capital letters were adopted because he was unable to read lower-case words. Lucia and Roberta, from Unit 2 onwards, were instructed to always read the words produced in dictation to composition tasks and printed words to auditory stimulus tasks. The prompts were defined based on an error analysis and several of the researcher's observations. The application of additional procedures had no sequence nor systematization. They were proposed as participants showed the need for aid during teaching sessions.

These procedures were adopted only in teaching. On the Reading and Writing Diagnosis, participants did not receive any consequences for their response or additional procedures.

Results

Students' performances in the DLE showed improvement at the posttest compared to pretests. Figure 2 shows their performance in reading and writing tasks in pretests (gray bars) and posttests (black bars). Participants' performances in pretest ranged from 70% to 100% for BB, CC, AB, and AC and from 30% to 70% for BC and CB. All showed improvement in posttests. Lucia and Roberta performed above 73% in reading tasks (CD) and between 33% and 46% in constructed words (AE). Felipe proved unable to read or write simple words in the pretest. In posttest, all students performed 100% in reading tasks (CD) and above 80% in constructed words (AE). Lucia and Roberta showed improved handwriting composition (AF).

Figure 2

Participants' performances in the reading and writing tasks of the Reading and Writing Diagnosis 1

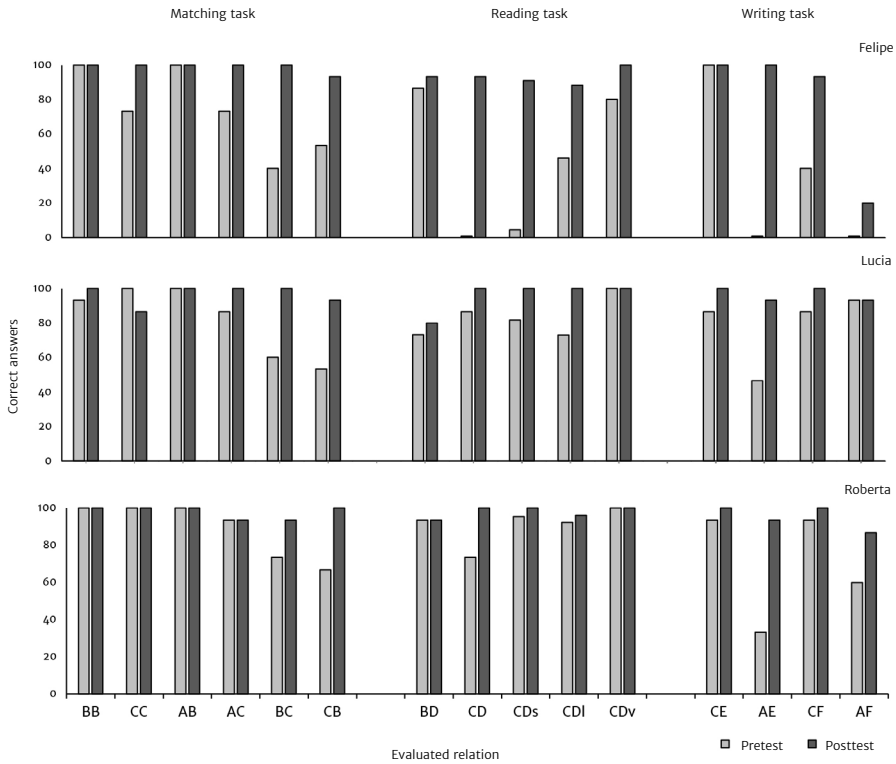
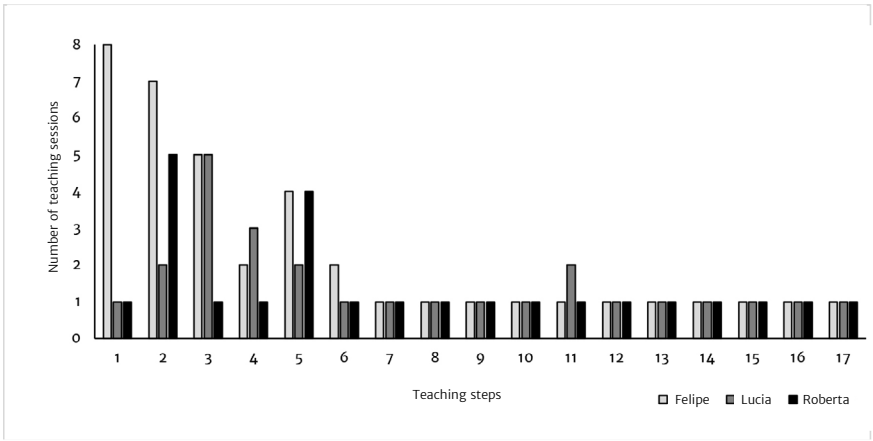


Figure 3 shows that the minimum number of teaching sessions to complete the program was 17. Felipe, Lucia, and Roberta realized 39, 26 and 24 sessions, respectively. For Felipe, Unit 1 used lower-case words while for Unit 2 onwards, the upper case was used.

Figure 3

Number of sessions per teaching step in Module 1



Discussion

The findings of the present study are consistent with those presented in the literature that used the program to teach reading and writing (Bandini et al., 2014; Benitez & Domeniconi, 2016; de Rose et al., 1992, 1996; de Souza et al., 2009b; Lucchesi et al., 2018; Melchiori et al., 2000), thus showing a feasible application of the programs from the curriculum among students with intellectual disabilities enrolled in a regular school. The literature also shows positive results in learning reading and writing skills based on the stimulus-equivalence paradigm conducted among individuals with intellectual disabilities (McIlvane et al., 1992; Maydak et al., 1995; Shimizu et al., 2003; Tanji & Noro, 2017).

Here, the results from the initial evaluation showed that all three participants had different initial repertoires, needed different additional procedures to advance in the program, and required different amounts of teaching sessions to complete Module 1. However, in the posttest, they all showed improved reading and writing skills (see Figure 2). The single-subject analysis allowed for the identification of specific needs for each participant and the proposition of additional procedures. Felipe showed nulled performance in reading (CD) and writing (AE and AF) on the pretest. He had difficulties using the software autonomously by stating he was unable understand the computer's commands (difficulty in understanding dictated

words). For him, the additional procedures may have contributed to the discrimination of word elements, for example, echoic behavior of sample stimuli in a leisurely way and identification of letters and syllables. In the pretest, Lucia performed well in CD, AE, and AF, but intermediately in reading comprehension (BC and CB) and figure naming (BD). Roberta performed poorly in dictation to composition (AE), which required mastering of stimulus control from the previous units that compose the word. For Lucia and Roberta, we proposed additional procedures to favor responding under the control of all word units and to minimize the misplacement or omission of these elements in the composition of words.

Melchiori et al. (2000) emphasized that additional procedures with corrective measures are usually needed when teaching reading and writing skills to special education students. The data suggests the importance of adding an automated protocol in the curriculum before Module 1 to teach fundamental relations (e.g., simple discrimination, identity matching, copy) and familiarize the participants with the contingency (e.g., paying attention to instructions, the comparison stimuli, the differential consequences).

In this study, repetitions of the teaching steps in Unit 1 are similar to the literature. In Melchiori et al. (2000), the average number of sessions per teaching unit were 1.1, 1.5, 2.0, and 3.9 for preschoolers, adults, first graders, and special education students, respectively. In the present study, the participant with intellectual disabilities and speech impairment performed 26 teaching sessions in Unit 1, thus requiring the repetition of 5.2 sessions on average in teaching steps. He required eight sessions to complete Step 1, seven for Step 2, five for Step 3, two for Step 4, and four for Step 5. The additional procedure was implemented from Unit 2 onwards. In general, all three participants required fewer repetitions throughout the units.

Considering the characteristics of the participants here, the researcher's unsystematic observations also contributed to identifying factors that contributed to minimizing difficulties. The researcher started to frequently praise students' correct responses by saying "Well done! You did it! You can write/read". After the researcher's social reinforcement, participants paid more attention to the computer task. For instance, Felipe would smile and say: "I'm learning, aren't I, miss? Now I can read!". He would also make comments such as: "I will be able to read a book, right? Then no one will need to help me read. I will know how to read everything, every single thing!". For Felipe, social consequences were important to improve his performance. In general, special education students in Brazil present significant gaps in academic skills, often being exposed to error conditions and feeling unwilling to engage in academics activities.

The data obtained in our study shows the contribution of the Learning to Read and to Write in Small Steps curriculum as a supplementary resource to classroom activities (de Souza et al., 2004). Interventions during early school years can contribute to the development of basic reading and writing repertoires and help students follow the content by lowering the gap

between what they learn and what the rest of the class learns, thus ensuring a higher motivation to participate in social and academic contexts. Future studies may investigate the generalization of these skills for new environments and contexts (classroom, family environment, specialized institutions).

Finally, we must highlight the limitations of this study. We did not perform a reliability analysis of naming data. However, the automatic recording of selection tasks for AC, BC, and CB point to an individual and gradual progress of all students. Future studies should improve recording response procedures to evaluate integrity and interobserver agreement. Other aspects that future studies should investigate are: 1) the differential consequences for all skills to be evaluated during extensive testing conditions (which has already been changed in the new versions); and 2) planning repertoire maintenance tests after completion of the program (follow up).

Despite the limitations, this study demonstrated a complementary alternative to classroom activities. The results of the studies that used the Learning to Read and to Write in Small Steps curriculum (Bandini et al., 2014; Benitez & Domeniconi, 2016; de Rose et al., 1996; de Souza et al., 2009b; Lucchesi et al., 2018; Melchiori et al., 2000) indicate that Brazilian children can benefit from the systematic application of an evidence-based teaching technology.

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