An Experimental Analysis of Two Error Correction Procedures Used to Improve the Textual Behavior of a Student with Autism

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Instructional programs often require that teachers correct student errors. The current project experimentally analyzed the effectiveness and efficiency of two error correction procedures in improving the oral reading of a girl with autism. The project assessed the effectiveness of a Word Supply and a Discrimination error correction procedure at enhancing accurate reading by measuring the number of error corrections required to teach the child to read segments of text from the same book with 100% accuracy. While both error correction procedures proved effective, the Word Supply corrections were more efficient than Discrimination Corrections in terms of both the number of error corrections required per segment of text and the number of instructional sessions required to reach the pre-set accuracy criterion. We discuss these findings and their implications for instructional planning within the context of earlier experimental work related to error correction procedures.
Keywords: error correction, reading, autism, discrimination.

Wherever teaching and learning happen, erring also probably happens. Accordingly, teachers should invest time, energy, and effort in designing, implementing, and evaluating error correction procedures they use with their students. How teachers correct errors their students make should constitute an important part of any instructional system (Heward, 1997) and may play an even more important for students with special needs such as autism, who often present quite a challenge to even the most skilled teachers. (Scott et al., 2000)

One may consider error corrections as one type of feedback that teachers give students. This feedback seeks to increase the probability that students will respond accurately in the future. Hogin (1996) distinguishes between three types of feedback that teachers might give students: (a) feedback given based on correct performance, (b) feedback given based on incorrect performance, and (c) feedback given based on both correct and incorrect performance. Kulvahy (1977) reviewed published literature on feedback in writing instruction and determined that feedback based on incorrect responses (error correction) proved most effective at increasing the accuracy of student performance.

Falvey, et al. (1980) as cited in Wolery, et al. (1988) defined error correction procedures as teacher-delivered feedback that occurs contingent upon a student responding incorrectly to a stimulus. Wolery, et al. (1988) suggested that teachers should group error corrections based on the suspected cause of the error. For example, Wolery et al. (1988) would classify error corrections that occur because a student lacks a prerequisite skill differently than corrections for errors caused by student inattention.

In instruction of students' textual behavior[1], behavioral researchers have evaluated two specific methods of correcting student errors: *Word Supply* error corrections and *Discrimination* error corrections. Word Supply error corrections involve providing the student with the full correct answer when the student makes a mistake. Discrimination corrections involve the teacher establishing a conditional discrimination within a student's repertoire by asking the student to respond differentially based on some feature of the textual cue that should have occasioned a correct response but did not. An example of a Discrimination correction would include asking a student to respond to the words "Cat" and "Cats" because the student said "Cat" when presented with the word "Cats." In this example, only a portion of the stimulus (the letters "c", "a", and "t", but not the letter "s") controlled the student's textual behavior.

[1] Skinner (1957) defined textual behavior as verbal behavior under the control of textual stimuli

When evaluating these two methods of correcting student errors with young typically developing learners who had difficulty with their reading skills, Carnine (1980) found that error correction procedures that involved highlighting phonemes were more effective than Word Supply error corrections. In contrast, while studying five developmentally disabled students' ability to read words from lists, Barbetta, et al. (1993) compared Word Supply error corrections to Discrimination corrections and found that students performed better when given a complete model than when using a phonemic prompting strategy similar to a Discrimination error correction.

The current project investigated which of the two error correction procedures described above (Word Supply or Discrimination error corrections) was most effective at teaching a student with autism to read stories correctly. The work undertaken by Barbetta, et al. (1993) is similar to the work done in the current project in that the Word Supply error correction procedures were almost identical to the Word Supply error correction procedures used here. Heward's (1997) phonetic prompting Discrimination correction was similar to the Discrimination correction routine used here.

We also hope that the dissemination of the methods we used to analyze the two error correction procedures and the results garnered from that analysis might encourage other scientist-practitioners to conduct further investigation into the effectiveness of error correction procedures they employ within instructional programs they either design or supervise.

Methods

Participant and Therapists

Katie was a young girl with a moderate autism. She was nine years old at the time of this project and received approximately 20 hours per week of in-home instruction under the direction of the authors. Katie had limited functional speech, but she could request things that she wanted using simple, two to three word sentences; Katie could not, however, engage in simple conversational exchanges. She attended her neighborhood public school where she spent her day divided between integrated experiences in a general education class and one-on-one instruction.

Three in-home therapists, hired and paid by Katie's family and trained by the authors to implement the in-home instructional programs designed for her, implemented the intervention procedures described here. Each therapist attended a local university and had worked with Katie for between three and nine months prior to the start of this project.

Experimental Design

To evaluate the relative effectiveness of the two error correction procedures, we employed a combination of two experimental designs—(1) an alternating treatment design followed by (2) a reversal design. For the first part of the experimental design, we employed an alternating treatment design with no baseline across three different pairs of word sets (Kazdin, 1982; Richards, et al., 1999) counterbalanced across time of day and order of implementation. After the last phase using the alternating treatment design, we implemented a reversal design by adding three additional phases during which only one error correction procedure was employed in each phase.

Setting

All therapy sessions took place in a recreation room located within Katie's home. The room was approximately 15 feet wide and 20 feet long and contained a folding card table and two chairs for the therapist and student, two personal computers, one couch, and one television connected to a video cassette

recorder. With the exception of the sessions viewed for the collection of reliability data, instructional sessions took place with only one therapist and Katie in the room.

Materials and Text Segmenting

Across all phases of this project, we used two trade books *Five Little Pumpkins* (Van Rynbach, 1995) and *I Hate My Bow* (Wilhelm, 1995), both of which are intended for beginning readers. Katie began reading text from *Five Little Pumpkins* and switched to *I Hate My Bow* approximately half-way through the third data phase. The texts were segmented into blocks of words by counting from the first word in the text to the 20th word in the text. Those 20 words comprised the first text block. Because text block lengths were fixed at 20 words, it was often the case that a block of text ended in the middle of a sentence. When this happened, we moved to the first word of the next sentence and began counting to 20 again to identify the next text block. Once all of the words in the book were counted, the text segments were marked with light pencil lines and correction procedure were randomly assigned (either Word Supply or Discrimination) for two blocks of text at a time. To do this, we went back to the first and second blocks of text and tossed a coin. If the coin landed heads up, the first block of text was assigned to the Word Supply error condition and the second block of text was then assigned to the Discrimination error correction procedure by default. We then looked at the third and fourth text blocks and tossed the coin again. If the coin landed tails up, the third block of text was assigned to the Discrimination error correction procedure and this meant that the fourth block of text was, by default, assigned to the Word Supply correction procedure. We allowed the error correction procedure assigned to the first block of each text block pair to determine the error correction procedure assigned to the second block of text to ensure that each day Katie would read words that were within both treatment conditions (thus allowing the use of an alternating treatments design) while still being able to proceed sequentially through the book.

Initial Therapist Training, Procedural Reliability, and Data Reliability

To ensure that the therapists implemented the two error correction procedures correctly, the first and second authors first modeled the correct implementation of both error correction procedures. Following this, the authors role-played with each therapist with one of the authors acting as the student and the other author providing feedback to the therapist as the therapist implemented each error correction procedure. Contrived practice continued until each therapist successfully conducted both error correction procedures with both of the authors.

Once data collection for the project started, we collected procedural reliability data for approximately 15% of all therapy sessions either via videotape review of each therapist implementing the error correction procedures with the student or by directly observing each therapist implementing each error correction procedure while they worked with Katie. We calculated procedural reliability data values using the method described in Billingsley, et al. (1980). It is important to point out that as part of evaluating the procedural reliability of the therapists' implementation of each error correction procedure, we included evaluation of whether or not the therapists counted and graphed the data for the project accurately. Thus, measuring the reliability of the data collection was subsumed within measuring the reliability with which the therapists implemented the procedures as prescribed. If the therapists did not count and record Katie's performance data accurately, this would reflect in the procedural reliability data because counting and graphing Katie's data accurately was measured as part of our procedural reliability assessment. The procedural reliability assessment measured the reliability of the data the therapists collected using a point-by-point agreement method (Kazdin, 1982). Each of the therapists delivered and counted both correction procedures with 100% reliability on all procedural reliability observations.

Daily Activities and Error Correction Procedures

The therapists implemented the error correction procedures with Katie during each therapy session. Katie received therapy two to six times per calendar week. Factors such as whether Katie had a cold, whether the therapists were ill, and whether Katie's family had alternate plans all contributed to the range in the frequency of weekly therapy sessions.

Each session began with a therapist seating themselves and Katie at the card table. The therapist then showed Katie the schedule of activities she needed to complete that day which included her reading work. The therapist opened the book to the page containing the set of blocked text Katie would start with for the day, positioned the book in front of Katie, and prompted her to read by asking her to begin and pointing to the first word of the first sentence within the text segment. Katie read aloud and continued to do so until she made an error. Once Katie made an error, the therapist implemented either a Word Supply or a Discrimination error correction depending upon the type of correction randomly assigned to that segment of text. After correcting the error, the therapist pointed to the beginning of the sentence and prompted Katie to read the sentence again. Katie moved on to the next sentence only when she could read the previous sentence with no errors. Katie read for 10 minutes per text block per day. Accordingly, Katie read one block of text assigned to each of the two error correction procedures each day.

Word Supply Error Correction Procedure

When Katie miscalled a word while reading text assigned to the Word Supply condition, therapists stopped her, said, "My turn. What word? [the correct word]. Your turn, Katie. What word?" and waited for Katie to respond. If she responded correctly, the therapists praised her and redirected her to read from the beginning of the sentence. If she responded incorrectly during the Word Supply correction, the therapist repeated the correction sequence from the beginning.

Discrimination Error Correction Procedure

When Katie miscalled a word while reading text assigned to the Discrimination Correction condition, the therapists stopped her and took out a piece of paper. They wrote the word on the paper the way Katie said it and wrote the word correctly—that is, as it appeared in the text. They then pointed to the word written correctly, modeled the correct response, and asked Katie to say the word correctly. The therapists then pointed to the word written as Katie said it (incorrectly), modeled that response, and asked Katie to say the word as she had read it in the text (incorrectly). As an illustration, if Katie saw the word "cat" and said the word "car," a Discrimination error correction looked like this:

Therapist writes the word "car" on a piece of paper.
Therapist writes the word "cat" on a piece of paper.
Therapist points to the word "cat" on the paper and says, "*My turn. What word? Cat. Your turn. What word?*"
Katie says, "*Cat*."
Therapist says, "*Yes, Cat*."
Therapist points to the word "Car" written on the paper and says, "*My turn. What word? Car. Your turn. What word?*"
Katie says, "*Car*."
Therapist says, "*Yes, car*."
Therapist points to the word "Cat" and says "*What word*?"
Katie says, "*Cat*"
Therapist points to the word "Car" and says, "*What word*?"
Katie says, "*Car*."

Each phase continued until Katie read both of the assigned text segments with no errors. Accordingly, she continued to read some segments of text with 100% accuracy for multiple days if she was not yet reading the other text segment without errors.

Data Collection and Dependent Variables

We assessed the relative effectiveness of Word Supply and Discrimination error correction procedures by counting the cumulative number of error corrections required for each type of error correction per block of text. During the alternating treatments portion of the project, each phase consisted of two blocks of text (20 words per block) with the therapists implementing both error correction procedures daily. During the second portion of the project, each phase consisted of one block of text, 20 words per block, with either (but not both) the Word Supply or the Discrimination error correction procedure used each day.

The therapists counted the number of each type of error correction procedure required per day and graphed those as cumulative per minute frequencies. Cumulative frequencies of error corrections required for both Word Supply and Discrimination error corrections were charted on the same graph to allow for easy comparison between the two.

Results

Table 1. Results of the differences between the two texts used in the study in terms of the complexity and repetition of the words contained in each text.

	Text	
Dimensions of Text Complexity	*Five Little Pumpkins*	*I Hate My Bow*
Number of words per book	71	73
Number of different words per book	45	36
Number of repeated words per book	10	19
Range of new words per page	0-6	0-5
Percent of words with one syllable	67%	93%
Percent of words with two syllables	13%	6%
Percent of words with more than two syllables	0%	1%
Median number of times words appear repeatedly	3	3
Range of times words appear repeatedly	0-9	0-8

Analysis of the Two Texts

To determine whether the two texts used in the project were similar to one another along potentially important dimensions, we analyzed the texts by counting the words in each along those dimensions. Table 1 shows the results of that analysis.

The two texts used in this project did not differ from one another in significant ways in terms of the complexity of the words they contained. Each of the texts contained a similar number of words and a

similar number of different words. The pages of each text contained the same median number of new words and a similar range of new words per page. Syllabically, the words in the two texts were also very similar with the majority of the words comprised of single syllables, and multisyllabic words appearing infrequently. Throughout each text Katie repeatedly encountered words the same median number of times and the same range in number of times.

Error Correction Effectiveness

Figure 1, a Daily per Minute Standard Celeration Chart (SCC) (Pennypacker, *et al*, 1972[2]) shows the cumulative number of error corrections required per 20 words of text as cumulative rates per minute across each ten-minute therapy session. The vertical lines on the SCC represent calendar days. The small horizontal lines on the SCC at the .1 cumulative rate per minute show the length of each measurement period and are called the record floors. They represent the smallest nonzero count that we could have attained given how long we measured daily. Placement of the record floor at the .1 indicates that the smallest nonzero count we could have attained was .1 per minute, or that we timed for ten minutes each day, and therefore the smallest nonzero count we could have attained was one in ten minutes or .1 per minute. Because the Y-axis of the SCC included here shows cumulative counts per minute and we timed for ten minutes each day, readers can determine the actual cumulative counts for each error correction per day by simply multiplying the rate on the SCC by ten. As an example, on the first day we implemented the Set 3 Words with Katie, the SCC shows that Katie required a rate of 2 Word Supply error corrections per minute, which represents 20 total Word Supply corrections (a rate of two per minute multiplied across a ten-minute timing).

Sets one, two, and three show the number of error corrections required when 20 words were assigned to the Word Supply condition and 20 words to the Discrimination condition and Katie worked on each set of words daily (the alternating treatments portion of the project). Katie required a total of 34 Word Supply corrections and 86 Discrimination corrections on the first 40 words (20 in each condition). While practicing reading the first two text segments (Set 1 Words), she attained the 100% accuracy criterion in four instructional session for the text segment on which she received the Word Supply error correction, but required 12 instructional sessions to reach that same accuracy criterion for the text segment words corrected using Discrimination corrections. She required 14 Word Supply and 103 Discrimination corrections for the second set of words, and 21 Word Supply and 70 Discrimination corrections for the third set of words. Katie's reading met the 100% accuracy criterion in four instructional sessions under the Word Supply condition with the Set 2 Words phase, but required 16 sixteen instructional session to meet the accuracy criterion in that same phase. For the Set 3 words, Katie's reading met the accuracy criterion in 14 instructional session under the Word Supply correction condition and required 15 instructional sessions to meet the accuracy criterion under the Discrimination error correction procedure.

[2] Readers who would like more information about the Standard Celeration Chart may consult the *Handbook of the Standard Celeration Chart* (Pennypacker, Guitierrez, & Lindsley, 2003), which readers may order online through the Cambridge Center for Behavioral Studies (www.behavior.org).

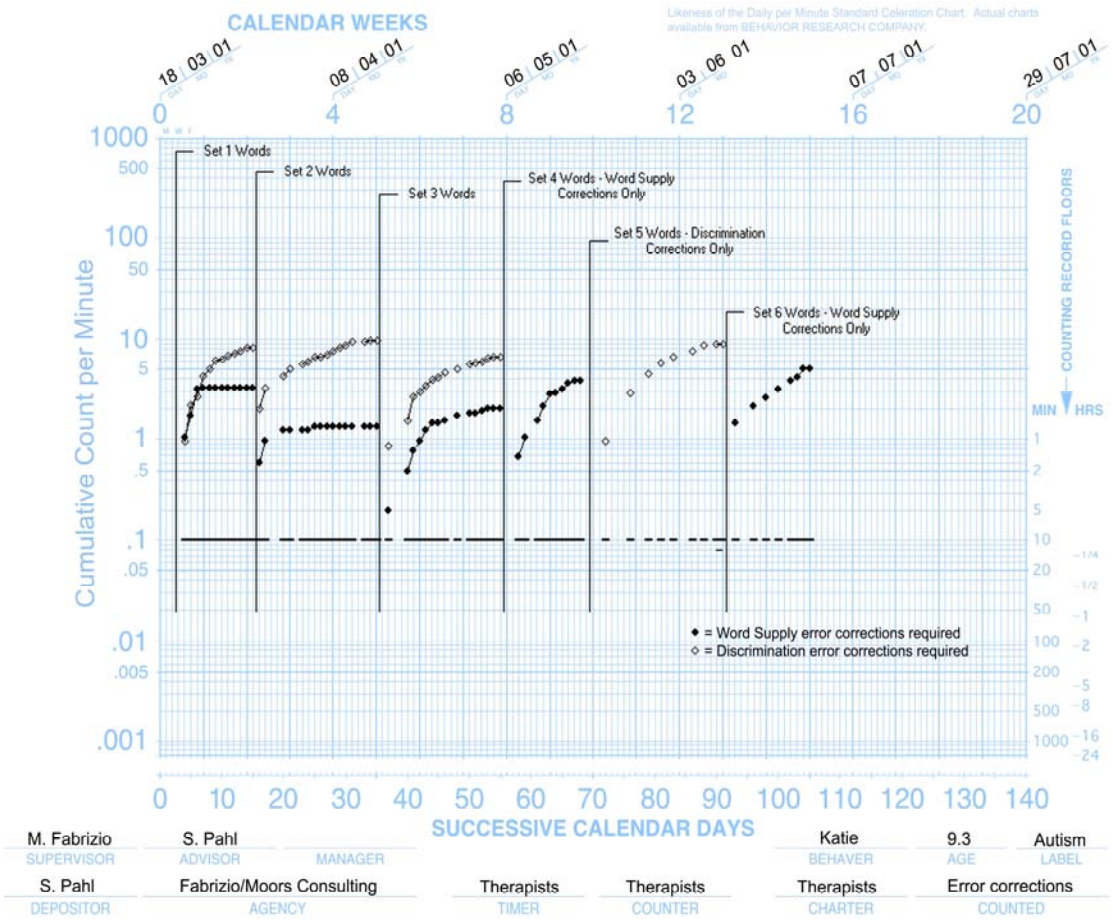

Figure 1. Cumulative per minute frequencies of Word Supply and Discrimination error corrections required per text segment

By the completion of the third set of 40 words (20 in each of the two error correction conditions), the data repeatedly showed that Katie required fewer Word Supply error corrections than Discrimination corrections, and for two of the three phases, she required noticeably fewer instructional sessions to read accurately when her therapists employed the Word Supply error correction when the two procedures were implemented concurrently. Because of these results, we evaluated the error correction procedures when implemented serially to investigate any interaction effects that may have existed in the alternating treatment phase from our concurrent application of the two correction procedures. Set four shows the number of Word Supply error corrections Katie required for the next set of 20 words. During this phase of the project, Katie only received Word Supply error corrections. For Set 4, Katie attained 100% accuracy on the next set of 20 words after 10 ten-minute instructional sessions, during which 40 Word Supply error corrections occurred.

Once she read the passage containing those words at 100% accuracy for two consecutive days, she went on to the next set of 20 words where the therapists corrected her errors using only Discrimination corrections each day. Katie required 93 Discrimination corrections across nine instructional sessions.

To finish the project, the therapists went on to the next set of 20 words and corrected Katie's word miscall errors using the Word Supply procedure. For this final set of words, Katie required 53

Word Supply corrections across eight instructional sessions to satisfy the 100% accuracy criterion across two consecutive instructional sessions for completion.

Error Correction Efficiency

Overall, Katie required a total of 162 Word Supply error corrections and 352 Discrimination corrections. She required an average of 32 Word Supply error corrections per text segment of 20 words and 88 Discrimination error corrections per text segment of 20 words across all phases of the project. When Word Supply and Discrimination corrections were used together (that is, during the alternating treatment design portion of the project), Katie required an average of 23 Word Supply and 86 Discrimination corrections on each text segment, which she mastered in an average of five instructional sessions using the Word Supply correction compared with an average of 14 instructional sessions using the Discrimination correction. When used serially during the reversal portion of the project (that is, the last three phases in Figure 1), Katie required an average of 47 Word Supply and 93 Discrimination error corrections and mastered each text segment in an average of nine instructional sessions for both error correction. Figure 2 shows the total number of Word Supply and Discrimination error corrections Katie required per set of 20 words.

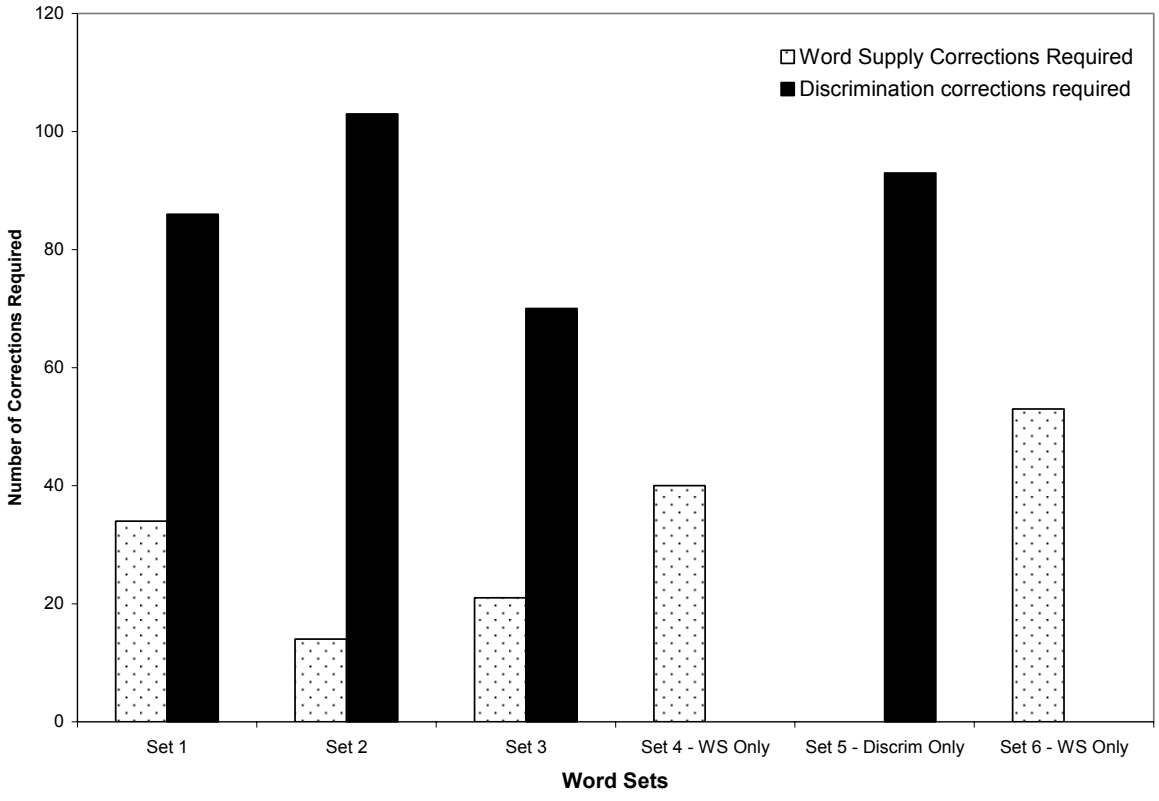

Figure 2. Bar graph showing the total number of each type of error correction required during each phase of the project.

Discussion

The findings of this project support those reached earlier by Barbetta et al (1993). Word Supply error corrections were superior to Discrimination corrections in producing accurate oral reading for Katie.

The Word Supply corrections were superior both in terms of the lower overall number of corrections required compared to Discrimination corrections, as well as the amount of time they saved Katie. Katie read the segments of text where therapists corrected her errors using Word Supply corrections with 100% accuracy in fewer instructional sessions than segments of text corrected using Discrimination corrections. Both error correction procedures appeared effective in helping Katie read text accurately, but the Word Supply proved substantially more efficient in terms of the number of discrete error corrections she required.

Unfortunately, the number of corrections required for either error correction procedure did not decrease over the course of the project. While data were not collected on which words Katie missed, neither the total number of corrections required per text segment nor the number of error corrections required per error correction type diminished as Katie worked her way through the two texts used in this project. Given that books written at such a low readability level as the ones used in this project (both books were written at the mid-first grade level) usually contain a rather narrow range of vocabulary, in all likelihood Katie required repeated error correction on several of the same words more than once.

Just as the results of this project mirror those of earlier projects, they also contradict other projects such as the work of Carnine (1980) who found that correction procedures that were closer to the Discrimination correction procedure used here were more effective at improving the reading performance of the students they studied. A particularly interesting question is why that might be the case; the answer likely lies in the current repertoires and histories of the learner What skills the learner brings to any instructional task is an essential variable for consideration when planning instruction. As Barbetta *et al* (1993) point out in their analysis of the discrepancy between their findings and those of Carnine (1980), the students Carnine used in his study were naïve to reading before the start of the project. Because of this, they received systematic reading instruction based on phonics before beginning the phase of the project where the authors compared the error correction procedures. Unlike the systematic and early instruction that students in the Carnine (1980) study received, the students in the Barbetta, *et al* (1993) study had mixed histories in terms of the reading instruction they experienced. They received both sight word reading instruction and explicit instruction in phonics, but probably had more extensive and frequent contact with sight word instruction than the children had in Carnine's (1980) study.

Katie's learning history in reading matched that of the students in the Barbetta, *et al* (1993) study much more closely than the history of the students in the Canine (1980) study. Prior to our starting to work with Katie, she had received reading instruction based on sight words. We attempted to teach her to read using phonics for a full year before the start of this project, but had very little success with this, and so reverted to teaching her reading through sight words. Prior to completing this project, we did not match the error correction procedures we used with Katie to her learning history. Following this project, we used only Word Supply error corrections when Katie miscalled a word during reading instruction and practice. It may be, then, that the closer the match between error correction procedures and the instructional history of the learner, the more efficient the procedure may prove in improving student performance.

The need to match instructional procedures to students' learning histories only heightens the importance of empirically validating instructional practices with individual students. Conducting the analysis reported here of the two error correction procedures was neither time nor energy intensive. The therapists were easily trained to implement the two error correction procedures reliably and to collect data reliably. The results of the project—knowing how to best correct miscall errors for Katie—allowed us to make better recommendations for her schooling and allowed us to provide her with higher quality clinical services.

While the data presented here have certainly helped us serve Katie better, they do have their limitations. For example, in the current project words were not assigned to error correction conditions randomly. The text was first divided into segments each containing 20 words, and the segments themselves were then randomly assigned to either the Word Supply or the Discrimination correction condition. Accordingly, it is possible there significant differences existed between the words within various segments and, subsequently, the words assigned to either condition. If such differences existed, they might have influenced the number of error corrections and the number of instructional sessions that Katie required to read the words accurately. This potential confound is mitigated by the reading level of the books used in the project. The books were written at the mid-first grade reading level. Books written for such young readers typically do not contain as wide a range of words as books written for readers with more advanced skills. The pool of words contained within books written for early readers is restricted by virtue of the audience for whom the books were written—younger, beginning readers tend not to know as many words as older, more accomplished readers. This restricted vocabulary range often found in books written for young readers reduces the chance that significant differences existed between words contained in different segments of text.

An outcome of this project that surprised us involved our prediction that the discrimination correction would have been more effective given the nesting of the Word Supply procedures within the Discrimination correction procedures. Each Discrimination error correction consisted of two Word Supply corrections plus the rapid alternation between the correct word and the word written the way Katie incorrectly pronounced it. The data generated by this project clearly indicated that, for Katie, Word Supply error corrections were superior as measured by the number of corrections required to read the text with 100% accuracy. Because each Discrimination correction consisted of two Word Supply corrections and juxtaposition of the correct and incorrect pronunciation, we anticipated that the Discrimination corrections would prove more effective, but that was not the case. Given Katie's long learning history as a sight reader, it may be that Katie' textual behavior could not be adequately occasioned by the correct word given the very fine discriminative responding required by the Discrimination error correction procedure we used. Additionally, the conditional discrimination required within the Discrimination procedure may have inhibited Katie's acquisition of the correct response to the erred word. In other words, requiring a discriminative response to the written incorrect word Katie said may have served to inhibit the acquisition of correct responding to the correct word. Further, the more parsimonious nature of the word supply procedure occasioned more correct responses per unit of time in error correction. This higher rate of correct responding to erred words could have been a substantial contributing factor in Katie's enhanced performance in the Word Supply correction.

Future research into the use of various error correction procedures with students should explore (1) aligning students to the error correction procedures selected and (2) refining the measurement, assessment, and evaluation of error correction procedures in clinical settings as two possible veins of meaningful inquiry. Applied researchers may do much to improve the effectiveness and efficiency of instruction that students receive in all areas if they advance the technology available that will assist clinicians in selecting error correction procedures for given students at given times.

Where error corrections are concerned, one size probably does not fit all; as results derived from applied behavior analytic research allow better and better matching of instructional procedures to learners, those results will improve the "goodness of fit" between procedures clinicians prescribe and the learners those procedures are designed to help. For example, future researchers interested in evaluating the relative "goodness of fit" between learners' histories and the error correction procedures employed in reading instruction, may evaluate the degree to which the learners' phonics skills predict whether a Discrimination correction or a Word Supply correction will likely be most effective and efficient.

Additionally, researchers might evaluate whether phonics instruction changes the relative effectiveness of each error correction procedure. Because Discrimination corrections rely on the reader's behavior coming under very fine conditional discriminative control—control often exerted by the change, addition, or deletion of one letter—readers without successful histories of forming such fine conditional discriminations to text may not have the prerequisite histories necessary to benefit from the correction procedure. Once we as a discipline better understand the nature of any functional relationships that may exist between learners' histories before reading intervention, their experiences during that intervention, and the interaction between the error correction procedure we use and those learner histories, we will find ourselves better able to knowingly prescribe error correction procedures for different students, at different times, under different conditions.

Beyond further exploration of the nature of the functional relationships between learners' histories and the correction procedures we use with them, another important step in allowing more refined prescription of error correction procedures will be the refinement of methods that allow better measurement, assessment, and evaluation of those procedures. One suggestion for improving measurement, assessment, and evaluation as they relate to error correction procedures includes counting the number of errors students repeatedly make within any given instructional task. Measuring the number of repeated errors across time as a function of the types of error correction procedures employed will help clinicians further evaluate the efficiency of the error correction procedures themselves. Those error correction procedures that decrease repeated errors may then be selected as more efficient.

A further area for progress in the measurement of error corrections may lie in including a time dimension in all measurement. All behavior (whether human behavior or that of any other organism) exists within the context of time. Regardless of what we do or do not do, time continues to flow. Because our interest is the study of various phenomena in context and their effects on human behavior, and that behavior occurs within a temporal context, we should include time as part of our measurement.

In practical terms, including time as part of our measurement may help us answer several potentially important questions about error corrections. First, does the amount of time required to implement various error correction procedures alter effectiveness? The length of time that students spend in error correction procedures may prove an important variable in enhancing their performance. If clinicians and researchers begin measuring the length of time students spend in actual error correction, this measurement would allow comparison of time spent in correction versus time spent in instruction and may also help inform evaluation of the efficiency of the correction procedures; teachers and clinicians could differentially select those procedures that proved not only effective but also efficient. While we measured instructional efficiency here as the number of instructional sessions required for Katie to reach accuracy and as the total number of correction required, measuring the time she spent experiencing each correction procedure may have added to or changed completely our evaluation of the two procedures' efficiency.

A second way in which measuring time may help us advance as a discipline in our understanding of error correction may relate to the density of that correction as measured by the number of error corrections students experience per unit of time. How much error correction students receive per unit of instructional time may affect both the efficiency and the effectiveness of the error corrections themselves. If we include time in our measurements, we may see that a linear relationship exists between the number of error corrections a student receives (the count) per unit of time. If we discovered such a linear relationship, we would know that he more error correction a student receives, the better off she is. Or, we may discover that a parabolic relationship exists between the density of error corrections and the improvement our students enjoy from those corrections. In this case, we would know that students' performance improves with increasing densities of error correction up to a certain point past which we see diminishing returns in terms of student improvement.

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