

**EFFECTS OF ACTIVE STUDENT RESPONSE DURING
ERROR CORRECTION ON THE ACQUISITION,
MAINTENANCE, AND GENERALIZATION OF SIGHT WORDS BY
STUDENTS WITH DEVELOPMENTAL DISABILITIES**

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We used an alternating treatments design to compare the effects of active student response error correction and no-response error correction during sight word instruction. Six students with developmental disabilities were provided one-to-one daily sight word instruction on eight sets of 20 unknown words. Each set of 20 words was divided randomly into two equal groups. Student errors during instruction on one group of words were immediately followed by the teacher modeling the word and the student repeating it (active student response instruction). Errors on the other group of words were immediately followed by the teacher modeling the word while the student attended to the word card (no-response instruction). For all 6 students, the active student response error-correction procedure resulted in more words read correctly during instruction, same-day tests, next-day tests, 2-week maintenance tests, and generality tests (words read in sentences).

DESCRIPTORS: error correction, instructional design, feedback, reading, developmentally disabled children

One of the most consistent findings of educational research in recent years is the positive correlation between active student response and academic achievement: Students' acquisition and maintenance of academic subject matter increase as a function of time spent actively engaged in directly related learning tasks (Berliner, 1980; Greenwood, Delquadri, & Hall, 1984; Pratton & Hales, 1986). *Active student response* (ASR) can be defined as

an observable student response made to an instructional antecedent (e.g., responding verbally to a question, writing a response to a math problem, reading aloud). Much of the support for increasing ASR during instruction comes from large-group correlational studies linking several instructional variables to student achievement (e.g., Fisher et al., 1980; Rosenshine & Berliner, 1978) and experimental studies such as direct instruction (Carnine & Silbert, 1979; Gersten, Carnine, & White, 1984) or peer tutoring programs in which increased ASR is part of an intervention package (Barbetta, Miller, Peters, Heron, & Cochran, 1991; Cooke, Heron, & Heward, 1983; Delquadri, Greenwood, Whorton, Carta, & Hall, 1986). Additional support comes from high-ASR instructional strategies such as choral responding (Heward, Courson, & Narayan, 1989), response cards (Gardner, Heward, & Grossi, in press; Narayan, Heward, Gardner, Courson, & Omness, 1990), and timed trials (Miller & Heward, 1992; Van Houten & Thompson, 1976) that occasion frequent student response by manipulating antecedent stimuli (materials used,

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questions asked, flash cards presented) and/or the students' response mode (vocal responses, written responses).

ASR can also be influenced by the way in which instructional feedback is provided. For example, direct instruction programming (Gersten, 1985; Gersten *et al.*, 1984) and several other effective instructional programs (e.g., Barbetta *et al.*, 1991; Delquadri *et al.*, 1986; Heron, Heward, Cooke, & Hill, 1983; Narayan *et al.*, 1990) require students to emit the correct response during error correction. Because error correction is only one part of these larger instructional packages, its contribution to their effectiveness is not clear. Research has shown that *directed rehearsal*, a remediation strategy that requires students to emit the correct response several times following an error, is effective (Dalrymple & Feldman, 1992; Hinerman, Jenson, Walker, & Peterson, 1982; Lenz, Singh, & Hewett, 1991; Matson, Esveltd-Dawson, & Kazdin, 1982; Singh, 1987; Singh, Singh, & Winton, 1984). This research, however, was not designed to determine the effects of requiring students to make only one active response during error-correction trials. Research is needed that experimentally demonstrates the relation between having students emit one active response during error-correction trials and student achievement.

In a previous study comparing remedial strategies on sight word reading by 5 students with developmental disabilities, we found that whole-word error correction (the teacher stated the complete word and the student repeated it) was more effective than phonetic prompts provided by the teacher (Barbetta, Heward, & Bradley, 1993). The present study investigated whether it is important that whole-word error-correction trials end with the student emitting the correct response. Specifically, we compared the effects of active student response (ASR) error correction and no-response (NR) error correction on the acquisition, maintenance, and generalization of sight words by students with developmental disabilities. During ASR error correction, each error-correction trial ended with the student emitting the correct response following a teacher-provided model. Correction of errors under

the no-response (NR) condition ended with the teacher making the correct response while the student passively attended.

METHOD

Participants and Setting

Four males and 2 females, aged 8 to 9 years, participated in the study. All of the children were enrolled in a primary self-contained class for students with developmental disabilities and were selected for the study by their teacher based on their need for improved sight word repertoires. Each student was mainstreamed into the general education program for part of the day.

Full-scale IQ scores ranged from 58 (Student 5) to 76 (Student 6). Results of the Brigance Inventory of Basic Skills (Brigance, 1983) administered prior to the study indicated that Students 1, 2, and 3 read at the preprimer level, Students 4 and 5 read at the first-grade level, and Student 6 read at the second-grade level. One-to-one instruction and testing sessions were conducted 5 days per week in a corner of the special education classroom. The first author served as the experimenter.

Sight Words

During each of the 8 weeks of the study for each student, the two-step pretesting method described in Barbetta *et al.* (1993) was used to create a new set of 20 unknown words from a pool of words identified by the classroom teacher. The 20 target words (from those a student missed twice) were printed by hand on index cards (3 in. by 5 in.) and were randomly assigned to either ASR or NR error correction.

Pretesting of words for which generality tests (words read in sentences) were taken included a third step. Words missed twice on cards were embedded in 20 different 3- to 10-word sentences (depending on each student's reading ability) composed of words in the student's reading repertoire. The experimenter asked the student to read each of the 20 typed sentences, one sentence at a time. Only those target words missed once in a sentence

(that were initially missed twice on word cards) were included in word sets to be instructed.

Procedure

One-to-one instructional sessions were conducted 4 days per week. A new word set was introduced weekly. Each 12- to 15-min session consisted of a next-day test, instruction with ASR and NR error correction, and a same-day test. As described in Barbetta et al. (1993), next-day and same-day tests were conducted by the experimenter shuffling the 20 word cards and presenting each individually. No feedback was provided for correct or incorrect responses during next- or same-day tests.

Instruction began immediately after the next-day test (with the exception of the first day of instruction for each set for which no next-day test was given). The experimenter told the student which correction condition (ASR or NR) would be used during the first instructional round (a round being the presentation of all 10 words assigned to a condition) and presented one word at a time from that condition. The experimenter began each practice trial by holding up a word card and saying, "What word?" Each correct student response was followed by brief praise (e.g., "good," "right"). Incorrect responses were followed by either ASR or NR error correction.

ASR error correction consisted of the experimenter modeling the word and having the student repeat it. When a student erred on an ASR word, the experimenter immediately said, "No, this word is _____. What word?" After the student repeated the word, the experimenter praised the student ("good," "yes") and presented the next word card.

NR error correction consisted of the experimenter modeling the word and the student looking at the word card. When a student erred on an NR feedback word, the experimenter immediately said, "No, this word is _____. Look at it." After 2 to 3 s (approximating the time used to make an active response in the ASR condition), the experimenter praised the student for attending ("good looking") and presented the next word card.

The experimenter presented each of the 10 words per correction condition a total of three rounds

per session. At the end of each round, she praised the students for "working hard."

Dependent Measures

The number of correct responses during ASR and NR instruction by each student was counted. These data include initially correct practice trial responses plus responses made during error-correction trials. Because no student responses were emitted during NR error-correction trials, NR response data include only initially correct practice trial responses and any occasion in which students inadvertently emitted a response during NR error-correction trials.

As described in Barbetta et al. (1993), data were also collected on (a) the number of words read correctly on same-day tests, (b) the number of words read correctly on next-day tests, (c) the percentage of words read correctly during instruction (three trials per word), (d) the percentage of corrected words read correctly on their next presentation during instruction (referred to as next-trial correct, NTC), and (e) the number and percentage of previously learned words (correct on the same-day tests after the fourth and final instructional session) read correctly on a 2-week maintenance test.

Data were also collected on the number of words read in sentences on generality tests administered on two of eight word sets (due to time constraints) for 5 of 6 students. Student 3 did not take generality tests because of his limited reading vocabulary. Words read correctly on a word card were read in the 3- to 10-word sentences developed during pretesting. Tests were administered after the second instructional session, the day after instruction ended on a word set, and 1 and 2 weeks following instruction on a word set. Sentences were presented one at a time. When a student erred on a word other than the target word, the experimenter provided the correct word, and the student was permitted to reread the sentence. Scores were determined by comparing target words read correctly on that day's test on cards (a same-day, next-day, or maintenance test) to target words read correctly in sentences. For all measures of sight word performance, a response was scored as correct if the

student pronounced the word correctly within 3 s. Self-corrections within 3 s were also scored as correct.

Experimental Design

An alternating treatments design was used to assess the effects of ASR and NR error correction. Each week 10 words were taught with ASR error correction and 10 words with NR error correction. The presentation order of the ASR and NR conditions was randomized and counterbalanced across sessions.

Interobserver Agreement

A trained independent observer recorded each student's performance on all dependent measures. The second observer sat near the student in full view of the presented word cards. Percentage of agreements was calculated using a word-by-word method, dividing the total number of agreements by the total number of agreements and disagreements and multiplying by 100%. Interobserver agreement measures were obtained for the following: (a) 66 of the 192 (34%) same-day tests, resulting in a mean agreement score of 99.8% (range across students, 99% to 100%); (b) 71 of 191 (37%) next-day tests, resulting in a mean agreement score of 99.9% (range, 99% to 100%); (c) 3,960 practice trials across 66 instructional sessions, resulting in 100% agreement; (d) target words read in sentences yielding 100% agreement; and (e) maintenance tests yielding a mean agreement score of 99.6%.

Treatment Integrity

The same observer recorded the occurrence or nonoccurrence of critical instructional procedures during 3,960 practice trials (660 practice trials per student) across 66 instructional sessions. The observer independently recorded whether the experimenter properly delivered ASR or NR error correction after student errors and whether she provided verbal praise for correct student responses. The experimenter provided error correction as described above for 100% of the 842 (ASR condition) and 1,151 (NR condition) student errors observed. She

praised 99.9% and 99.6% of all correct responses during ASR and NR error correction, respectively.

RESULTS

ASR error correction resulted in more student responses during instruction than did NR error correction. With ASR error correction, the total number of student responses per session was always 30 for each student (initial correct practice trial responses plus responses made during error correction). The mean number of student responses per session for each student with NR error correction was 11.3 for Student 1, 9.3 for Student 2, 5.9 for Student 3, 14.3 for Student 4, 14.5 for Student 5, and 20.4 for Student 6 (group mean = 12.6).

Same-Day Tests

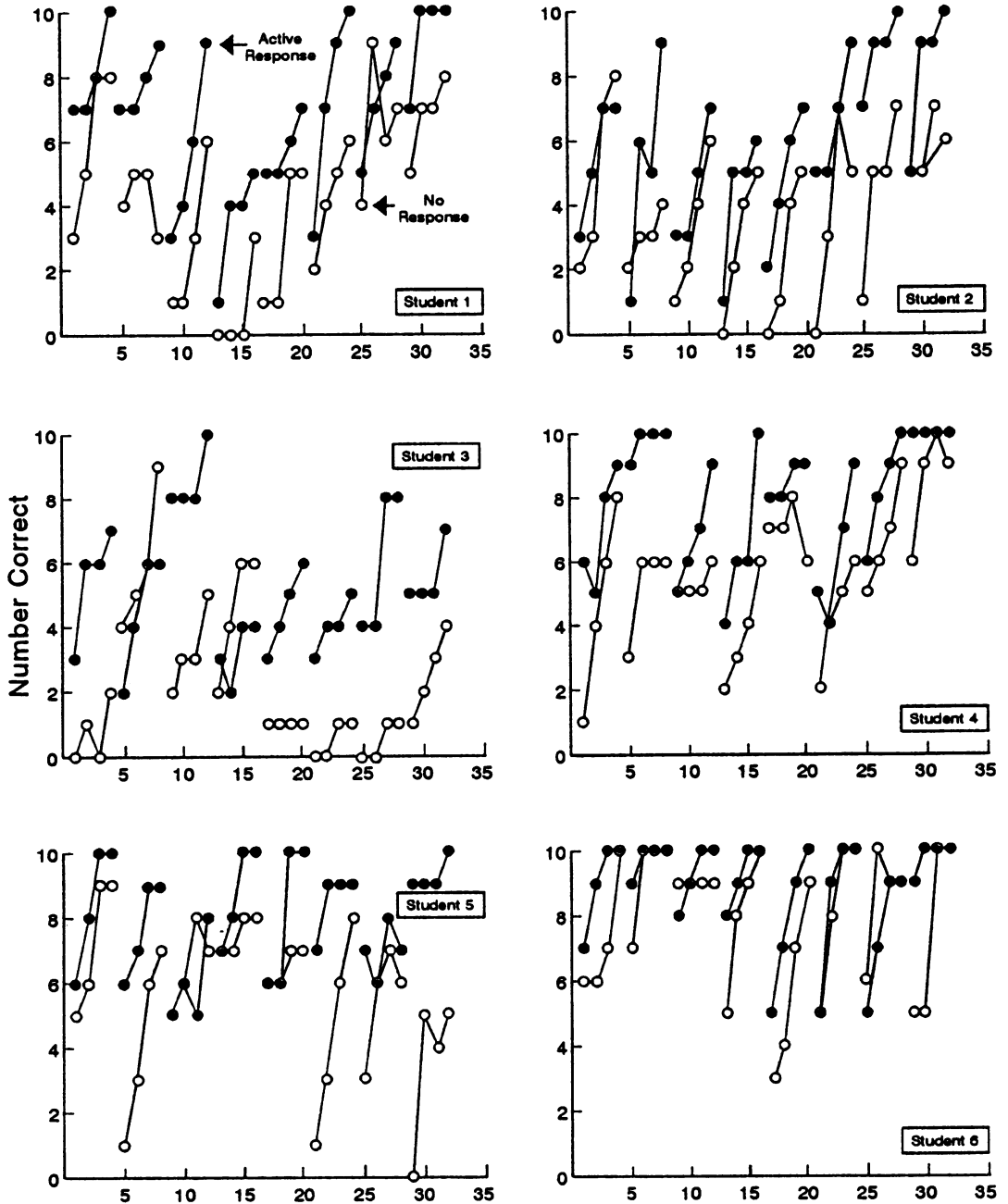
Figure 1 shows each student's performance on 32 same-day tests given immediately after instruction. Same-day test scores on ASR words were higher than scores on NR words on 153 (80%) of 192 tests, the same as NR words on 26 tests (14%), and were lower than scores on words instructed with NR error correction on 13 (7%) tests.

ASR error correction produced higher mean same-day test scores for all 6 students on each of the 4 days of instruction. As a group, the mean same-day test scores on each successive day of instruction across all word sets in the ASR condition were 5.4, 6.7, 7.8, and 8.6, and the mean scores in the NR condition were 3.0, 4.6, 5.9, and 6.4.

Next-Day Tests

Figure 2 shows that next-day test scores on words instructed with ASR error correction were higher than scores of NR words on 148 (77%) of 191 tests (one next-day test was missed because of an absence), the same as NR words on 20 tests (10%), and lower than scores with NR error correction on 23 (12%) tests.

ASR error correction produced higher mean next-day test scores for all 6 students on each of the four next-day tests. As a group, the mean next-day test scores on each successive day of instruction across all word sets in the ASR condition were 4.0,



Sessions

Figure 1. Number of sight words read correctly on same-day tests given immediately after instruction. Solid data points show the number of correct responses on words taught with ASR error correction; open data points show number correct on words taught with NR error correction. Breaks in data paths separate word sets.

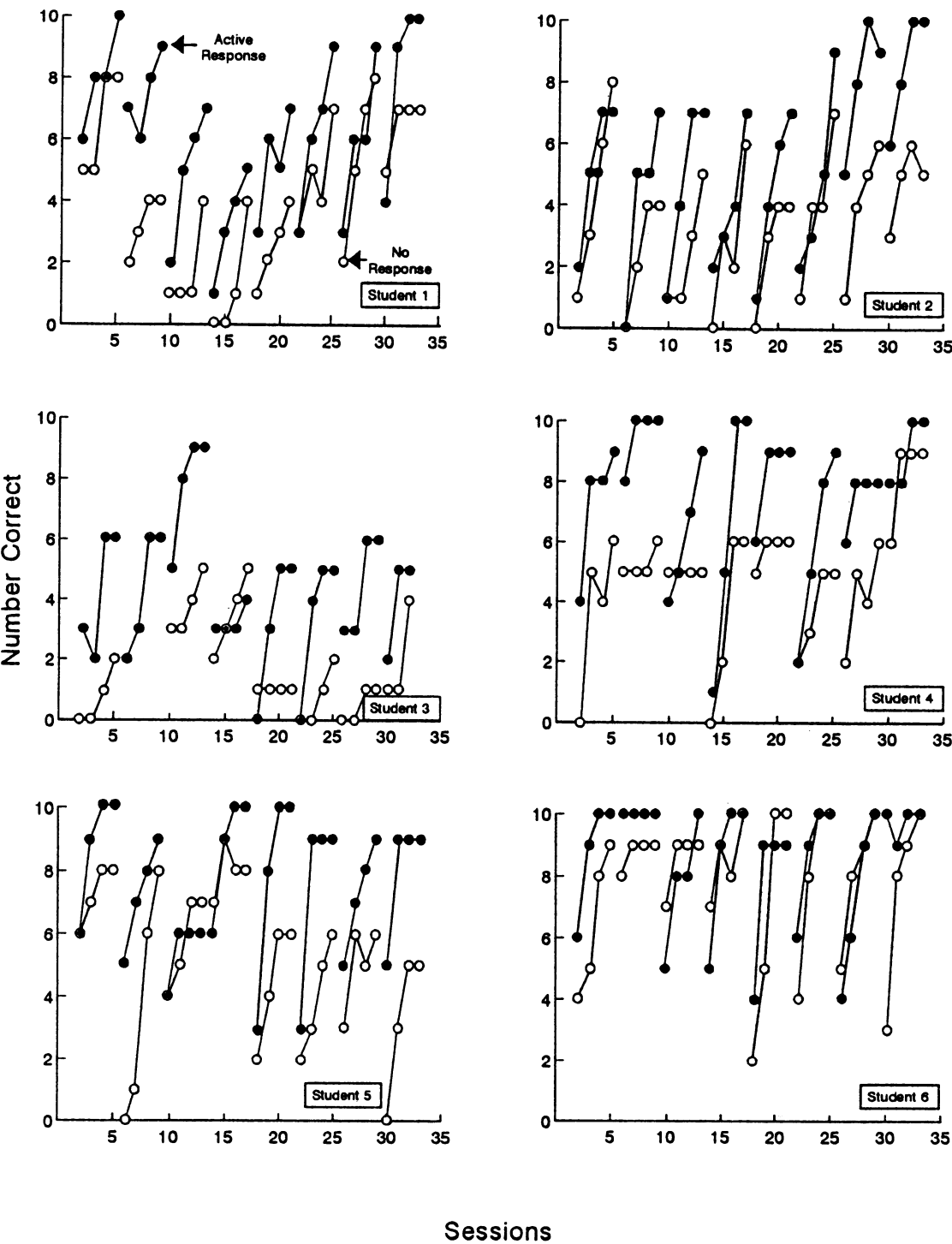


Figure 2. Number of sight words read correctly on next-day tests given the day after instruction. Solid data points show the number of correct responses on words taught with ASR error correction; open data points show number correct on words taught with NR error correction. Breaks in data paths separate word sets.

Table 1
Percentage and Number of Correct Responses during Practice Trials and Corrected Words Read Correctly on Their Next Presentation

Student	Practice trials		Next-trial correct	
	Active	No response	Active	No response
1	60% 528 ^a	37% 323	20% 85/420 ^b	11% 68/618
2	50% 444	31% 277	17% 89/520	9% 67/737
3	42% 373	20% 177	14% 84/581	5% 41/775
4	76% 670	51% 453	29% 81/275	17% 88/513
5	72% 632	50% 437	28% 86/310	16% 81/501
6	82% 722	73% 639	36% 79/221	36% 108/302
Group	64% 3,369	44% 2,306	22% 504/2,327	13% 453/3,446

^a Numbers represent the total number of correct responses (total possible = 880 due to elimination of the first round of practice trials per set).

^b First number is total number of next trial correct; the second number is the total number of practice trial errors.

6.5, 7.7, and 8.3, and the mean scores in the NR condition were 2.6, 4.2, 5.4, and 6.2.

Performance during Instruction

The 6 students made 1,063 more initially correct responses on words with ASR error correction than on words taught with NR error correction, even though the number of instructional trials was held constant under both conditions (see Table 1, two left columns). Data in the two right columns of Table 1 show that 5 of the 6 students read correctly more just-corrected words on their next presentation (NTC) following ASR error correction than following NR error correction. Student 6 had 36% NTC under both error-correction conditions, but erred on 81 more practice trials with NR error correction.

Maintenance of Performance

ASR error correction resulted in more words correct on tests given 2 weeks after instruction for Students 2 through 6 (see Table 2, two left columns), although the difference was marginal for Student 6 (who maintained almost all learned words in both conditions). Student 1 maintained 78% of

the words learned in both error-correction conditions; however, because he learned 19 more words during ASR error correction, more words were maintained.

Generality of Performance

Table 2 (right columns) shows that ASR error correction produced a higher percentage of target words read correctly in sentences for Students 1 and 2, and the same or negligibly higher performance for Students 4, 5, and 6.

DISCUSSION

Students learned, maintained, and generalized more words instructed with ASR error correction than words instructed with NR error correction. This study extends the findings of Barbetta et al. (1993), in which whole-word error correction was found to be more effective than phonetic-prompt error correction. Results of the present study show that whole-word error correction is more effective when it includes the student's emission of the correct response following a teacher-provided model.

Table 2
Number and Percentage of Learned Words Maintained and Generalized

Student	2-week maintenance		Generalization	
	Active	No response	Active	No response
1	78% 47/60 ^a	78% 32/41	92% 36/39 ^b	80% 16/20
2	89% 50/56	71% 30/42	84% 43/51	71% 25/35
3	74% 25/34	38% 10/26	— ^c	—
4	83% 55/66	74% 37/50	91% 50/55	91% 38/42
5	92% 59/64	80% 40/50	98% 61/62	94% 43/46
6	99% 68/69	96% 64/67	97% 76/78	96% 73/76
Group	87% 304/349	77% 213/276	93% 266/285	89% 195/219

^a First number is the number of words read correctly on 2-week maintenance tests. Second number is total number of learned words for which 2-week maintenance tests were taken.

^b First number is the number of target words read correctly in sentences (given after the 2nd day of instruction on a word set, the day after instruction ended on a word set, and 1 and 2 weeks after instruction ended on a word set). Second number is the total number of identical target words read correctly on cards those same days.

^c Due to his low reading vocabulary, Student 3 did not read target words in sentences.

Our findings lend further support to research showing a positive relationship between active student response and academic achievement (Greenwood et al., 1984; Narayan et al., 1990). This study adds a dimension to the ASR literature that has focused primarily on the manipulation of instructional antecedents and/or student response modes to improve academic achievement. Requiring the student to emit the correct response is a component of the systematic error-correction procedure in several documented programs of effective instruction (e.g., direct instruction, various tutoring programs), and our results suggest the ASR error-correction component may have positively contributed to the effectiveness of those programs. Finally, this study supports the use of error-correction strategies such as directed rehearsal, a remedial strategy that requires students to emit the correct response several times following an error.

One possible reason for the relative effectiveness of ASR error correction is that it resulted in students emitting many more responses than in the NR

error-correction procedure. Given the empirical evidence for a positive relation between active student responding and student achievement (e.g., Greenwood et al., 1984), it is likely that the increased frequency of student responses contributed to the effectiveness of ASR error correction.

The results have several implications for classroom practice and future research. ASR error correction is a tactic for increasing student responses that can be easily adapted to various types of instruction. For example, after a correct response to an error has been modeled during large-group instruction, the teacher could provide an opportunity for the student who initially erred to produce the correct response. During group instruction in which every student responds to every question or item (e.g., choral responding, response cards), teachers could provide the correct answer to erred questions and then immediately repeat the practice trial for group response, perhaps returning again to that question or item later during the lesson (Heward et al., 1989). Teachers should also consider using

ASR error correction for errors that occur during one-to-one instruction and during incidental teaching.

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