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An Examination of Methods for Testing Treatments: Conducting Brief Experimental Analyses of the Effects of Instructional Components on Oral Reading Fluency

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Abstract

Brief experimental analyses of academic performance are emerging as a new tool educators can use to link assessment to intervention. This approach involves testing treatments directly using single-case experimental design elements to select intervention strategies for oral reading fluency problems. The purpose of this investigation was to refine the methods reported in previous studies. The procedures were revised to examine a different format for making brief treatment comparisons for selecting intervention components on an individual basis. Effective treatment packages were identified and confirmed for all five participants. The packages themselves differed across the participants. The results are discussed in terms of the advantages of the new procedures, implications for practice, and directions for future research.

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There is an emerging area of research that has been combining direct measures of student academic performance (Shapiro, 1996; Shinn, 1989) with academic intervention research (Daly, Lentz, & Boyer, 1996) in an effort to develop brief experimental analysis procedures for academic performance problems. This research is unique not only in that it targets students' academic responding, but also in the way that it approaches treat-

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ment selection. Because academic performance problems are behavioral deficits, the goal of these studies has been to increase rates of accurate responding by directly applying treatments. This approach has been applied successfully to spelling and reading comprehension (McComas et al., 1996), spelling and math computation (Hendrickson, Gable, Novak, & Peck, 1996), classroom behavior (Kern, Childs, Dunlap, Clarke, & Falk, 1994), and oral reading fluency (Daly, Martens, Dool, & Hintze, 1998; Noell et al., 1998).

In each of these studies, instructional and/or reward conditions were alternated with control conditions to determine which intervention procedures improved student responding the most. For example, Daly et al. (1998) administered test conditions in an alternating fashion until an increase in oral reading fluency was observed. A mini-reversal was used to confirm the results. Outcomes were measured both in passages in which instruction was delivered and in passages with high content overlap. These latter passages allowed the authors to probe for generalization of effects. For some of the participants, the analyses were extensive. Daly, Martens, Hamler, Dool, and Eckert (1999) reduced the number of treatment conditions necessary for each participant by combining instructional components across conditions, increasing the efficiency of the analyses without compromising treatment effects.

These studies were promising, preliminary attempts at developing a technology that might be useful and feasible for school settings because of their emphasis on (a) directly testing treatments, and (b) comparing a small number of treatments using a brief format. Several issues, however, still need to be resolved through further research. For example, due to the brief nature of the experimental designs used by Daly and his colleagues, the procedures do not allow for evaluation of level, trend, and/or variability in student responding (Martens, Eckert, Bradly, & Ardoin, 1999). In addition, the procedures required significant decision making regarding next steps, and it was not always clear which test condition to implement next.

In these studies, decisions regarding treatment effectiveness were made based only on their effect relative to baseline levels of responding. There was no analysis of how many intervention sessions with a passage were necessary to improve student responding to desired reading fluency rates. Finally, the contingent reward condition had minimal effects across virtually all of the participants, limiting its utility in the decision making process. Most likely, all of the participants in these two studies "truly" had difficulty learning to read and rewards themselves would not have been sufficient, which is representative of the types of referrals the authors generally receive in schools. It may be more productive to look at whether rewards interact with instructional interventions to increase the intervention effects before deciding whether they add anything useful to the intervention package.

The purpose of this study was to investigate a set of procedures for conducting brief experimental analyses of the effects of reading interventions on oral reading fluency. The procedures described in this investigation differ from those used in prior investigations in that the results of the brief analysis could be confirmed or disconfirmed through a more extended analysis where a treatment package was alternated with control passages. This procedural change allows the examiner to determine whether stable changes in level and/or variability occur across reading texts. A second purpose of this investigation was to examine a set of procedures for evaluating the relative effects of adding a contingent reward component to previously chosen instructional components. Specifically, contingent rewards were systematically combined with the previously identified level of assistance (i.e., instructional variables) necessary to improve student reading. This condition was implemented until the student reached criterion levels of performance.

Method

Participants

Participants were five second grade students. All the participants were regular education students who were referred by their teachers for reading problems. Three of the participants were male. Two of the males were African American (Dion and Hanif), and one was Caucasian (Chad). The two female participants (Lashawnda and Ashley) were African American. At the beginning of the study the teachers were asked the instructional level of each participant. Lashawnda (7 years, 4 months) and Chad (8 years, 7 months) were being instructed at the second grade level. Hanif (7 years, 9 months), Dion (8 years, 6 months), and Ashley (8 years, 1 month) were being instructed at a first grade level. All but one of the participants attended an urban public school. Chad attended a suburban parochial school.

A screening was conducted using the first grade passage (form A) of the Burns/Roe Informal Reading Inventory (Burns & Roe, 1989) to assess students' reading fluency and comprehension prior to participation in the study. Their performance was scored as correctly read words per minute, errors per minute, and percent of correctly answered comprehension questions. Students' gender, age, grade, and screening results are displayed in Table 1.

Table 1
Participant Information

Student	Gender	Age	CRW/min (Errors)	Comprehension
Hanif	Male	7	17 (6)	62.5%
Lashawnda	Female	7	22 (5)	25%
Chad	Male	8	14 (3)	50%
Dion	Male	8	6 (6)	72%
Ashley	Female	8	8 (6)	25%

Note. CRW/min, Errors, and Comprehension scores are based on performance in the first grade passage (Form A) of the Burns/Roe Informal Reading Inventory (Burns & Roe, 1989).

Materials

Instructional passages. First and second grade reading passages were chosen randomly from the Silver, Burdett, and Ginn basal reading series (Pearson et al., 1989). Phonics passages were chosen from the beginning of a phonics reading series (Modern Curriculum Press, 1986). Only narrative and expository texts were used. Readability scores were obtained for all the passages. The Spache formula (Spache, 1953) was used to calculate the readability scores for the first and second grade passages. Scores for the phonics passages were calculated using the computerized Flesch-Kinkaid readability analysis (Clariana, 1993)[1]. The obtained readability scores for the phonics passages indicate that all but one passage were at a pre-first grade reading level (with the exception of the short "a" instructional passage which was estimated to be at a 2.34 grade level). The readability and length (no. of words) of the passages are presented in Table 2.

High content overlap passages. High content overlap (HCO) passages were passages containing a high percentage of the same words in a corresponding instructional passage (Daly, Martens, Kilmer, & Massie, 1996). The HCO passages were created by rewriting the original passages, using the majority of words from the original instructional story. The length and readability of the passages are presented in Table 2. On average, the readabilities calculated for the HCO passages showed that these passages were slightly more difficult than the corresponding instructional passages at the first and second grade levels. The percentage of word overlap was calculated by dividing the number of words appearing in both passages by the total number of words in the HCO passage. The mean word overlap was 92% (range, 83% to 98%) for the phonics passages, 87% (range, 77.8% to 98.5%) for the first grade passages, and 85% (range, 79.8% to 94.3%) for the second grade passages.

Table 2
Passages: Number of Words and Readability

Passages	Mean Length (range)	Mean readability (range)
Phonics		
Instructional	46 (39 to 51)	0.29 (0 to 2.34)
HCO	37 (34 to 48)	0 (0 to 0)
First Grade		
Instructional	114 (96 to 154)	1.57 (1.4 to 1.9)
HCO	99 (83 to 128)	1.9 (1.5 to 2.1)
Second Grade		
Instructional	118 (89 to 138)	2.29 (2 to 2.6)
HCO	100 (87 to 133)	2.94 (2.3 to 3.7)

Note. HCO = High Content Overlap

Dependent Variables

Correctly read words per minute (CRW/min) and errors per minute in instructional and HCO passages were used to assess the effects of baseline and treatment conditions. A correctly read word was defined as a word that was pronounced correctly within 3 s. An error was defined as a word that was not pronounced correctly within 3 s. Omissions, mispronunciations, and hesitations of more than 3 s were recorded as errors. While the student read the passage aloud, the examiner scored CRW and marked errors during the 1st minute. One student (Lashawnda), read some of the passages in less than 1 min. The number of CRW/min that she read was calculated by totaling the number of words read and dividing that number by the time (in seconds) within which she read the passage. This number was then multiplied by 60 to estimate CRW/min. Sessions were taped using an audiocassette recorder in order to assess interrater agreement.

Independent Variables and Treatment Conditions

Treatment strategies were made up of various instructional components. Individual conditions contained one or more treatment conditions which were not necessarily equated for antecedent modeling or prompting, opportunities to respond, or feedback.

Baseline. No instruction was provided in baseline (B) conditions. The students read the entire instructional passage and then read the HCO passage for 1 min. The reported results (CRW and errors per minute) are based on the participant's reading performance during the 1st minute of both

passages.

Repeated readings. In the Repeated Readings (RR) condition, students read an instructional passage four times and were told how long it took to read the passage after each reading (Rashotte & Torgesen, 1985). The reported results are based on the participant's reading performance during the 1st minute of the final reading of the instructional passage and the 1st minute of the HCO passage.

Listening passage preview/repeated readings. In the Listening Passage Preview/Repeated Readings (LPP/RR) condition, the experimenter first read the passage to the student (modeling fluent reading) (Daly & Martens, 1994). The student then read the story three more times. The experimenter told the student how long it took to read the passage after each reading. The reported results are based on the student's reading performance during the 1st minute of the final reading of the instructional passage and the 1st minute of the HCO passage.

Easier materials. The Easier Materials (EM) condition served as a control condition to estimate the magnitude of effects of treatment combinations in easier materials relative to an EM-only condition. Students read passages that were one grade level below the level at which they were being instructed. In the case of several students who were being instructed at a first grade level, phonics passages containing the simplest phonics rule (i.e., single consonant short vowel words) were used for this condition. The reported results are based on the participant's reading performance during the 1st minute of both passages.

Easier materials/listening passage preview/repeated readings. The Easier Materials/Listening Passage Preview/Repeated Readings (EM/LPP/RR) condition was the same as LPP/RR except that the treatment was carried out in passages that were one grade level below the student's current instructional level. The purpose of this condition was to determine whether easier materials might improve a student's responding to other treatment components by creating a more optimal instructional match (Daly, Martens, et al., 1996). The reported results are based on the participant's reading performance during the 1st min of the final reading of the passage and the 1st minute of the HCO passage.

Phrase drill. In the Phrase Drill (PD) condition, students practiced reading phrases containing words previously read incorrectly. While the student was reading a passage aloud for the first time, the examiner underlined words read incorrectly by the student. When the student was done reading the passage, the examiner showed each error word to the student, read it aloud to the student, and had the student read the entire phrase three times in a row (O'Shea, Munson, & O'Shea, 1984). The reported results are based on the student's reading performance during the 1st minute of the final reading of the instructional passage and the 1st minute of the HCO passage.

Sequential modification. In the Sequential Modification (SM) condition, a briefer version of the treatment applied in the instructional passage was also applied to the HCO passage. This component was implemented when there was evidence that the student was not generalizing treatment effects observed in the instructional passage to HCO passages. The purpose was to promote generalized responding by applying the treatment components across passages (Stokes & Baer, 1977). The briefer version consisted of having the student read the passage one fewer time in the HCO passage. Because the sequential application of the treatment to both the instructional and HCO passages was expected to substantially improve student performance, a briefer version that would keep the length of the treatment sessions shorter appeared justifiable. The reported results are based on the student's reading performance during the 1st minute of the final reading of the instructional passage and the 1st minute of the final reading of the HCO passage.

Word list. In the Word List (WL) condition the student read a list containing phonics words that frequently appeared in the instructional and HCO passages. The student read the entire list (e.g., a list containing short "e" words) five times before other treatment components (i.e., LPP/RR) were used. This treatment component was applied to one student (Ashley) who did not improve her performance with other treatment components during the second part of the analysis (see Extended Analysis below). The purpose was to provide training in applying a phonics rule in isolation before having her read words in texts, a strategy used in Direct Instruction (Grossen & Carnine, 1991). This treatment component was used only during the third part of the analysis for Ashley, where rewards were compared to instruction. The reported results are based on the student's reading performance during the 1st minute of the final reading of the instructional passage and the 1st minute of the HCO passage.

Contingent reward. In the Contingent Reward (CR) condition, students were first offered their choice of tangible items to work for (e.g., fancy pencils and pens, stamp markers, baseball cards). Students chose one item at a time. They were told that they could earn the reward when they read the HCO passage in a specified amount of time with 3 or fewer errors. Criterion rates of performance were established as 30% improvement above their best performance to date in prior conditions. For example, if a student's best performance in prior conditions was 60 CRW/min, the criterion rate for performance was set at 78 CRW/min [60 + (60 x .30)]. Students worked repeatedly on a passage across days until they met the criterion rate and earned the reward. The chosen reward was always displayed on the table during reading sessions. At the end of each session the student was told how quickly he or she read the passage and how many errors he or she made. Students were told whether they met the goal or not. When a student met the goal, the chosen item was given to him or her. The purpose of

this condition was to determine whether rewards for more proficient reading were likely to improve student responding (Lovitt, Eaton, Kirkwood, & Pelander, 1971). The reported results for the instructional and HCO passages are based on the 1st min of the final reading of both passages.

Experimental Design and Procedures

The analysis of student performance was conducted in three parts. First, a brief analysis was conducted in which two control and three treatment conditions were administered in a standard order. Next, a multielement design was used to compare the effects of treatment combinations to baseline conditions on an individual basis. This portion of the analysis, referred to as the extended analysis, was designed to test specific hypotheses regarding the effects of combinations of treatment components on student's reading fluency based on the results of the brief analysis. Finally, the effects of instruction-only and instruction plus contingent rewards were analyzed to determine whether adding rewards improved the efficiency of the treatment package by helping students to improve to criterion levels of performance more quickly. In this portion of the analysis, treatments were applied to passages until student performance improved by 30% above their best performance in prior conditions. The number of trials to criterion under instruction-only and instruction plus contingent rewards was used to evaluate their effects.

Throughout all of the phases, each condition was administered individually to the student in a room outside the classroom. Each session lasted approximately 15 to 20 min. No more than two conditions were administered per day. For each condition, experimenters followed scripted protocols, which held feedback and correction constant across conditions. Students were praised and encouraged for effort, but experimenters avoided providing praise based on a student's performance level.

In the first two parts of the analysis, each condition contained an independent set of instructional and HCO passages (Daly et al., 1999). During the third part of the analysis (comparing instruction-only with instruction plus rewards), two of the four passages were passages that had been used previously as baseline passages. One passage was assigned to the instruction-only condition and one was assigned to the instruction plus rewards condition. The other two passages were independent passages that had not been read previously. Within each condition, the student was asked to first read the instructional passage (where the treatment was applied) and then read the HCO passage. Students were always asked to read the entire instructional passage (even in control conditions—B and EM) even though only the 1st min of the final reading was scored and graphed. For example, in the RR condition the examiner scored the 1st minute during the fourth reading of the passage but the student read the entire passage. With the

exception of conditions containing SM, students were asked to read the HCO passage for only 1 min. In conditions that contained SM, the treatment was applied to the HCO passage as well. The results were based on the 1st min of the last reading of the instructional and HCO passages. Each of the treatment conditions is discussed below. Each treatment component is summarized briefly in Table 3.

Table 3
Brief Descriptions of Individual Treatment Components

Treatment Component	Description
Repeated Reading (RR)	Student read the passage four times.
Listening Passage Preview (LPP)	Examiner read the passage to the student.
Easier Materials (EM)	Student read in an easier passage.
Phrase Drill (PD)	Examiner read the error word to the student who read the entire phrase three times.
Sequential Modification (SM)	Treatment components were applied to the HCO passage.
Word List (WL)	Student read a word list containing words in the instructional passage five times.
Contingent Reward (CR)	Student received a tangible reward for meeting or beating criteria for accuracy and fluency.

Brief analysis. During the brief analysis, the following conditions were administered to all participants: B, RR, LPP/RR, EM/LPP/RR, and EM. Each condition was administered once. The purpose of doing the brief analysis (testing out different combinations of treatment components) was to identify the least intrusive but most effective treatment package that was likely to improve student performance. A large, visible difference between control (i.e., B and EM) and treatment conditions in instructional and HCO passages was sought. The purpose of HCO passages in B and EM (i.e., the control conditions) was to show equivalence of the passages across conditions.

Extended analysis. The results of the brief analysis were examined individually for each participant. Decisions were made regarding combinations of treatment components that would improve oral reading rate. Guidelines for how treatment components were chosen for the extended analysis are presented in the appendix. A large, visible difference across treatment conditions was sought as a basis for choosing instructional components for this part of the analysis. If, for example, RR produced a large effect on reading fluency in the instructional passage but LPP/RR did not

improve reading fluency substantially above the effects of RR, RR was chosen over LPP/RR as a treatment component. In other words, the simplest and fewest number of treatment component(s) that produced the largest effect, based on visual analysis, were chosen for further analysis. This strategy of choosing treatment components based on incremental effects was believed to produce simpler (rather than more complex) intervention strategies. Simpler intervention packages were thought to be more desirable, as they were more likely to be implemented in natural settings (e.g., tutoring sessions, small group reading instruction). Two treatment components that were not included in the brief analysis (PD and SM) were also considered for this portion of the analysis. If the student displayed a high error rate in the brief analysis (i.e., error rate ≥ 4 errors per min), PD was chosen as a treatment component. If the student improved in the instructional passage under one or more treatment conditions but did not improve in the HCO passage, SM was also chosen as a treatment component.

The purpose of this part of the analysis was to identify the treatment package that was most likely to improve student reading rates and empirically examine the effects of the treatment package by alternating it with baseline conditions. In the extended analysis, the treatment package and baseline were administered in an alternating fashion two to three times. All sets of passages were independent of one another, and reported results are based on the 1st minute of the final reading of the instructional and HCO passages. Specific treatment packages chosen for each student were as follows. RR/PD/SM was chosen for both Hanif and Lashawnda. LPP/RR/SM was chosen for Chad. EM/LPP/RR/PD/SM was chosen for Dion and for Ashley.

Trials to criterion with and without reward. After the effects of the treatment package were evaluated in the extended analysis, the effects of adding rewards to the treatment package were evaluated. First, the treatment package was administered repeatedly with one set of passages on separate days until students improved their performance by 30% above their highest performance in all prior conditions. This step was done twice with two different passages in order to determine the number of trials to criterion with instruction only. The criterion rate for Hanif was 52 CRW/min in second grade passages. The criterion rate for Lashawnda was 140 CRW/min in second grade passages. The criterion rate for Chad was 29 CRW/min in second grade passages. The criterion rate for Dion was 66 CRW/min in phonics passages. The criterion rate for Ashley was 64 CRW/min in phonics passages. Lashawnda did not meet her goal in three attempts on either passage in the instruction-only condition. The condition was stopped after three attempts in each passage to avoid frustration and boredom with multiple, repeated attempts to attain her goal. Criterion rates were not told to students. They were merely told that they would practice

the passages until they got better at reading them.

The CR condition was then combined with the instructional treatment package. The students were offered rewards for meeting their goals. Goals were described as how quickly students needed to read the passage (with a criterion for number of errors). The treatment package was administered repeatedly under the CR condition with one set of passages on separate days until students improved their performance by 30% above their highest performance in all prior conditions. This step also was done twice with two different passages in order to determine the number of trials to criterion with instruction plus rewards. The same criterion rates were used for this condition for all students except Lashawnda. In her case, her criterion was her best performance in the prior instruction-only condition after three attempts. All students earned their rewards for both passages. A visible difference in number of trials to criterion and slopes of improvement was sought between instruction-only and instruction plus rewards conditions.

Interobserver Agreement

The audiotape recorded sessions were listened to by independent observers who scored the passages for CRW and errors. The total number of agreements (CRW and errors) was divided by the total number of words in the passage (representing all possible agreements plus disagreements) to compute interobserver agreement. A total of 53 sessions (56% of all sessions) were checked for interobserver agreement. The mean interobserver agreement was 97% (range, 88 to 100%).

Treatment Integrity

Treatment integrity was also assessed by the independent observers. A checklist was developed that described the instruction/assessment sequence for each treatment condition[2]. While listening to the audiotape recording of the session, the observer recorded whether each step was completed accurately. The total number of steps completed was then divided by the total number of steps in the treatment. Treatment integrity was assessed for 53 sessions (56% of all sessions). The mean number of correctly implemented sessions was 98% (range, 75 to 100%).

Results

Brief analyses. The results of the brief analyses for all participants are reported in Table 4 and displayed in Figures 1 and 2 as CRW/min and errors per minute in instructional and HCO passages. Visually discriminable changes in levels of responding across conditions were sought. All five participants demonstrated visible improvements in performance in at least one condition relative to the control conditions in the instructional passages. There were individual differences across partici-

pants in how well they improved their reading fluency across treatment conditions. Treatment components were chosen for the next portion of the analysis for each participant by (a) selecting the treatment component(s) that led to the largest incremental improvements relative to control conditions, (b) examining error rates in treatment conditions, and (c) examining whether generalized effects were observed in the HCO passages.

Table 4
Number of Correctly Read Words per Minute in Instructional and HCO Passages for The Initial Brief Analyses

	Condition									
Participant	B		RR		LPP/RR		EM/LPP/RR		EM	
	I	HCO	I	HCO	I	HCO	I	HCO	I	HCO
Hanif										
CRW	24	31	48	31	48	29	36	57	19	24
Errors	7	4	5	4	5	8	16	4	12	6
Lashawnda										
CRW	36	49	80	53	57	51	84	57	61	71
Errors	6	4	4	3	0	3	7	4	2	1
Chad										
CRW	13	16	20	20	36	17	48	28	23	28
Errors	5	5	5	4	6	3	1	3	5	2
Dion										
CRW	18	14	28	12	24	22	38	24	16	43
Errors	6	5	5	8	7	8	4	4	6	3
Ashley										
CRW	23	12	24	29	27	21	29	23	10	24
Errors	6	7	11	11	7	9	9	8	10	18

Hanif's best performance in the instructional passages was in the RR and LPP/RR conditions, where he read the same number of CRW/min for both conditions. In these conditions, Hanif read at a rate that was two times greater than his performance in the B condition. His performance was actually lower in the EM/LPP/RR condition. Therefore, RR was chosen for further analysis as a treatment component because it produced effects that were as great as the LPP/RR condition and was simpler (i.e., required less adult effort). There was a visible improvement in the HCO passages in the EM/LPP/RR condition. However, this effect was regarded as an outlier in view of the fact that the treatment, which was applied to the instructional passage only, did not produce effects of the same magnitude in the instructional passage. There was no visible improvement in the HCO passages for the RR or LPP/RR conditions. Therefore, SM was included for further analysis as a treatment component. Finally, Hanif's error rates were high across all conditions. His lowest error rate was in the RR condition. For this reason, PD was also chosen for further analysis as a treatment component. Based on these results, the combination of RR/PD/SM was used as the treatment package that would be tested out in the

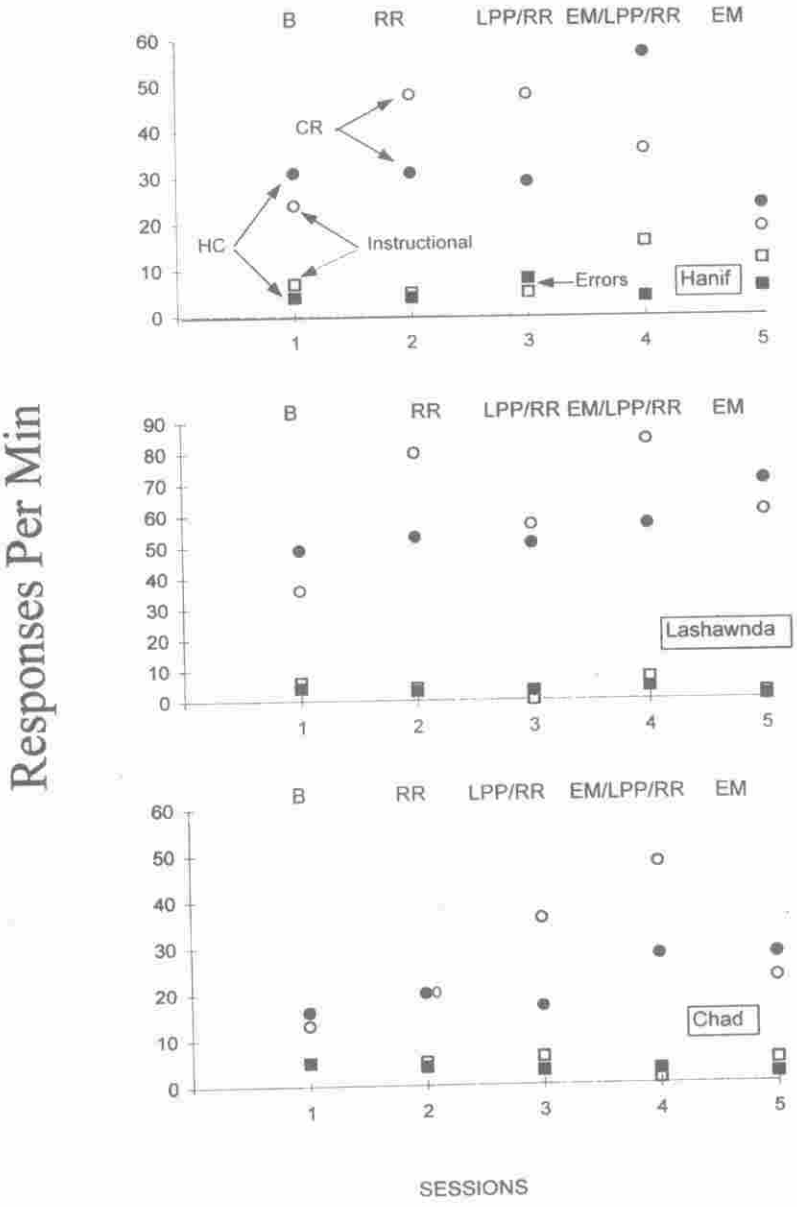

Figure 1. Number of correctly read words and errors per minute in instructional and HCO passages for Hanif, Lashawnda, and Chad during the brief analyses. B = baseline; RR = Repeated Readings; LPP/RR = Listening Passage Preview and Repeated Readings; EM/LPP/RR = Listening Passage Preview and Repeated Readings in Easier Materials; EM = Easier Materials.

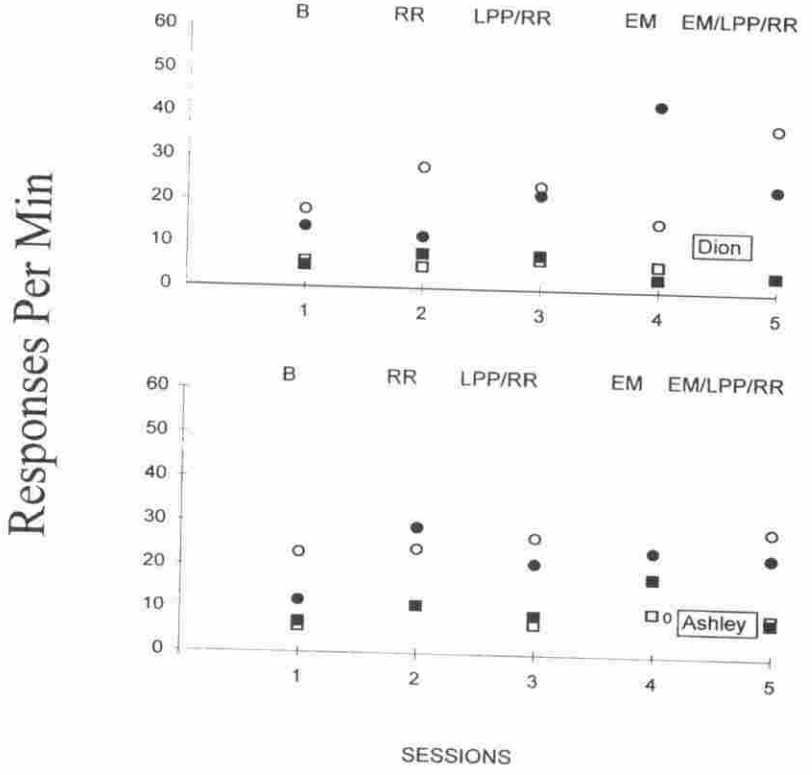

Figure 2. Number of correctly read words and errors per minute in instructional and HCO passages for Dion and Ashley during the brief analyses. B = baseline; RR = Repeated Readings; LPP/RR = Listening Passage Preview and Repeated Readings; EM/LPP/RR = Listening Passage Preview and Repeated Readings in Easier Materials; EM = Easier Materials.

next part of the analysis.

Lashawnda's best performance in the instructional passages was in the RR condition. In RR, Lashawnda read at a rate that was more than two times greater than her performance in the B condition. Her performance in the instructional passage dropped in the LPP/RR condition. Her performance on the instructional passage in the EM/LPP/RR condition was slightly higher than her performance in the RR condition. However, the magnitude of the treatment effects for RR relative to B was greater than the treatment effects for EM/LPP/RR relative to EM. RR, a simpler intervention component requiring less adult effort, appeared to produce incrementally greater effects than EM/LPP/RR relative to respective control conditions. RR was therefore chosen for further analysis as a treatment

component.

There was no large visible improvement in the HCO passages in the treatment conditions. A modest improvement was observed in the EM condition. Therefore, SM was included for further analysis as a treatment component. Finally, Lashawnda's error rates were high in the RR condition. For this reason, PD was also chosen for further analysis as a treatment component. Based on these results, the combination of RR/PD/SM was used as the treatment package that would be tested out in the next part of the analysis.

Chad's performance improved in both the LPP/RR and EM/LPP/RR conditions. Although EM/LPP/RR produced the highest rate of responding, the difference between LPP/RR and B in the instructional passages (i.e., a difference of 23 CRW/min) was of the same magnitude as the difference between EM/LPP/RR and EM, where there was a difference of 25 CRW/min. Because conducting LPP/RR at the level at which he was being instructed was less intrusive than EM/LPP/RR, which required changing the difficulty level of instructional materials for Chad, LPP/RR was chosen for further analysis as a treatment component.

There was no visible improvement in the HCO passages for Chad in any of the treatment conditions. His performance in the treatment conditions was at the same level as his performance in the control conditions, B and EM. Therefore, SM was also chosen for further analysis as a treatment component. Finally, although Chad's error rate was high in LPP/RR, a decision was made to not include an error correction strategy. First of all, the treatment combination (LPP/RR/SM) was already seen as quite lengthy and the examiner reported that Chad appeared to fatigue easily with the sessions. Adding additional components would have lengthened the treatment sessions. Because an acquisition component was already included in the treatment package (i.e., LPP which involves modeling reading of correct words), the decision to not include an error correction strategy was believed to be justified. Therefore, based on these results, the combination of LPP/RR/SM was used as the treatment package that would be tested for the next part of the analysis.

Dion's best performance in the instructional passages was in the EM/LPP/RR condition. The magnitude of the difference between EM/LPP/RR relative to EM (a difference of 22 CRW/min) was greater than the difference between B and RR (the next highest treatment effect), which was a difference of 10 CRW/min. For this reason, EM/LPP/RR was viewed as the treatment combination that produced the largest incremental effect and was chosen for further analysis as a treatment combination. There was no visible difference in the HCO passages for treatment conditions relative to control conditions (however, Dion's performance in the HCO passages for the EM condition was much higher than the others). SM was included for further analysis as a treatment component. Because

Dion's error rate was high in the EM/LPP/RR condition, PD was included as a treatment component. The treatment package chosen for Dion was EM/LPP/RR/PD/SM for the next part of the analysis.

Ashley's highest rate of responding was in the EM/LPP/RR condition. Her performance in this condition was incrementally larger, relative to the EM condition, than her best performance in the other treatment conditions (LPP/RR). This latter difference represented an improvement of only 4 CRW/min over B. Therefore, EM/LPP/RR was chosen as a treatment combination. Ashley's performance in the HCO passages improved a little in the RR and LPP/RR conditions relative to B and did not improve in the EM/LPP/RR condition relative to the EM condition. Because larger generalized treatment effects were not observed, however, SM was added to the other treatment components for the next portion of the analysis. Because Ashley's error rate was very high in the EM/LPP/RR condition, PD was also added to the other treatment components for the next portion of the analysis. Based on these results, the combination of EM/LPP/RR/PD/SM was used as the treatment package that would be tested out in the next portion of the analysis.

Extended analyses. During this phase of the analysis, specific hypotheses regarding the effects of promising treatment components were tested by alternating individualized treatment packages with baseline conditions. In all but one case, treatment conditions and baseline conditions were each applied three times. For Chad, treatment conditions and baseline conditions were each applied twice. Results were measured in both the instructional and HCO passages as CRW and errors per minute. Visible differences across treatment and baseline conditions were sought in both sets of passages.

The results for each participant are displayed toward the left hand side in Figures 3, 4, and 5. Numbers on the horizontal axis represent sessions. Three sessions for each of the conditions (treatment and control) were conducted for four of the students. For Chad, two sessions for each condition were conducted. Also, treatment packages and summary information for each participant are reported in Table 5, which describes medians for baseline and treatment conditions. Medians were chosen because they are better overall indicators of central tendency than means when there is a small number of observations.

Table 5

Participants' Median Number of Correctly Read Words per Minute in Instructional and HCO Passages for Baseline and Treatment Conditions

Participant	Treatment Package	Instructional		HCO	
		B Med	T Med	B Med	T Med
Hanif	RR/PD/SM	18	55	24	39
Lashawnda	RR/PD/SM	35	94	53	92
Chad	LPP/RR/SM	11	27.5	18	20
Dion	EM/LPP/RR/PD/SM	16	45	20	31
Ashley	EM/LPP/RR/PD/SM	17	36	17	24

Note. HCO = High Content Overlap; B Med = Baseline Median; T Med = Treatment Median.

Hanif's results are displayed on the left side of the top two panels of Figure 3. When RR/PD/SM was alternated with B, visible effects were observed in the instructional passage. More modest treatment effects were found in the HCO passages, where a high baseline point overlapped with the treatment data points. There was a difference of 37 CRW/min between the baseline median and the treatment median in the instructional passages (favoring the treatment condition) and a difference of 15 CRW/min between the baseline median and the treatment median in the HCO passages (also favoring the treatment condition). Hanif's errors under treatment in the instructional passages (range, 2 to 3) were lower than his baseline errors in the instructional passages (range, 5 to 10). His errors under treatment in the HCO passages (range, 2 to 6) were more variable and overlapped more with his baseline errors in the HCO passages (range, 5 to 6).

Lashawnda's results are displayed on the left side of the bottom two panels of Figure 3. When RR/PD/SM was alternated with B, visible effects were found in both the instructional and HCO passages. The effects were larger in the instructional passages. There was a difference of 59 CRW/min between the baseline median and the treatment median in the instructional passages (favoring the treatment condition) and a difference of 39 CRW/min between the baseline median and the treatment median in the HCO passages (also favoring the treatment condition). Lashawnda's errors under treatment in the instructional passages (range, 1 to 2) were lower than her baseline errors in the instructional passages (range, 4 to 8). Her errors under treatment in the HCO passages were also low (range, 0 to 1). However, they overlapped with her baseline errors in the HCO passages (range, 1 to 4) which were also relatively low.

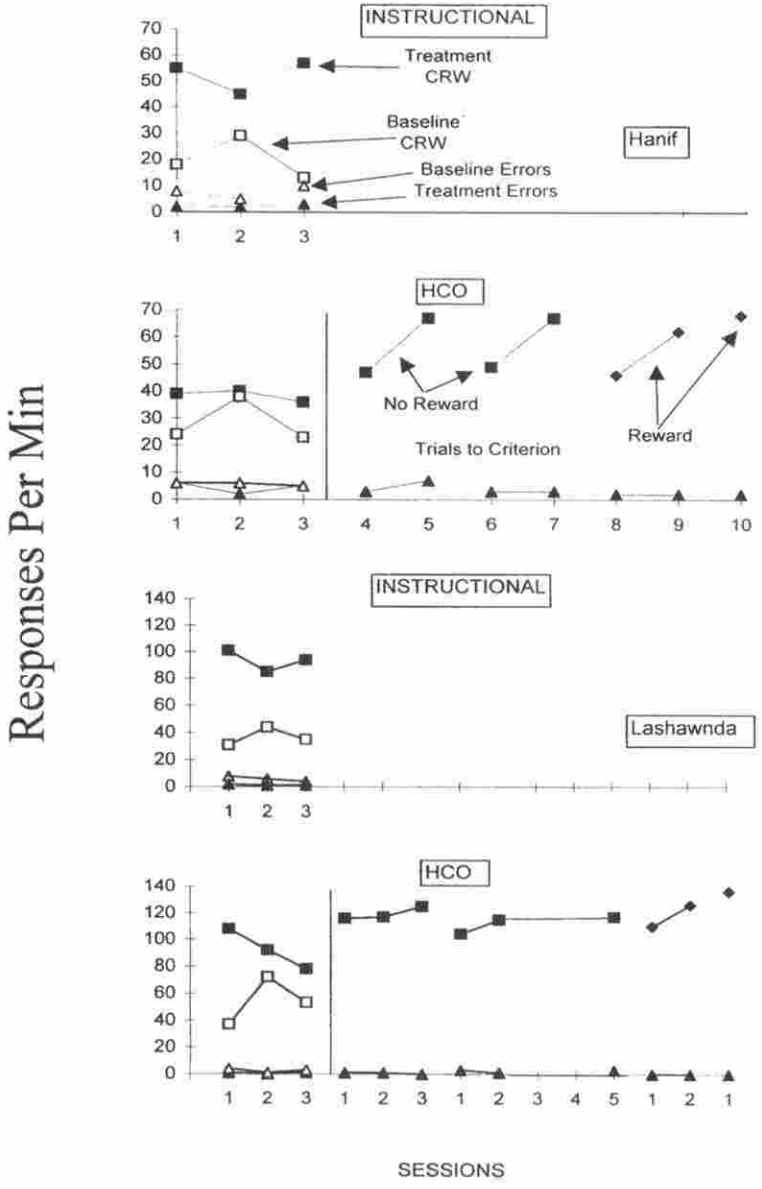

Figure 3. Number of correctly read words and errors per minute in instructional and HCO passages for Hanif and Lashawnda during the extended analysis and trials to criterion phase.

Chad's results are displayed on the left side of the top two panels of Figure 4. When LPP/RR/SM was alternated with B, a visible effect was found in the instructional passages but not in the HCO passages. It is noteworthy that Chad's performance in both sets of the B passages (range, 8 to 14 for instructional passages, and 17 to 19 for the HCO passages) was much lower than Hanif's and Lashawnda's performances in the B passages (range for Hanif, 18 to 29 for instructional passages, and 23 to 38 for HCO passages; range for Lashawnda, 31 to 44 for instructional passages, and 37 to 72 for HCO passages). There was a difference of 16.5 CRW/min between the baseline median and the treatment median in the instructional passages (favoring the treatment condition) and a difference of only 2 CRW/min between the baseline median and the treatment median in the HCO passages (favoring the treatment condition). Chad's errors under treatment in the instructional passages (range, 2 to 5) overlapped with his baseline errors in the instructional passages (range, 4 to 7). His errors under treatment in the HCO passages (range, 2 to 4) also overlapped with his baseline errors in the HCO passages (range, 2 to 3).

Dion's results are displayed on the left side of the bottom two panels of Figure 4. When EM/LPP/RR/PD/SM was alternated with B, a visible effect was observed in both the instructional and HCO passages. The effect was larger in the instructional passages where Dion was reading more than two times the rate in the treatment condition than in the baseline condition. In the HCO passages, the highest baseline data point overlapped with the second treatment data point. There was, however, a difference of 29 CRW/min between the baseline median and the treatment median in the instructional passages (favoring the treatment condition) and a difference of 11 CRW/min between the baseline median and the treatment median in the HCO passages (favoring the treatment condition). Dion's errors under treatment in the instructional passages (range, 1 to 2) were lower than his baseline errors in the instructional passages (range, 5 to 6). His errors under treatment in the HCO passages (range, 1 to 3) overlapped more with his baseline errors in the HCO passages (range, 2 to 6) because he made only 2 errors in the first baseline HCO passage. He made 6 errors on the other two baseline HCO passages.

Ashley's results are displayed on the left side of Figure 5. When EM/LPP/RR/PD/SM was alternated with B, her performance was much more variable under treatment than in the baseline condition. In both the instructional and HCO passages, two of the three treatment data points are above the highest baseline data point. There was a difference of 19 CRW/min between the baseline median and the treatment median in the instructional passages (favoring the treatment condition) and a difference of 7 CRW/min between the baseline median and the treatment median in the HCO passages (favoring the treatment condition). Ashley's errors under treatment in the instructional passages (range, 3 to 7) were quite vari-

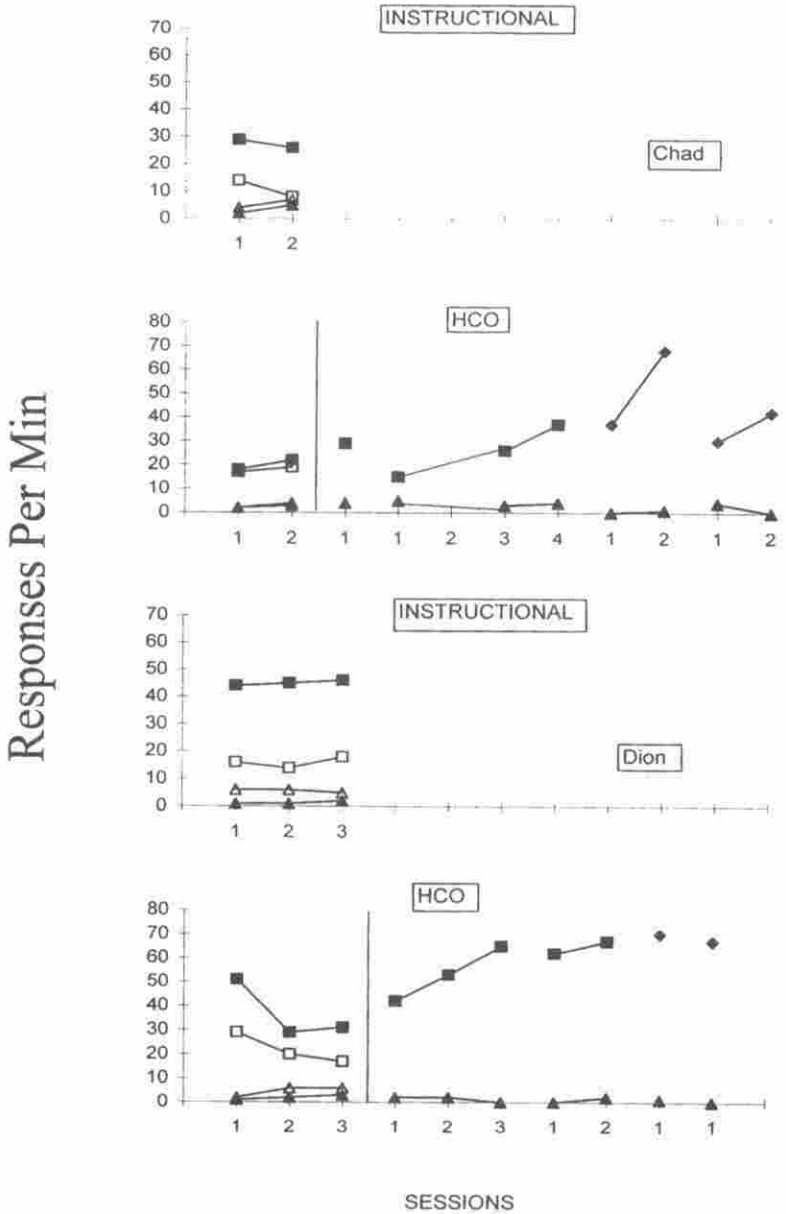

Figure 4. Number of correctly read words and errors per minute in instructional and HCO passages for Chad and Dion during the extended analysis and trials to criterion phase.

able, but generally lower than her baseline errors in the instructional passages (range, 6 to 11). Her errors under treatment in the HCO passages (range, 9 to 10) were actually higher than her baseline errors in the HCO passages where she made 8 errors on all three administrations of baseline.

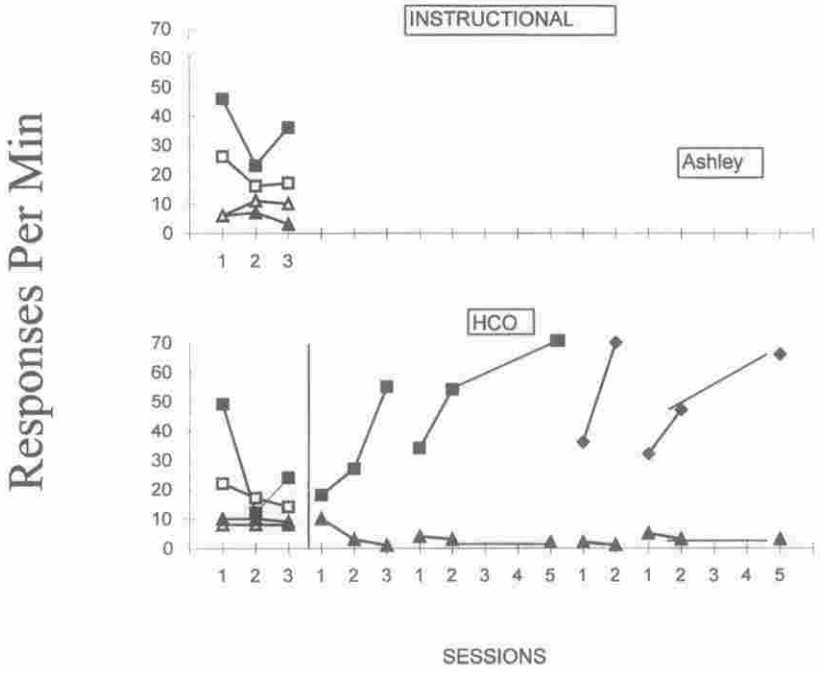

Figure 5. Number of correctly read words and errors per minute in instructional and HCO passages for Ashley during the extended analysis and trials to criterion phase.

Overall, treatment effects were observed for the individualized treatment packages across participants. Larger effects were consistently obtained in the instructional passages than in the HCO passages. Treatment effects on errors were less substantial. Decreases in error rates were observed for three of the participants in the instructional passages. Error rates for treatment conditions overlapped more with baseline conditions across participants in the HCO passages.

Analyses of trials to criterion with and without reward. During the final phase of the analysis, individualized treatment packages used for the prior phase were applied sequentially to four passages. There was one modification to a treatment package for one of the participants. Specifically, because the treatment effects were more limited for Ashley, the WL component was added to the other treatment components during this third phase.

Instructional treatments were applied to the first two passages. Rewards were added to the instructional treatments for the last two passages.

Because participants worked on each passage until they met criterion levels of performance (or were administered the treatment three times) in the HCO passages, the slopes of improvement within passages, beginning and ending levels of performance, and number of trials to criterion could be used to compare instruction-only with instruction plus rewards. If there were greater slopes of improvement, higher beginning and ending levels of performance, and/or fewer trials to criterion for instruction plus rewards than for instruction-only, the results were interpreted to suggest that adding rewards to the treatment package may increase the overall efficiency of the treatment package. If none of these conditions was met, the results were interpreted to suggest that adding rewards to the treatment package did not improve the treatment package incrementally. The results for each participant are displayed to the right of the bar in the HCO passages in Figures 3, 4, & 5. Each session represents one trial to criterion. The data points for each passage are connected. Where series are disconnected, there was a change in passages. Dark squares represent CRW/min in non-reward conditions. Dark diamonds represent CRW/min in reward passages. Dark triangles represent errors in both reward and non-reward conditions.

The results for Hanif are displayed on the right side of the second (i.e., HCO) panel of Figure 3. It took Hanif 2 trials to reach criterion levels of performance on both passages of the instruction-only condition (4 trials in all across passages). When offered rewards, it took him 2 trials on the first passage and 1 trial on the second passage. Rewards only reduced the overall number of trials to criterion by 1 trial (25% fewer trials). His initial performance in the first instruction plus reward passage was at the same level as his initial performance in the instruction-only passages. The slopes were similar and his final performance under rewarding conditions was not substantially higher than his final performance under non-rewarding conditions. For Hanif, therefore, whether rewards are judged to have incrementally increased the efficiency of the original treatment package depends ultimately on the perspective of the intervention agent responsible for carrying out the procedures. Although the effect was not large, the 25% reduction in the number of intervention sessions necessary to obtain criterion rates of responding might be viewed by some as large enough to warrant their inclusion in a treatment package. Interventionists must balance the effort and cost of adding a contingent reward component to the treatment package with the possible reduction in future intervention sessions. In Hanif's case, the data do not make an overwhelming case for including rewards, but may be convincing enough to some to include this condition as a part of a treatment package.

The results for Lashawnda are displayed on the right side of the bot-

tom panel of Figure 3. As mentioned above, Lashawnda never reached her initial criterion levels of performance because of her already high performance in the treatment conditions in the extended analysis. The instructional treatment was applied three times in both instruction-only passages, which led to slight, increasing slopes of improvement. The results were consistent across passages. When rewards were introduced, Lashawnda exceeded her performance in the instruction-only passages both times. It took her 2 trials and 1 trial, respectively, to do so, which amounted to 50% fewer trials under rewarding conditions than under non-rewarding conditions. Unlike Hanif, introducing rewards appeared to improve the treatment package by producing higher performance levels in a short amount of time.

The results for Chad are displayed on the right of the second panel of Figure 4. Under the instruction-only condition, Chad met his criterion levels of performance in 1 trial and 3 trials, respectively. It took the same number of trials to meet criterion levels when rewards were introduced. However, Chad's initial performance was higher under rewarding conditions than under non-rewarding conditions, and the slopes of improvement are visibly greater. These results suggest that adding rewards to the treatment package for Chad may improve the overall efficacy of the intervention at producing outcomes.

The results for Dion are displayed on the right side of the bottom panel of Figure 4. Under the instruction-only condition, Dion met his criterion levels of performance in 3 and 2 trials, respectively. When rewards were introduced, Dion met criterion levels of performance in 1 trial both times, which represents 60% fewer trials. Perhaps even more than the others, the evidence clearly indicated that adding rewards to the treatment package would be likely to improve its efficiency in producing outcomes.

The results for Ashley are displayed in the second panel of Figure 5. Under the instruction-only condition, it took her 3 trials to meet criterion levels of performance both times. When rewards were added, she met criterion levels of performance in 2 trials and 3 trials, respectively. Unlike Dion, adding rewards did not appear to improve the visible efficiency or effectiveness of the treatment package.

This portion of the analysis indicated rewards appeared to be promising additions to the treatment packages for at least three of the participants. Lashawnda, who was reading approximately 53 CRW/min in the HCO baseline passages during the extended analysis, read 126 CRW/min by only the second trial of the first administration of rewards plus instruction and 136 CRW/min on the first trial of the second administration of rewards plus instruction. Chad, who was reading approximately 18 CRW/min in the HCO baseline passages during the extended analysis, read 68 CRW/min and 42 CRW/min on the second trial of both administrations of rewards plus instruction. Dion was reading approximately 20 CRW/

min in the HCO baseline passages during the extended analysis. Under rewarding conditions, he read 70 and 67 CRW/min, respectively, for the two passages on the 1st trial. A small effect for rewards was observed for Hanif. Rewards did not appear to improve results for Ashley. Repeated administration of the instruction-only conditions did have rapid effects. Hanif read approximately 24 CRW/min in the HCO baseline passages during the extended analysis. By the second administration of the passages under instruction-only conditions, he read 67 CRW/min both times. In the case of Ashley, who read 17 CRW/min in the HCO baseline passages during the extended analysis, she read 55 and 71 CRW/min under instruction-only conditions after the third administration.

Discussion

The results of this investigation extend the literature on the use of brief analyses of the effects of various instructional components on students' reading fluency. The procedures led to the identification of strategies that increased responding for all participants, yet revealed individual differences in their responsiveness to combinations of treatment components. Treatment packages that increased participants' reading fluency relative to control conditions were identified for all five students. Treatment components were selected for each student by examining their incremental contribution to prior treatment conditions. Procedures like those reported here should be of interest to educational practitioners (such as special education teachers and school psychologists) and researchers alike. Educators can expand their direct assessment skills by "testing out" treatments before making recommendations through the use of multielement design elements and effective educational strategies. This process should allow treatment recommendations to be data-based. This type of analysis allows the examiner to make relatively quick decisions about promising intervention packages in a standardized format with outcome data that are directly relevant to classroom instruction.

There are several advantages to the methods of analysis reported in this investigation. The extended analyses have at least two advantages. First, they confirmed the results of the brief analyses in all cases, which should increase confidence in the results of brief analyses. Furthermore, when practitioners are in doubt about the findings of brief analyses, they can compare treatments to baseline or other treatments using a multielement design like the one used in this investigation, thereby gaining greater certainty about the generalizability of effects across passages. These analyses were purposefully kept brief (i.e., only 2 to 3 sessions) so that practitioners might see them as more feasible in applied settings. However, from an experimental standpoint longer analyses would have strengthened our confidence in the choice of intervention components even more.

Interventions derived from brief experimental analyses may be useful as adjuncts to the current instruction children are receiving. Brief experimental analyses are conducted against a backdrop of ongoing classroom instruction. The child is referred because the current instruction is not effective. Brief experimental analyses may be helpful for determining whether adding modeling, practice, error correction, materials adjusted for difficulty level, and/or contingencies for performance might help to improve the current instructional program on a case-by-case basis. The students who participated in this study had significant reading problems. Reading accuracy and fluency were quite poor for all students, as evidenced by the high errors and low CRW/min in the initial screening. Interestingly, although they were all second graders in the same school, different interventions were identified across the students. These students were chosen because they were referred to the first author for intervention. However, their low reading level may have interfered with finding passages that they could read with reasonable accuracy without some instruction preceding initial reading. In future investigations, it may be more appropriate to choose students whose accuracy is more appropriately matched to the difficulty level of the materials.

For some students, a fundamentally different approach to reading instruction might be necessary. Students like Ashley and perhaps Dion who read in a labored, word-by-word fashion because they have not mastered basic decoding skills may actually benefit more from instructional strategies that teach decoding and/or sound blending and segmenting, an area not addressed in this investigation. These instructional strategies will take longer and are probably not as well suited to brief experimental analysis but have been shown to establish firm mastery of sound-symbol relations that can be generalized to decodable connected text (Adams, 1990).

Ashley's performance in the brief test conditions reveals a weakness of the procedures reported in this study. The EM condition was supposed to represent easier materials. However, because the prior conditions (B, RR, LPP/RR) were carried out in first grade materials, choosing materials for the EM condition posed a problem. We *assumed* that phonics passages containing only single-consonant, short vowel words would be easier for Ashley and Dion because the words were highly predictable and represented the simplest kinds of single consonant words that can be found in text. It turned out that this assumption was incorrect, probably because of their poor decoding skills, as described above. This finding reinforces the conclusion that other methods may be better for students who have significant decoding or word segmenting deficits.

A unique feature of these methods is that they include a measure of generalization of responding to passages that contain many of the same words but represent a different story (HCO passages). The ideal situation is one in which generalization of responding across stimulus materials is

achieved through an intervention. The HCO passages may help investigators and practitioners alike probe for generalization. Unfortunately, in this study limited generalized increases were observed for all the treatment conditions. SM was necessary for all the participants. It may be that the tactic of choosing the simplest intervention that produces the highest response rates ends up minimizing the generalization of effects. Indeed, greater generalized increases might have been observed had the materials been more carefully configured to be at a better instructional level (Daly, Martens, et al., 1996). Future research may find that the "biggest bang for the buck" in outcomes may result from giving precedence to instructional match over an intervention's naturalistic qualities. Studies of this nature would need to identify if and how difficulty level interacts with instructional strategies (e.g., modeling and practice) themselves. With respect to this particular set of procedures, when practitioners resort to targeting generalization explicitly through a procedure like SM, they lose all indices of generalization.

Many aspects of this investigation could stimulate further research. Future research should explore other ways of combining treatments. One area that is particularly ripe for further experimental analysis is the way in which rewards can be expected to interact with students' baseline proficiency levels and different types of instructional components. The decision rules also warrant further investigation. In this area, it is difficult to interpret performance in an absolute sense across students because of their different levels of proficiency at baseline. More research that guides practitioners in setting optimal criteria for including or excluding instructional components would have great utility. Research that compares treatments while carefully describing participants' baseline proficiency levels (Daly, Lentz, et al., 1996) would be helpful for understanding which decision rules lead to greater increases and which decision rules should be revised.

It is critical to keep in mind that the results of these analyses do not guarantee increases over time. Brief treatment comparison methods should *not* replace ongoing assessment of outcomes over time. Herein lies the most important form of educational measurement, referred to as formative evaluation (Fuchs & Fuchs, 1986). Future investigations should examine the long-term treatment outcomes of interventions derived from idiographic analyses of academic responding.

One potential, uncontrolled source of variability in this investigation was how theoretically equivalent passages may vary greatly in difficulty level for unskilled readers. The particular vocabulary of any passage and its overlap with the learner's very limited reading vocabulary and/or decoding skills will probably create more variability in how unskilled readers respond to passages than more-skilled counterparts. The experimental analysis rests on the assumption that differences in performance are a function of the intervention, not selection of the passage. Choosing students with reading levels of at least second grade and for which they are at least

90% accurate might reduce this problem.

There was a confound of sequence in the third part of the analyses that should be addressed in future studies. The reward plus instruction condition always followed the instruction-only condition. We chose this strategy to avoid problems with withdrawing rewards once they were introduced. This issue was seen as especially important because the students were being asked to work for the rewards. From an experimental standpoint, withdrawing rewards after they had been introduced could exaggerate differences across conditions (in favor of producing larger effects for reward conditions). It appears that more basic research on the interaction of rewards with instructional variables is necessary before further technological improvements will occur. It is important to note that the reinforcement contingency was probably not the only variable influencing performance. The contingent rewards included feedback about performance and goal setting. Therefore, one cannot conclude that it was the reward contingency itself that was effective. Rather, the contingent reward component should be viewed as a multi-component package itself that may or may not supplement the effects of the instructional interventions.

Finally, future studies should examine the role of social attention more carefully. Although the experimenters followed the guidelines for social attention described in the Procedures section, we observed anecdotally that some children attempted to recruit social attention for reading, saying things like, "How did I do that time?" It is necessary to study the role of social attention and other variables like the satisfaction of beating one's own score (which may take on reinforcing properties itself) in order to further refine techniques like these and help practitioners identify sources of variability more accurately.

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Appendix

Guidelines for Selecting Treatment Components
Based on The Brief Analysis Sequence

1. If RR produces as large an effect as LPP/RR (or almost as large as LPP RR), select RR.
2. If the addition of LPP clearly increases the student's performance relative to RR, select LPP/RR.
3. To decide whether to use easier materials, compare the ratio of RR or LPP/RR (the larger of the two) to B with the ratio of EM/LPP/RR to EM. If the latter ratio is incrementally larger, select EM/LPP/RR. Otherwise, select RR or LPP/RR (the larger of the two).
4. If the student's performance improves with a treatment in the instructional passage but does *not* improve in the HCO passage, apply a brief version of the intervention (i.e., one fewer repeated readings) to the HCO passage as well.
5. If the child makes 4 or more errors in treatment conditions, add Phrase Drill error correction. If there are high errors in some conditions but not others, check to see whether the student is merely missing the same word repeatedly.

Footnotes

[1]The Flesch-Kinkaid readability analysis used for the phonics passages is based on the number of syllables per word and the number of words per sentence which appears to be a more justifiable type of analysis for these kinds of passages. Other readability formulas such as the Spache are based on the frequency with which words appear in text in the English language. Phonetically regular passages are created to provide frequent opportunities to read words that exemplify a phonic rule. As such, a smaller percentage of common English words will appear and readability scores will be inflated using the latter type of formulas (John M. Hintze, personal communication).

[2] Available from the first author upon request.