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A BRIEF EXPERIMENTAL ANALYSIS FOR IDENTIFYING INSTRUCTIONAL COMPONENTS NEEDED TO IMPROVE ORAL READING FLUENCY

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Brief experimental analyses of oral reading fluency were conducted with 4 participants who had been referred by teachers and parents for reading problems. The procedures involved the sequential application of reading interventions to improve students' oral reading fluency. Following a baseline condition, instructional treatments were combined with prior conditions until there was improvement in oral reading fluency in the instructional passages and passages with high content overlap. Differentiated response patterns, assessed via a multielement design, were obtained for all participants. Results are discussed in terms of the potential benefits and limitations of conducting brief experimental analyses for selecting reading interventions.

DESCRIPTORS: brief experimental analysis, functional assessment, oral reading fluency

The goal of instruction is for curricular demands and materials to occasion student responding without additional assistance or prompting. In other words, we say that students "learn" an academic task when their responding comes under the control of appropriate academic stimuli (Vargas, 1984). With respect to oral reading, Skinner (1957) described the basic process in the following way: "When a child learns to read, many verbal operants are set up in which specific responses come under the control of visual . . . stimuli" (p. 65). Making sound–symbol associations must become fluent and durable (i.e., compete with other responses across time and passages) for students to become proficient readers who "comprehend" what they are reading (Adams, 1990; Binder, 1996). A nonproficient reader displays low rates of responding, presumably because the configurations of letters that make up the words in a text fail to function as discriminative stimuli.

A substantial amount of treatment research has been conducted on the effects of various interventions on students' oral reading fluency (Daly, Lentz, & Boyer, 1996; Lentz, 1988; Martens, Witt, Daly, & Vollmer, 1999). Most investigations have involved comparing the effects of one set of procedures with other procedures. Because

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oral reading fluency is sensitive to instructional changes (Fuchs & Fuchs, 1986; Shinn, 1989), it has been used in treatment research to evaluate the immediate effects of reading interventions on student performance.

Research in this area has permitted some inferences regarding the predictable effects of various principles of instruction. Specifically, different instructional techniques can be utilized to maximize the likelihood of active student responding for students at different proficiency levels (Haring, Lovitt, Eaton, & Hansen, 1978; Howell, Fox, & Morehead, 1993; Wolery, Bailey, & Sugai, 1988). Because of the wealth of existing treatment research in this area, behavior analysts have become increasingly interested in providing educators with efficient and reliable methodologies for evaluating and selecting useful intervention components. Functional assessment may prove useful for this purpose, especially when used in conjunction with empirically derived principles of academic instruction.

Reports of attempts to evaluate potential treatment components efficiently have recently appeared in the literature (Cooper et al., 1992; Harding, Wacker, Cooper, Millard, & Jensen-Kovalan, 1994). This approach to functional assessment is characterized by brief test conditions administered singly and, in the case of Harding et al., by hierarchically ordered treatments. The brief and hierarchically ordered nature of the analyses may increase their potential applicability to settings in which time is a significant factor in the delivery of services.

McComas et al. (1996) extended this approach to academic responding when they conducted experimental analyses of spelling and reading comprehension by alternating instructional strategies within a brief multielement design. Four students with learning disabilities participated in the study, and instructional strategies were developed based on those reportedly used by the classroom teacher. Each strategy was introduced in sequence until improvements in performance were obtained, at which time the effective and ineffective procedures were alternated within a brief multielement design. Results showed changes in academic performance to be associated with at least one instructional strategy for each child.

The purpose of this study was to evaluate the effects of reading interventions grouped hierarchically as a treatment package to develop individualized treatment recommendations for students who experience difficulties learning to read. Through the use of a brief multielement design, treatments were applied to independent passages, and their effects were compared to baseline and to other treatments. When a treatment or combination of treatments improved student responding, a brief reversal was conducted to partially confirm the pattern of effects across passages. In addition, probes that contained many of the same words as the passages in which treatments were conducted, but in a different configuration, were administered to assess improved fluency in an untreated passage.

METHOD

Participants

Participants were 4 students who had been referred for reading problems. All 4 students were in regular education classrooms. Two students had been referred by teachers, and 2 students had been referred by parents. Teachers and parents reported that the students were having difficulty learning to read and were seeking recommendations for reading interventions. None of the participants was receiving special education services.

Participants were 2 girls (Michelle and Jill) and 2 boys (Stephen and Jacob). Teachers and parents were asked to report the stu-

Table 1
Passages: Number of Words and Readability

Passages	Mean length (range)	Mean readability (range)
First grade		
Instructional	114 (96–154)	1.57 (1.4–1.9)
HCO	99 (83–128)	1.9 (1.5–2.1)
Second grade		
Instructional	118 (89–138)	2.29 (2–2.6)
HCO	100 (87–133)	2.94 (2.3–3.7)
Fifth grade		
Instructional	160 (126–188)	5.72 (5.5–6.4)
HCO	112 (92–130)	5.98 (5.3–6.9)

Note. HCO = high content overlap.

dents' grade level, and teachers were asked to report the grade level at which the students were being instructed. Michelle (6 years 7 months) was in first grade and was being instructed at a first-grade reading level. Jacob (8 years 10 months) was in second grade and was being instructed at a second-grade reading level. Stephen (9 years 8 months) was in third grade and was being instructed at a second-grade reading level. Jill (12 years 8 months) was in sixth grade and was being instructed at a fifth-grade reading level. Jill's responses to the first five instructional passages were reported previously in Daly, Witt, Martens, and Dool (1997) as a case study.

Materials

Instructional passages. Passages were drawn randomly from the Silver, Burdett, and Ginn basal reading series (Pearson et al., 1989). Only narrative and expository texts were used. The length (i.e., number of words) and readability of the passages are presented in Table 1. Readability scores for the first- and second-grade passages were computed using the Spache formula, which estimates the difficulty level of first- through third-grade passages (Spache, 1953). Readability scores were calculated for each of the fifth-grade passages using the Dale-Chall formula, which estimates the difficulty level of passages fourth grade and above (Dale & Chall, 1948).

High content overlap passages. High content overlap (HCO) passages were passages that contained a large percentage of the same words in a corresponding instructional passage (Daly, Martens, Kilmer, & Massie, 1996). The HCO passages for the first-, second-, and fifth-grade levels were created by rewriting the original passages using most of the words from the original passage as a different story. The length (i.e., number of words) and readability of the passages are presented in Table 1. The HCO passages on average were slightly more difficult than the corresponding instructional passages. The percentage of words overlapping with a corresponding instructional passage was calculated for each passage by dividing the number of words that appeared in both passages by the total number of words in the HCO passage. The average amount of word overlap was 87% for the first-grade passages (range, 77.8% to 98.5%), 85% for the second-grade passages (range, 79.8% to 94.3%), and 85% for the fifth-grade passages (range, 80.2% to 89.2%).

Dependent Variable

The effects of treatment conditions on students' reading were assessed by measuring the number of correctly read words (CRW) per minute in instructional and HCO passages. A correctly read word was defined as a word that was pronounced correctly in 3 s. While the student read a passage aloud, the examiner scored CRW and marked errors during the 1st minute. One participant (Jill) read some of the passages in less than 1 min. In this case, her score was prorated by dividing the number of CRW by the time (in seconds) and multiplying by 60 to obtain an estimate of CRW per minute. An audiocassette recorder was used to tape the stu-

dents' reading samples for the purpose of assessing interscorer agreement.

Independent Variables and Treatment Conditions

The treatment strategies included the following components: a reward for rapid reading (RE; Lovitt, Eaton, Kirkwood, & Pelander, 1971), repeated readings (RR; Rashotte & Torgesen, 1985), listening passage preview (LPP; Daly & Martens, 1994), application of a treatment to both the instructional and the HCO text (sequential modification, SM; Stokes & Baer, 1977), and lowering the difficulty level of the materials by using passages that were taken from one level lower than the prior level at which the student was being instructed (easier materials, EM; Daly, Martens, Kilmer, & Massie, 1996).

Individual conditions contained one or more of these treatment components. The conditions were not intended to be equated for antecedent modeling or prompting, opportunities to respond, or feedback. Rather, as conditions were administered, if performance did not improve, the treatment was augmented by adding further components to subsequent treatment conditions. Baseline was first administered. The general sequence of treatment conditions was RE, followed by RR, followed by LPP/RR (LPP was added to RR by having the experimenter read the passage to the participant during the first pass through the text). In many cases, a treatment (e.g., RR) was applied to both the instructional and the HCO texts (RR/SM). In other cases, treatment conditions were augmented by using easier texts (e.g., LPP/RR/EM).

Baseline. No instruction was provided in baseline. The participant first read the entire instructional passage. He or she then read the HCO passage for 1 min. Having the participant read the entire instructional passage in baseline controlled for opportunities to respond relative to the treatment conditions in which the participant read the instructional passage in its entirety at least once.

Reward. Following baseline, RE was always the first intervention strategy administered. Students were asked to choose three items from an informal reinforcement survey that they would be willing to work for in order of preference. Criteria for performance were based on Shapiro's (1996) recommended criteria for mastery rates (60 CRW per minute for first and second grade and 100 CRW per minute for third through sixth grade). The student was told that if he or she read the entire passage at a rate greater than 60 CRW per minute for the first- and second-grade passages (described as how quickly the participant needed to read the entire passage in minutes and seconds) or 100 CRW per minute for the fifth-grade passages, he or she could have the first preferred item reported in the survey. The student was also told that if he or she read the passage at a rate approximately equal to 60 CRW per minute for the first- and second-grade passages or 100 CRW per minute for the fifth-grade passages, he or she could have the second preferred item reported in the survey. Finally, the student was told that if he or she read the passage in just under the rate approximately equal to 60 CRW per minute for the first- and second-grade passages or 100 CRW per minute for the fifth-grade passages, he or she could have the third preferred item. All three preferred items were shown to the student before the condition was administered. If offering a reward in this manner improved fluency, there would be little need to evaluate other instructional strategies. Rewards were offered in no other conditions. Participants were exposed to each passage (i.e., instructional and HCO) only once in this condition. Assessment results were based on the 1st minute of reading in both passages.

Repeated readings. RR was implemented next because it requires less adult involvement than other treatment strategies that may involve modeling or error correction. RR was intended to increase students' opportunities to respond in curricular materials by having them read the passage repeatedly four times. Each time, the experimenter told the student how quickly he or she read the passage. Assessment results were based on the 1st minute of the last reading of the text.

Repeated readings/sequential modification. If RR did not lead to improved performance, subsequent components were combined with the RR condition. RR/SM was conducted if there was a clearly visible improvement in performance in the instructional text under RR but not in the HCO text. Following RR in the instructional text, the experimenter conducted RR in the HCO text.

Listening passage preview/repeated readings. If RR did not improve performance in the instructional condition, the experimenter first read the passage to the student (to model fluent reading and provide a practice opportunity for words that the student could already read). Next, the experimenter had the student read the passage aloud three times while he or she received feedback from the experimenter about how quickly he or she read the passage. This condition maintained the same number of opportunities to respond as the RR condition (i.e., the students were exposed to the passage four times) but added modeling of fluent reading.

Listening passage preview/repeated readings/sequential modification. LPP/RR/SM was conducted if there was a clear improvement in performance in the instructional text under LPP/RR but not in the HCO text. Following LPP/RR in the instructional text, the experimenter conducted LPP/RR in the HCO text.

Listening passage preview/repeated readings/easier materials. LPP/RR/EM was conducted if performance did not improve in the instructional text under LPP/RR; it was hypothesized that the student would benefit from instruction using less difficult reading materials. In this condition, LPP/RR was administered in materials one grade below the level of materials used in prior conditions.

Experimental Design and Procedures

A brief multielement design was used to compare the effects of treatment conditions to baseline and to other treatment conditions (Cooper et al., 1992; Harding et al., 1994). Following baseline (during which the students' oral reading fluency was assessed in both the instructional and HCO passages), treatments were ordered based on considerations of how much adult involvement was necessary to administer the treatments as well as the results of the prior condition. Each successive intervention required more adult involvement than the prior treatment conditions; for example, supervision of repeated readings was followed by having the experimenter read to the student, which may have been followed by using materials of a difficulty level that was different from that which was currently being used with the student in the classroom. The purpose was to identify the treatment package that required the minimum amount of adult involvement necessary to produce performance that was clearly discriminable from baseline and preceding treatment conditions.

All sessions were conducted individually in a school or university setting, or at the home of the child in the case of 1 participant, and no more than two conditions were attempted in one meeting. The general sequence of the treatment sessions was as follows: Treatment was applied to the instructional text, and performance was assessed during the final reading of the instructional passage; performance was then assessed in the HCO text. In conditions that incorporated SM, treatment was applied to the

Table 2
Order of Treatments Administered to Participants

Participant	Treatment conditions					
	RE	RR	RR/SM	LPP/RR	LPP/RR/SM	LPP/RR/EM
Jill	●	●	●			
Stephen	●	●	●			
Michelle	●	●		●	●	
Jacob	●	●		●		●

Note. RE = reward; RR = repeated readings; RR/SM = repeated readings/sequential modification; LPP/RR = listening passage preview/repeated readings; LPP/RR/SM = listening passage preview/repeated readings/sequential modification; LPP/RR/EM = listening passage preview/repeated readings/easier materials.

HCO text after treatment and assessment in the instructional text and before assessment in the HCO text. Each condition was administered with an independent set of instructional and HCO passages (Sindelar, Rosenberg, & Wilson, 1985). When a treatment was readministered, a different set of passages was used.

During assessment in the instructional passage, although only words read correctly during the 1st minute of reading were calculated, the participant read the entire passage (an exposure that was a component of treatment); during assessment in the HCO passage, the participant read the passage for only 1 min during the last reading of the passage. The experimenters followed scripts that held feedback and correction constant across conditions. The experimenter praised the student with encouraging statements but did not provide praise for specific performance levels.

Table 2 contains a list of treatment conditions for all participants in the order in which they were administered. RR/SM was the last treatment received by Stephen and Jill. LPP/RR/SM was the last treatment received by Michelle. LPP/RR/EM was the last treatment received by Jacob. When an intervention led to a clearly visible difference in performance relative to baseline and other treatment conditions, a minireversal was conducted. The minireversal consisted of a baseline condition followed by the last effective treatment condition.

Interobserver Agreement

An observer independently scored the assessment passages to assess interobserver agreement. Three individuals served as observers. The observer listened to an audiocassette recording of the session to score student performance on the assessment passages. Each word was scored as correct or incorrect. Interobserver agreement was computed by dividing the number of agreements (i.e., on words read correctly and words read incorrectly) on a word-by-word basis by the total number of words in the passage (which represented all possible agreements and disagreements). In all, 56 (76%) of the assessment passages were assessed for interobserver agreement. The mean interobserver agreement was 97% (range, 82% to 100%).

Treatment Integrity

The independent observers also assessed treatment integrity during 28 (76%) of the treatment assessment conditions. Using a checklist that described the instruction-assessment sequence for each treatment condition, the observer recorded whether the step was completed. The average correct implementation of experimental conditions was 96% (range, 71% to 100%).

RESULTS

The individual performances of the 4 participants are displayed in Figures 1 and 2 as CRW per minute in instructional and HCO passages. All participants improved their reading fluency in at least one condition relative to baseline in the instructional passages. All 4 participants also improved their reading fluency in at least one condition relative to baseline in the HCO passages. Finally, all participants improved their reading fluency in one treatment condition relative to prior treatments in both the instructional and HCO passages. Experimental control was demonstrated via a minireversal for all participants. Results are described below based on visually discriminable changes in level of responding across conditions.

Jill and Stephen showed the most improved performance in the RR/SM condition (see Figure 1). During the course of the assessment, RR was administered twice to Jill (with a baseline assessment interspersed) when it appeared that her reading fluency increased in the instructional passage of this condition. A decision was made, however, to apply RR to the HCO passage as well to observe the effects of its application across passages. These results suggested that there was an incremental benefit in Jill's case to repeatedly applying RR across texts with high content overlap.

Stephen's performance in all RR conditions (including RR and RR/SM) was higher than in all other conditions (including both baseline and RE conditions) in the instructional passage. There was more variability in his performance in the HCO passages. Although his highest performance in the HCO passage was in the second administration of the RR/SM condition, his performance in the first administration of this condition was not higher than the initial baseline or the RR condition.

Michelle's best performance occurred in the LPP/RR/SM condition (see Figure 2). Michelle's reading fluency nearly doubled in both the instructional and the HCO passages relative to baseline when LPP/RR was applied to both passages. The repeated application of LPP/RR across texts with high content overlap led to improved performance in both passages relative to no instruction and prior instructional conditions for Michelle. It appears that there was an incremental benefit to applying this treatment repeatedly under the condition of high content overlap.

The LPP/RR/EM condition led to the largest treatment effect for Jacob (see Figure 2). Under this condition, his reading fluency in both the instructional and the HCO passages was higher in the LPP/RR/EM condition than in any other condition, suggesting that conducting LPP/RR in easier materials led to higher fluency rates when compared to no instruction and that there was an incremental benefit in applying this condition relative to conducting LPP/RR in more difficult instructional materials.

DISCUSSION

The results of this investigation indicated that it may be possible to conduct brief analyses of the effects of combining instructional components on students' oral reading fluency. These procedures hold promise for applied settings in which educators can efficiently probe reading interventions in an idiographic manner prior to making treatment recommendations. Moreover, these procedures can be conducted quickly and repeatedly during the school year. At the very least, they may rule out potentially ineffective conditions by identifying treatments that fail to produce immediate results. However, it is likely that brief experimental analyses of this type will not produce clearly discrminable results across conditions for all students in future applications. In this case,

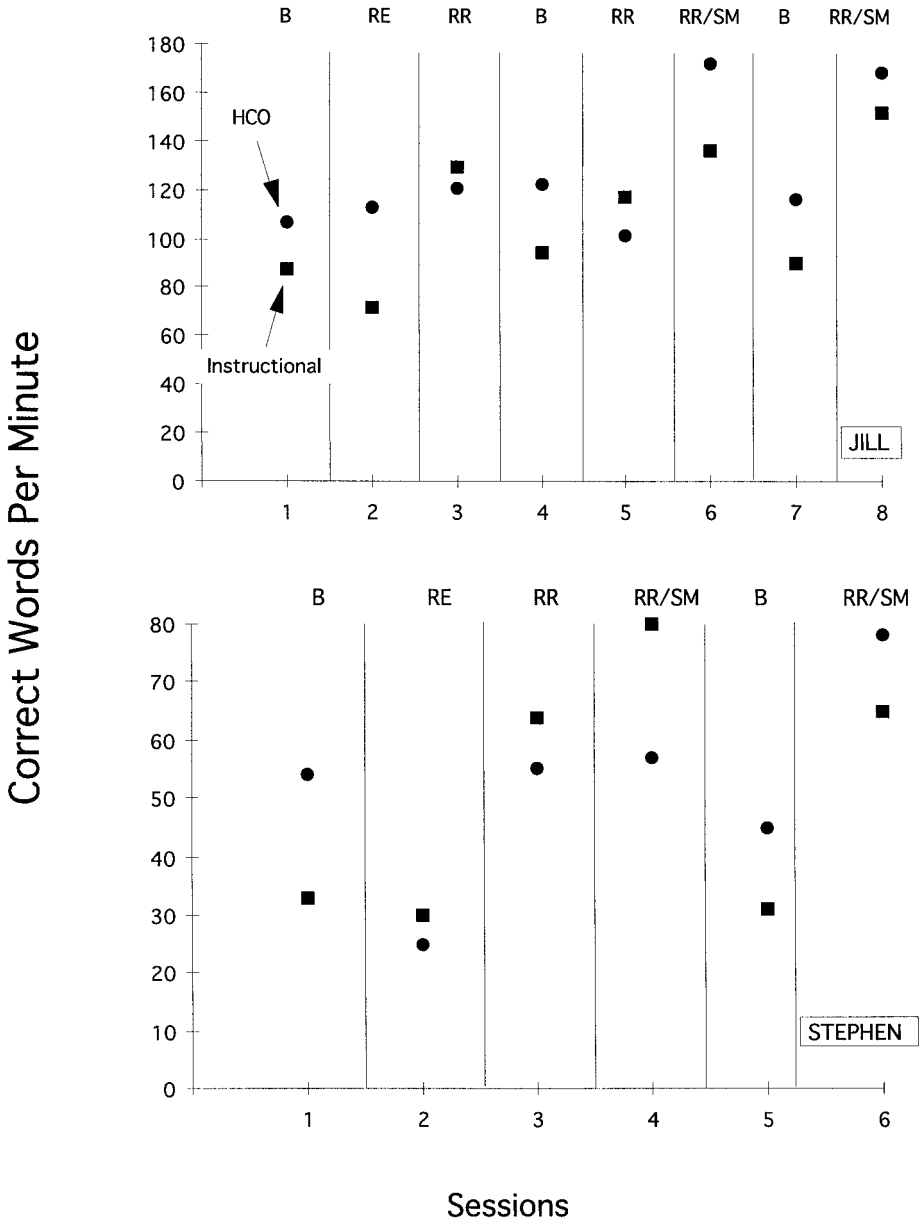

Figure 1. Number of words read correctly per minute in instructional and HCO passages for Jill and Stephen. B = baseline; RE = reward; RR = repeated readings; RR/SM = repeated readings/sequential modification.

the analysis might be extended across passages through the application of a multielement design to examine whether clearly discriminable data series emerge across treatments. Therefore, the value of this type of analysis may be best appreciated within a decision framework for progressing from brief to more extended experimental analyses (Vollmer, Marcus, Ringdahl, & Roane, 1995). The efficiency of the procedures and their emphasis on academic performance may serve to stimulate and broaden future research on the development of functional assessment strategies in educational settings.

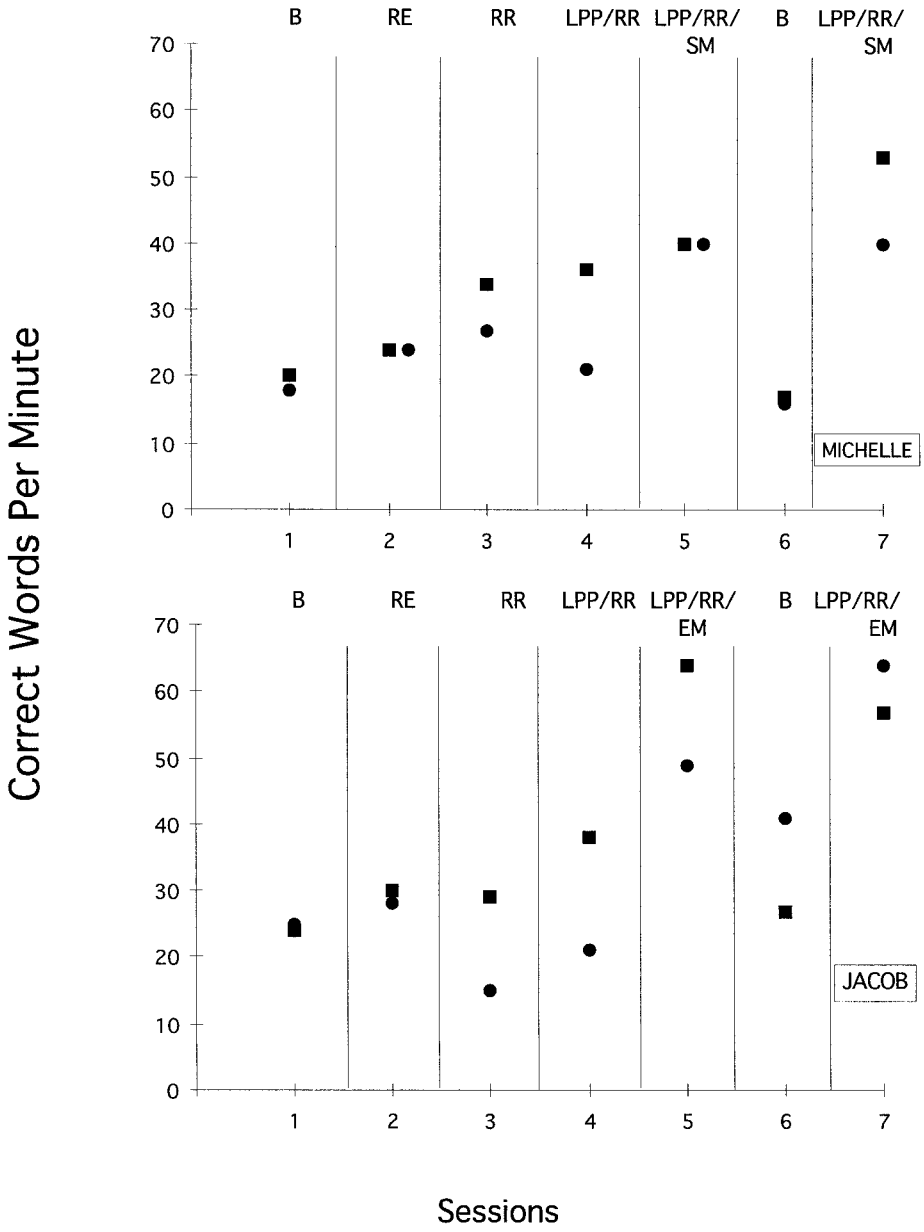

Figure 2. Number of words read correctly per minute in instructional and HCO passages for Michelle and Jacob. B = baseline; RE = reward; RR = repeated readings; LPP/RR = listening passage preview/repeated readings; LPP/RR/SM = listening passage preview/repeated readings/sequential modification; LPP/RR/EM = listening passage preview/repeated readings/easier materials.

The attempt to assess generalization across passages with high content overlap was a unique feature of the procedures, but repeated application of treatments to the HCO passages was necessary for all but 1 child. This finding suggests that, although oral reading fluency is a sensitive measure, generalization cannot be assumed. The HCO passages served initially as probes. If improved performance was not observed in the HCO passage, it then served as material in which instruction was delivered. Whether

the sequential application of treatments across passages enhances reading of usual texts is a subject for future research.

Successful, repeated application of a treatment occurred during five conditions for 3 of the participants (Jill, Stephen, and Michelle). In three of these conditions, responding in the HCO passage was higher than in the instructional passage; responding in the HCO passage was either equal to or lower than in the instructional passage for the remaining conditions. It is not immediately apparent why higher response rates were not obtained in the HCO passages for a larger percentage of conditions. One would expect that the repeated application of the treatment across passages with high content overlap should lead to higher response rates in the HCO passages relative to the instructional passages in virtually all conditions. The fact that the first-, second-, and fifth-grade HCO passages were slightly more difficult than the instructional passages (according to the readability analyses) might provide a clue to this finding. Further investigation of the mechanisms that lead to generalization of academic responding is necessary to clarify this issue.

Future investigations should examine whether factors such as differences in passage difficulty across instructional and HCO passages affect outcomes differentially. Future investigations should also examine how differences in difficulty level interact with different types of instruction. Alternately, it may be that the participants did not have the endurance to maintain high performance levels throughout the session (Binder, 1996). This hypothesis could be investigated in the future by asking students to read the entire passage and measuring CRW for each minute of reading rather than asking them to read for 1 min, permitting an analysis of within-session variability (Vollmer et al., 1995).

This article reports one way in which treatments were ordered and combined sequentially. We assumed that assessment should begin at the level at which the teacher was currently providing instruction. We assumed also that interventions that improved responding at the level at which the student was being instructed would be viewed more favorably and probably be implemented with greater integrity by the classroom teacher. Teachers often group students for reading instruction and may find it difficult to change the materials for an individual child (i.e., the one referred for intervention). For this reason, we placed the analysis of the role of easier materials at the end of the sequence. Future research in this area should examine alternate sequences of treatment conditions and the utility of other conceptual rationales for ordering treatments to determine whether there are more efficient ways to conduct such analyses.

Comparison of results across students brings up the obvious question of how criteria for evaluating effects and deciding on treatment recommendations can be specified, given the idiographic nature of the analyses. Because students are responding at different levels at baseline depending on the difficulty of the materials, standardized criteria for outcome effects are not likely to be helpful. An increase of 10 CRW per minute for a student reading 30 CRW per minute is a much larger increase than for a student reading 75 CRW per minute. Describing the criteria as a proportion of baseline levels of performance is also not likely to be helpful, because students who are only slightly behind (e.g., a fifth-grade student reading 110 CRW per minute) may be approaching the limits of a theoretical parameter for responding when an arbitrary proportion (e.g., a 30% improvement over baseline) is imposed. At the very least, it is reasonable to assume that the criterion would need to be at different fluency levels, reducing its utility in the first place. Further research is needed

to understand the "elasticity" of oral reading (i.e., how amenable it is to change under the best possible conditions) to assist in operationalizing decisions about which treatment is most likely to maximize response rates on a daily basis and the associated long-term effects of such instructional modifications.

Another limitation of this study is that the proximity of treatment and assessment does not permit conclusions regarding the long-term effects of the interventions. The procedures in this study reflect current practices in assessing dependent variables in academic intervention research. The purpose of this investigation was to distill this type of analysis into a brief format for making treatment recommendations. Additional research should be conducted to further evaluate the internal and external validity of the procedures. For instance, the brief analyses of reading interventions can be evaluated by comparing their results to extended experimental analyses using a multielement design. They can also be evaluated by examining the results that they produce in natural classroom settings across time. Investigations of this type may provide information regarding the accuracy of brief experimental analyses in identifying incrementally useful interventions for improving oral reading fluency.

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STUDY QUESTIONS

1. According to the authors, under what conditions would one conclude that learning has occurred? How did this definition differ somewhat from that used as the dependent variable in the study?

2. How were the high content overlap (HCO) passages constructed, and what was their purpose?

3. What was the dependent variable? How was it defined and scored?

4. Describe the basic features of the reward (RE), repeated readings (RR), and listening passage preview (LPP) treatment components.

5. What general strategy was used to determine the order in which treatments were implemented?

6. What appeared to be the most effective intervention for each student, based on performance during instructional passages? What additional procedures were required to improve performance during the HCO passages?

7. Given that the RE condition produced little or no change in the performance of any of the participants, how would you respond to a critic's claim that "Reinforcement is ineffective as a means of improving reading performance"?

8. What is the main benefit and limitation of the brief assessment procedure illustrated in this study?

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