Beginning Reading Intervention as Inoculation or Insulin: First-Grade Reading Performance of Strong Responders to Kindergarten Intervention

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Abstract

This study examined the first-grade reading progress of children who participated in an intensive beginning reading intervention in kindergarten. Specifically, the study investigated whether kindergarten intervention could prevent first-grade reading difficulties, or produce an “inoculation” effect, for some children under certain instructional conditions. Participants included children at risk for developing reading difficulties who received a 7-month beginning reading intervention in kindergarten. In October of first grade, 59 children who had achieved criterion levels on measures of phonological awareness and alphabetic knowledge were randomly assigned to one of two types of first-grade reading instruction: (a) code-based classroom instruction and a supplemental maintenance intervention, or (b) only code-based classroom instruction. February posttest measures assessed oral reading fluency, word reading, nonword reading, and comprehension. Between-group analyses indicated that instructional groups did not differ on any posttest measure. The students’ absolute levels of achievement were compared to national and local normative samples. These results indicated that between 75% and 100% of students in both conditions attained posttest levels and demonstrated growth comparable to their average-achieving peers. These results support the hypothesis that strong responders to kindergarten intervention can experience an inoculation effect through the middle of first grade with research-validated classroom reading instruction.

Over the past 20 years, our understanding of reading acquisition and reading disabilities (RD) has increased dramatically. This understanding has been informed by the ongoing consolidation of a substantial scientific knowledge base in beginning reading, consisting of converging, multidisciplinary research evidence (Adams, 1990; National Reading Panel, 2000; National Research Council, 1998). One of the most salient and compelling conclusions to emerge from this knowledge base is the vital and cumulative consequences of establishing or failing to establish beginning reading skills in the early grades (Cunningham & Stanovich, 1998; Stanovich, 1986). In response, reading researchers have strengthened their focus on prevention and early intervention efforts as a primary way to combat reading difficulties before they snowball into long-term RD. As a result of these efforts, beginning reading interventions have become more and more effective at increasing the reading skills of young students identified as at risk of developing RD (Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998; Simmons et al., 2001; Torgesen et al., 1999).

For example, Torgesen (2000) conducted an analysis of the results of five recent intervention studies that implemented carefully designed, explicit beginning reading instruction with young students at risk of RD with phonological deficits. The beginning reading skills of the students targeted in these studies were all initially in the lowest 20th percentile compared to their peers. Torgesen calculated that after intervention, approximately three quarters of the students in each at-risk sample were able to achieve word reading skills above the 30th percentile on standardized measures of word reading and decoding. Torgesen concluded that by intervening early and systematically, using the best of what we know, a significant percentage of young children at risk of experiencing RD can, in effect, catch up to their peers who are not at risk.

Findings such as these reinforce the immediate positive effects that result from effective early intervention targeted toward critical beginning reading skills. Questions remain, however, about the enduring effects of these interventions (Lyon & Moats, 1997). To truly evaluate the effectiveness of prevention efforts, it is necessary to examine the subsequent reading progress of students who take part in beginning reading interventions to determine if students who caught up during intervention were able to continue to make
acceptable progress following intervention and, in fact, stay caught up. This information has important implications for the learning disabilities community, where there is currently considerable debate about the impact of prevention efforts in beginning reading on the number of students who eventually are referred for and receive special education services (Lyon et al., 2001; Scruggs & Mastropieri, 2002).

In this article, we consider two hypotheses regarding the enduring effects of beginning reading intervention and some of the factors that may mediate or influence these effects. Next, we present the results of a study examining the first-grade reading progress of children at risk of RD who participated in an intensive beginning reading intervention in kindergarten. Specifically, the study investigated experimentally whether kindergarten intervention could prevent first-grade reading difficulties for children at risk for RD. We refer to these hypotheses as “inoculation” and “insulin.”

Enduring Effects of Intervention: Two Hypotheses

There are at least two possible hypotheses, broadly conceived, for the subsequent reading progress of students at risk of RD who participate in beginning reading interventions. We refer to these hypotheses as “inoculation” and “insulin.”

Inoculation

Early intervention that is strategic, intensive, and timely may prevent further reading difficulties for many at-risk children (Vellutino et al., 1996). This hypothesis holds that early intervention, if carefully designed and delivered, is sufficient to remediate, within a specified window of time, the phonological and alphabetic deficits of a significant percentage of children who are initially identified as at risk for RD, making further intensive intervention unnecessary. Early intervention, in this sense, acts like a “jump-start” (O’Connor, 2000, p. 43).

This view draws heavily on Stanovich and Share’s (Share, 1995; Share & Stanovich, 1995; Stanovich, 1986) conceptualization of reading acquisition. According to this model, there are reciprocal effects of establishing strong phonological and alphabetic skills at high criterion performance levels. The early and timely establishment of these skills facilitates the building of fully specified orthographic representations in memory, which then become the foundation for the successful acquisition of later reading skills such as word reading automaticity and text reading fluency. These successful encounters with connected text, in turn, help further strengthen and reinforce these representations.

Thus, students who develop adequate reading-related skills in the early grades benefit from the rich-get-richer phenomenon that Stanovich (1986) described as Matthew effects. Share (1995) similarly refers to a self-teaching mechanism that results from the development of a strong phonological and alphabetic base, facilitating the further development of more complex reading skills. According to this view, early intervention in reading, if properly designed and delivered, should act as a vaccination, inoculating children against the later occurrence of reading failure or RD.

Insulin

The validity of the inoculation hypothesis has been questioned in the literature. For example, Shanahan and Barr (1995) expressed concerns with the ability of early intervention to completely prevent further reading difficulties:

To use a medical analogy, early interventions are supposed to operate like a vaccination, preventing all future learning problems, no matter what their source or severity. It appears, however, that early interventions, no matter how successful, are more similar to insulin therapy. That is, substantial treatment effects are apparent right away, but these gains can be maintained only through additional intervention and support. (p. 982)

This second hypothesis holds that the positive short-term effects (i.e., the elimination of at-risk status) gained through early intervention can be maintained only with continued intensive support. This view can also be found in the National Research Council’s (1998) report:

It is unrealistic to think of (early intervention) as a one-shot inoculation against reading difficulties for children at risk. Rather, its greater demonstrated value is as the first of many aggressive steps that can be taken in an ongoing effort to intensify all facets of reading instruction for school children who need it. (p. 251)

According to this “insulin” view of beginning reading intervention, children at risk for experiencing reading difficulties not only require highly explicit and systematic instruction to gain initial access to the complex alphabetic writing system, but they also require ongoing and intensive intervention to acquire later, more advanced reading skills. Like insulin-dependent patients, if intervention is discontinued for students initially identified with phonological and alphabetic deficits, they will once again become vulnerable to developing reading difficulties and RD.

Factors That May Mediate Enduring Effects of Intervention

Although on a broad, abstract level, the contrasting inoculation—insulin dichotomy is an interesting and useful characterization of the possible enduring effects of beginning reading intervention for children at risk of experiencing reading difficulties, the reality is likely to be much more complex. There are a multitude of factors that
may mediate the ultimate impact of beginning reading intervention. In other words, for some students under certain conditions, intervention may act more like an inoculation, whereas for other students under different conditions, intervention may be similar to the first shot of insulin.

A conceptual framework for considering some of the factors that may affect or mediate the enduring effects of beginning reading intervention includes three broad categories—student factors, instructional factors, and methodological factors (Coyne, 2001). Student factors include the characteristics of students identified as at risk for experiencing reading difficulties (e.g., phonological awareness deficits, rapid naming deficits, experiential/instructional deficits) and individual students’ response to intervention. Instructional factors include the nature of the intervention (e.g., instructional focus, intensity, length), the time when the intervention is initiated (e.g., kindergarten, first grade), and the nature of postintervention instruction (e.g., whether subsequent classroom instruction is consistent with the instruction provided during the intervention). Finally, methodological factors include the type of reading outcomes measured at follow-up (e.g., word identification, comprehension, fluency), the type of follow-up analyses (e.g., mean differences between treatment and control groups, absolute levels of achievement), and the time of follow-up (e.g., 6 months, 1 year, 2 years).

According to this conceptual framework, inoculation or insulin effects may not be an either–or phenomenon. Variations in any of the factors outlined, alone or in combination, could influence the enduring effects of beginning reading interventions. Therefore, follow-up studies must explicitly examine and carefully isolate at least some of these mediating factors to establish the conditions under which beginning reading intervention acts like an inoculation or, conversely, like insulin (Lyon & Moats, 1997; Torgesen et al., 2001). However, most follow-up studies have not comprehensively addressed many of these factors (Coyne, 2001). The present study was designed to address this limitation by specifically considering critical instructional, student, and methodological factors hypothesized to affect or mediate the enduring effects of beginning reading intervention. This section provides an overview of selected factors that are relevant to the design of this study.

An example of a student factor that may mediate the enduring effects of beginning reading intervention is individual students’ response to instruction. To date, most attention in the literature has been paid to the prospect of those students making the least progress after participating in beginning reading intervention. These students, or treatment resisters (Torgesen, 2000), usually make up 20% to 40% of the at-risk sample and show little or no growth despite receiving intervention. There is little in the literature, however, about the enduring effects of early intervention for those students who show the strongest response to treatment—that is, those at-risk students whose reading-related skills after intervention are no longer distinguishable from their peers who are not at risk.

According to the inoculation hypothesis, students who make less than adequate gains in beginning reading intervention programs (i.e., treatment resisters) would not appear to enjoy the reciprocal benefits that theoretically result from the establishment of critical beginning reading skills. These students would not have established the foundational phonological and alphabetic skills at high criterion levels of performance to support later growth. On the other hand, students who make strong gains and establish skills equal to those of their peers who are not at risk would seem to be ideally positioned to reap these very benefits and, therefore, continue to make acceptable progress in reading without further support. There may, in fact, be critical performance levels associated with certain beginning reading skills that predict future reading success (Good, Simmons, & Kame’enui, 2001). Reciprocal or self-teaching effects may only commence after children attain these threshold levels. It may be that an inoculation effect is valid only for these strong responders to early intervention.

In one of the few intervention studies that specifically followed the subsequent reading progress of strong responders to early intervention, Velutino, Scanlon, & Sipay (1997) reported findings that support this hypothesis. In this study, researchers identified the lowest 15% of first graders on measures of word reading and provided these students with individualized reading intervention through the end of the year. At the end of first grade, the participants were grouped on the basis of their response to treatment. Students who made very good growth (VGG) were monitored during second grade, whereas the rest of the students received continued intervention. Two groups of average readers were also monitored as comparison groups. Velutino et al. (1997) found that “following intervention, the performance level of the VGG group was more like that of the two normal reader groups than like those of the other tutored groups” (p. 360). The students in the VGG group “approached the level of the normal readers and maintained their advantage over children in all other tutored groups (through the end of second grade)” (p. 371).

More recently, Berninger et al. (2002) found similar results in a follow-up study of a first-grade reading intervention. They found that the faster responding at-risk readers in the first-grade intervention maintained their relative gains throughout second grade. Berninger et al. concluded that the “early boost” provided by the first-grade intervention provided these students with a “sufficient jumpstart to function consistently in the average range over a yearlong interval” (p. 64).

An example of an important instructional factor is the time when the intervention is initiated. Simeonsson (1994)
writes that there may be “‘critical points’ at which intervention is differentially more effective or efficient than at other points” (p. 21). There is some evidence that a window of opportunity exists in the early grades, where intensive intervention is differentially more effective at producing an inoculation effect, or preventing reading difficulties, for many students at risk. In a meta-analysis of phonological awareness training studies, Bus and Jansen-Doorn (1999) found that training effects on measures of phonological awareness and reading skills were largest for children in preschool and smallest for children in the later primary grades. They concluded that an “early start with phonological training tends to facilitate the process of learning to read” (p. 412). The National Reading Panel (2000) also found that phonemic awareness and phonics instruction resulted in the greatest effect sizes in kindergarten and first grade.

These results are consistent with the self-teaching hypothesis of Share and Stanovich (1995). If children who are at risk of RD are able to establish foundational reading-related skills early in their school experience, before a serious discrepancy develops between their skills and the skills of their peers, they should be better positioned to develop subsequent skills at a rate comparable to these peers. The remediation of reading-related skill deficits in kindergarten, for example, permits at-risk students to benefit from a similar number of successful encounters with connected text (i.e., self-teaching experiences) as their classmates from the beginning of first grade, thus allowing them to keep pace in the development of their sight-word vocabularies and reading fluency (Torgesen et al., 2001). In this way, children who receive early intervention are not confronted with the same insidious Matthew effects (i.e., an ever widening gap in skills and exposure to text) that older children have to overcome when beginning intervention in later grades.

Another example of an instructional factor is the nature of postintervention instruction. Previous research has found that the effects of research-based interventions can be diminished if general class instruction is inconsistent or incompatible with the supplemental instruction provided to students experiencing reading difficulties (O’Connor, 2000; Torgesen et al., 1999). Similarly, the type of instruction and support that students receive after they take part in a beginning reading intervention may also influence their later outcome. For example, Grade 1 classroom instruction could be incompatible with the kind of intervention provided to students experiencing reading difficulties in kindergarten. Students may have received an explicit, code-based intervention program in kindergarten, followed by a literature-based program in first grade that does not address phonological and alphabetic principles systematically. Students may have a more difficult time maintaining intervention gains with this type of postintervention instruction. Thus, when investigating the enduring effects of beginning reading interventions, it is important to consider the type of postintervention instruction that students receive. Controlling or adjusting the type of instruction that students receive after completing an intervention program could accomplish this. In this way, it would be possible to compare the relative effects of different levels of support on students’ continued reading progress.

Finally, an example of a methodological factor that may mediate the enduring effects of beginning reading intervention is the type of analysis used to determine follow-up effects. Very different criteria for success are used depending on the type of analysis conducted. For example, most follow-up analyses test for statistically significant differences between the experimental group and a control group (e.g., Byrne & Fielding-Barnsley, 1993; O’Connor, Notari-Syverson, & Vadasy, 1998). If mean differences continue to exist at the follow-up measurement point, the intervention is said to have produced long-term effects. This type of analysis usually precludes an examination of the absolute level of reading achievement of children that participated in the intervention. Torgesen et al. (1999) highlighted this limitation, “Because standardized measures of reading skill are frequently not reported, we often do not know whether student reading skills were in the average range following instruction or whether they were better than the control group but still seriously behind in reading” (p. 580). In other words, without a detailed analysis of absolute reading achievement levels and subsequent learning trajectories at appropriate follow-up points, it is impossible to determine if the students who benefited during intervention were able to continue to make acceptable progress following intervention compared to criterion levels of performance (Shanahan & Barr, 1995).

Purpose of the Study

This study examined the first-grade reading progress of children at risk of experiencing reading difficulties who participated in a 7-month beginning reading intervention in kindergarten. Specifically, the study examined whether a kindergarten beginning reading intervention could prevent first-grade reading difficulties, or produce an “inoculation” effect, for some children under certain instructional conditions by explicitly considering a number of critical student, instructional, and methodological factors that were hypothesized to influence subsequent reading outcomes.

First, this study focused only on the strongest responders to the kindergarten intervention. Strong responders were defined as students who achieved criterion levels of performance on measures of phonological awareness and alphabetic knowledge at the beginning of first grade. These criterion levels of performance have been shown to be a strong predictor of subsequent reading progress in first grade (Good et al., 2001).
Second, this study experimentally manipulated the type of first-grade instruction and support provided to these strong responders to the kindergarten intervention. In October of first grade, participants were randomly assigned to one of two types of postintervention instruction: (a) code-based classroom instruction plus an additional maintenance intervention, or (b) code-based classroom instruction only. The 10-week intervention was designed to help students maintain the phonological and alphabetic skills they had established in kindergarten and to reinforce material being introduced in first grade. The purpose of this contrast was to examine the intensity of support that strong responders to kindergarten intervention required in order to continue to make acceptable reading progress in first grade.

Finally, the data were analyzed in a number of ways to address two primary research questions. First, between-group analyses were conducted to determine which type of first-grade instruction and support produced the greatest effects on reading outcomes in February. Second, group and individual performance was examined in comparison to national and local normative samples to determine students’ absolute levels of achievement.

By addressing and controlling for these key instructional, student, and methodological factors, this study was able to pose a more specific, directed question than most traditional follow-up studies: Do children initially at risk for experiencing reading difficulties who responded strongly to an intensive, specialized kindergarten reading intervention benefit from an inoculation effect through February of first grade? Second, group and individual performance was examined in comparison to national and local normative samples to determine students’ absolute levels of achievement.

Method

Kindergarten Study

Because all first-grade participants in this study took part in an intensive, specialized beginning reading intervention in kindergarten, a brief description of this earlier study is presented to provide a context for the present study (Simmons et al., 2001). Participants in the kindergarten study (and in the current study) included students from seven elementary schools in two suburban school districts in western Oregon. Both districts share comparable demographics, including the percentage of students of European American background (89% and 90%) and the percentage of the student population living in poverty (18% and 17%; Oregon Department of Education, 2000). All seven schools qualified for Title 1 funds.

All kindergarten students from the seven elementary schools were screened using the Onset Recognition Fluency (OnRF) and the Letter Naming Fluency (LNF) subtests from the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Kaminski & Good, 1996). These measures assess the important reading-related skills of phonological awareness and letter knowledge and are highly predictive of future reading difficulties (Good et al., 2001). To be considered at risk, students were required to score less than 11 onsets per minute on the OnRF and to name less than 6 letters per minute on the LNF. These criteria identified the lowest quartile of the children that took part in the screening.

In October of kindergarten, the 112 identified students were randomly assigned to one of three intervention groups. Each of the three interventions consisted of 30 minutes of instruction a day between November and May. The interventions supplemented general kindergarten classroom instruction and took place during nonschool hours (i.e., either before or after the general half-day kindergarten). Each of the three interventions was designed to explicitly teach the critical beginning reading skills of phonological awareness (i.e., oral blending and segmenting) and alphabetic understanding (i.e., letter–sound correspondences and word decoding). The three intervention conditions varied in their instructional emphasis (i.e., percentage of time dedicated to code-based instruction versus meaning-based instruction) and instructional specificity (i.e., level of explicitness, supportiveness, intensity). Analyses of kindergarten data indicated that the condition that included the strongest emphasis on code-based instruction and the highest degree of instructional specificity produced the largest effects. However, all three interventions were effective at substantially increasing the students’ beginning reading skills (Simmons et al., 2001).

Participants

Participants in the present study included the strongest responders to the kindergarten intervention, a subsample of those students who took part in the kindergarten study just described. The following procedure was used to identify these strong responders: In October of first grade, all students who had participated in the kindergarten study who were still attending either of the school districts (n = 80) were screened on measures that assessed phonological awareness and letter–sound correspondence. These measures included the Phoneme Segmentation Fluency (PSF) and the Nonsense Word Fluency (NWF) subtests from the DIBELS. Good et al. (2001) considered students who were able to segment 35 phonemes per minute on the PSF and identified 20 letter–sound correspondences per minute on the NWF at the beginning of first grade to have established phonological and alphabetic skills. These benchmark levels are also thought to be positive predictors of later reading achievement. Therefore, the students who met these criteria were considered to be strong responders to the kindergarten intervention and to have attained reading-related skills similar to their peers who were not at risk. A total of 60 students met these criteria, or three quarters of the students who participated in the kindergarten intervention study. One student moved during the course of the
study, resulting in 59 students completing posttest assessments. Participants included 36 boys and 23 girls. Mean age was 80 months (SD = 3.62). Participants included 49 European American students, 9 Hispanic students, and one African American student.

**Procedure**

**Participant Assignment.** Participants were ranked within each school by their scores on the NWF, paired, and randomly assigned to instructional condition. For example, in a given school, the two students with the highest NWF scores were considered a pair. One student was randomly assigned to one condition and the other student was automatically assigned to the other condition (Tabachnick & Fidell, 1996). This procedure was repeated for each remaining set of ranked pairs. The purpose of this procedure was to ensure equivalency of the groups on NWF scores. After assignment, a series of one-way ANOVAs were conducted for each pretest measure to test for comparability of groups. There were no statistically significant differences between groups on either pretest measure, suggesting that the two groups were comparable with respect to each variable. Means and standard deviations for pretest measures are presented in Table 1.

**Instructional Conditions.** The experimental independent variable was instructional condition, which was treated as a between-subjects variable with two levels, experimental and comparison. Students in both groups participated in all general classroom code-based reading instruction. However, students in the experimental condition received an additional 30 minutes of intervention daily over the course of 50 instructional days between November and February.

**Classroom reading instruction.** The seven elementary schools in this study used one of three core beginning reading programs in first grade, Open Court, Read Well, or Reading Mastery. Each of these three reading programs emphasized phonological awareness, letter-sound correspondences, decoding strategies, and text reading. Each program included a carefully sequenced schedule for introducing new skills and used explicit, teacher-directed presentations. The curricular content and instructional design of these programs were consistent with research on effective beginning reading instruction (e.g., Kame’enui, Carnine, Dixon, Simmons, & Coyne, 2002; National Reading Panel, 2000) and were aligned with the focus and approach of the three interventions from the kindergarten study. Furthermore, all seven elementary schools had made significant efforts to improve beginning reading instruction over the previous several years through schoolwide restructuring and extensive professional development (Coyne, Kame’enui, & Simmons, 2001; Simmons et al., 2000). These efforts included committing to beginning reading as a top instructional priority, providing teachers with extensive staff development, setting ambitious and measurable reading goals, organizing data in a schoolwide student database, providing differentiated instruction for the full range of learners, and acquiring current, research-based beginning reading curricula and supplemental instructional tools. In each school, between 60 and 90 minutes of protected instructional time was allocated to reading instruction. All schools used a combination of whole-class and small-group instruction delivered by teachers and assistants. Student groupings were dynamic and based on skill level. In sum, each of the seven participating schools provided students with high-quality first-grade reading instruction.

**Experimental intervention.** The first 15 minutes of the intervention focused on enhancing phonological awareness and alphabetic skills and consisted of instruction from the Write Well program (Sprick & Howard, 2000). This program emphasizes phonological and alphabetic skills through spelling and

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**Table 1**

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*Note.* NWF = Nonsense Word Fluency subtest of the Dynamic Indicators of Basic Early Literacy Skills (Kaminski & Good, 1996); WRMT-R = Woodcock Reading Mastery Test–Revised (Woodcock, 1987); ORF = Oral Reading Fluency (Deno, 1989).

\[n = 28, n = 31.\]
writing instruction and practice. The major components of this program include reviewing letter–sound correspondences and letter combinations, orally segmenting teacher-dictated words into individual phonemes and sequentially writing the letters that correspond with each phoneme to spell words, decoding words to confirm spellings, and spelling whole words and sentences from dictation. This program includes teacher-directed, explicit instruction and a carefully structured scope and sequence.

Write Well was chosen for the intervention because it focused on research-validated big ideas in beginning reading instruction (National Reading Panel, 2000), it aligned with the general first-grade beginning reading programs, and it reinforced the critical skills introduced in the kindergarten intervention (i.e., phonemic segmentation, letter–sound correspondences, reading and spelling decodable words). Implementation of the Write Well program was standardized across interventionists to ensure consistency.

The second 15 minutes of the intervention focused on providing students with practice in reading words and connected text and consisted of an instructional program developed by researchers at the University of Oregon. The components of this program included word reading practice with both regular and sight words, teacher-supported group readings of decodable storybooks, and partner readings of storybooks. Students completed multiple readings of storybooks with controlled, decodable text. This program was designed as a less intensive continuation of the kindergarten intervention and included similar attention to research-validated instructional design principles (e.g., focus on big ideas, explicit instruction of conspicuous beginning reading strategies, mediated scaffolding, strategic integration, primed background knowledge, judicious review; see Kame’enui et al., 2002). Implementation was standardized across the trained interventionists (e.g., Title 1 teachers, educational assistants) to ensure implementation fidelity. Instruction was delivered in small groups (i.e., 3–5 students) during the general school day. Intervention groups did not meet during general classroom reading instruction.

**Fidelity of Implementation.** In October, prior to the beginning of the study, all interventionists were trained in the implementation of the experimental intervention. The training session focused on lesson formats, instructional procedures, and lesson materials. Trainers modeled the procedures and then provided interventionists with opportunities to practice the procedures with guided feedback. Critical components of the interventions were identified, and an observation checklist was developed to document and evaluate fidelity of implementation (Gersten, Baker, & Lloyd, 2000; Gresham, MacMillan, Beebe-Frankenberger, & Bocian, 2000). Members of the research team observed each interventionist a total of four times over the course of the study. Fidelity of implementation of the experimental intervention averaged more than 90%.

**Dependent Measures**

**Phoneme Segmentation Fluency.** The PSF measure is a standardized, individually administered test of phonological awareness that assesses a student’s ability to fluently segment regular three- to four-phoneme words into their component sounds. Examiners orally present words, and students respond by saying the individual letter sounds. The final score is the number of correct letter sounds produced in 1 minute. Alternate-form reliability ranges from .67 to .87, and concurrent validity with other reading measures ranges from .35 to .55 (Kaminski & Good, 1996).

**Oral Reading Fluency.** The Oral Reading Fluency (ORF; Deno, 1989) test is a standardized, individually administered method of assessing reading fluency and overall reading performance. Students read a grade-level passage of connected text for 1 minute. The ORF is scored by totaling the number of words read correctly. Test–retest and alternate-form reliability of ORF measures are consistently above .90, and criterion-related validity with other standardized measures of reading, decoding, and comprehension is similarly high (Fuchs, Fuchs, Hosp, & Jenkins, 2001).

**Word Attack Subtest.** The Word Attack subtest of the Woodcock Reading Mastery Test–Revised (WRMT-R; Woodcock, 1987) measures a child’s skill in reading a list of nonwords (e.g., _tet_) presented in isolation. The raw score is the number of nonwords read correctly, which is converted into a standard score. Internal consistency reliability for the subtests of the WRMT-R ranges from .92 to .98 (Woodcock, 1987). Criterion-related validity of the Word Attack subtest with the Woodcock-Johnson Psycho-Educational Battery broad reading score for first grade is .69.

**Nonsense Word Fluency.** The NWF measure is a standardized, individually administered test assessing children’s ability to identify letter–sound correspondences and phonetically decode regular one-syllable nonwords. Students are asked to read VC and CVC nonsense words (e.g., _sig_, _ray_, _ov_). Partial credit is given for producing individual letter sounds. The final score is the number of correct letter sounds produced in 1 minute. Alternate-form reliability ranges from .73 to .91 (Kaminski & Good, 1996).
subtests of the WRMT-R ranges from .92 to .98 (Woodcock, 1987). Criterion-related validity of the Word ID subtest with the Woodcock-Johnson PsychoEducational Battery broad reading score for first grade is .82.

Passage Comprehension Subtest.
The Passage Comprehension subtest of the WRMT-R measures comprehension of text by requiring a student to produce a missing word to form a sentence. The raw score is the number of words correctly produced, which is then converted into a standard score.

Data Collection
First-grade screening measures included PSF and NWF and were administered in the second week of October at each of the seven elementary schools by research team members. Pretest measures were collected in the last two weeks of October and included ORF, Word Attack, Word ID, and Passage Comprehension. Posttest measures were administered at the end of February and included NWF, ORF, Word Attack, Word ID, and Passage Comprehension. Graduate students from the University of Oregon were trained to administer and score all measures. Data collectors were required to demonstrate at least 90% reliability for administration and scoring.

Results
Effects on Reading Performance in February
The first research question focused on the type of reading instruction or support that strong responders to kindergarten intervention received during the beginning of first grade. In October of first grade, students who had participated in a 7-month kindergarten intervention study were screened on measures of phonological awareness and nonsense word decoding. Students who met a performance-based criterion on these measures were randomly assigned to one of two instructional conditions: code-based classroom instruction with an additional maintenance intervention, or code-based classroom instruction only. By experimentally controlling the type and intensity of first-grade instruction, it was possible to examine the level of support that strong responders to kindergarten intervention require to continue making acceptable reading progress in first grade. More specifically, this research question asked whether either of the two instructional conditions would result in higher reading outcomes in February.

Analysis of covariance (ANCOVA) was used to determine whether there were statistically significant mean differences between the experimental and comparison groups at posttest on each dependent measure after controlling for pretest scores. Prior to conducting these analyses, three assumptions for ANCOVA were tested (Tabachnick & Fidell, 1996). First, the correlation between each pretest measure and its corresponding posttest measure was consistently high (i.e., above .50), thus validating the appropriateness and usefulness of each covariate. Second, there were no statistically significant group differences on any pretest measures, indicating that the covariates were not confounded with group. Third, no statistically significant interactions were found between group and covariate for any of the posttest measures, ensuring homogeneity of regression. In other words, group effects were similar on each posttest measure for all levels of the corresponding covariate.

Separate, one-way between-subjects ANCOVAs were conducted for each measure with the posttest score as the dependent variable, group as the independent variable, and the corresponding pretest score as a covariate. There were no statistically significant group effects for any measure: ORF, F(1, 56) = .73, p = .40; NWF, F(1, 56) = .26, p = .62; Word ID, F(1, 56) = .23, p = .63; Word Attack, F(1, 56) = .29, p = .56; Passage Comprehension, F(1, 56) = .32, p = .57. Means and standard deviations for pretest and posttest measures are presented in Table 1.

Thus, for the students in this study, participation in a supplemental maintenance intervention did not confer any benefits in addition to those attributable to the general code-based reading instruction provided in the general education classroom under typical instructional conditions. In explanation for the lack of group differences, it is possible that these students may not have needed additional support to maintain growth in reading skills. Participants were selected at the beginning of first grade because they had met criterion levels on measures of phonological awareness and word decoding—levels that predict positive first-grade reading outcomes (Good et al., 2001). It was hypothesized that because the participants were originally identified as at risk of experiencing reading difficulties in kindergarten and had attained phonological and alphabetic skills only through intensive intervention, they might require continued additional support in first grade to ensure the maintenance and subsequent growth of these skills (O’Connor, 2000; Shanahan & Barr, 1995). However, the supplemental intervention may have been redundant and unnecessary for these students. They may have developed a strong enough phonological and alphabetic foundation in kindergarten to continue to make progress in first grade with only the classroom code-based instruction (Share & Stanovich, 1995). To determine whether the intervention was, in fact, unnecessary for these children, the second research question examined overall student reading achievement.

Absolute Level of Performance in February
The second research question examined the absolute reading achievement of strong responders to kindergarten intervention in February of first grade. Participants were chosen at the beginning of first grade because they appeared to be performing similarly to
their peers who were not at risk. However, the demands of first-grade reading instruction are high, and students acquire skills in the first half of the year at a profoundly rapid rate (National Research Council, 1998). Given these challenges, this research question asked simply, “How are they doing?” To answer this, group and individual performance was examined in comparison to a national normative sample of children of similar age and a local sample of first-grade students. Because no statistically significant differences in achievement were found between students who received classroom reading instruction combined with the maintenance intervention and students who received only classroom instruction, these analyses were conducted for the total sample of participating students.

**Performance Compared to National Normative Sample.** To determine how the participants performed compared to a large national sample of students of similar age, standard scores on subtests from the WRMT-R were calculated. Torgesen (2000) has suggested that students scoring above the 30th percentile compared to a normative sample should be considered as performing in the average range. Conversely, a score below the 15th percentile would indicate significant reading difficulties (Stanovich, 1999). Table 2 shows the percentage of students who scored above the 75th, 50th, and 30th percentiles and students who scored below the 15th percentile on subtests from the WRMT-R in February of first grade. The results presented in Table 2 indicate that as a whole, the performance of participants on the WRMT-R compared very favorably to a large normative sample of children of similar age. A total of 97% (n = 57) of the participants scored above the 30th percentile on the Word ID subtest, 100% (n = 59) scored above the 30th percentile on the Word Attack subtest, and 92% (n = 54) scored above the 30th percentile on the Passage Comprehension subtest compared to only 2%, 0%, and 5% who scored below the 15th percentile on the same measures. A substantial number of students also performed above the 75th percentile on the WRMT-R subtests, with 53% (n = 31) and 71% (n = 42) of the participants reaching this level on the Word ID and Word Attack measures.

Table 2 also illustrates that the participants gained standard score points between pretest and posttest. Mean student performance increased from 105 to 110 on Word ID, from 110 to 113 on Word Attack, and from 96 to 101 on Passage Comprehension. Because standard scores reflect age-adjusted performance, they remain stable over time for specific achievement levels. For example, a student performing at the 50th percentile in October and also in February would receive a standard score of 100 at both points in time. Thus, the increase in standard scores for participants between fall and winter of first grade indicates that these students made more growth than the normative sample during this time period.

In February of first grade, these students, as a whole, were clearly performing above average in real word and nonword reading and average in reading comprehension compared to a national sample. These results differ from other follow-up studies of beginning reading interventions that found long-term effects on measures of decoding skill but not word recognition (Bus & Ijzendoorn, 1999).

**Performance Compared to Local Normative Sample.** To put these students’ scores in perspective, their performance on NWF and ORF was compared to the performance of other first-grade students in their school district. The school district that a majority of the participating students attended regularly collected NWF data on all first graders in September and NWF and ORF data in January. These data were used to determine how the participants compared with their first-grade peers. Mean scores were calculated for the district, and a districtwide norm table was constructed that paired raw scores with their corresponding percentile ranks. Because the districtwide assessment took place in September and January, participant scores from these measurement points were used in these analyses instead of the October and February pretest and

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**TABLE 2**

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Group performance*</th>
<th>Individual performance</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretestb</td>
<td>Posttestb</td>
<td>&gt; 75% n</td>
<td>&gt; 50% n</td>
<td>&gt; 30% n</td>
<td>&lt; 15% n</td>
</tr>
<tr>
<td>Word Identification</td>
<td>104.83</td>
<td>109.71</td>
<td>31  53</td>
<td>54  92</td>
<td>57  97</td>
<td>1   2</td>
</tr>
<tr>
<td>Word Attack</td>
<td>109.80</td>
<td>113.42</td>
<td>42  71</td>
<td>56  95</td>
<td>59  100</td>
<td>0   0</td>
</tr>
<tr>
<td>Passage Comprehension</td>
<td>96.37</td>
<td>101.39</td>
<td>12  20</td>
<td>40  68</td>
<td>54  92</td>
<td>3   5</td>
</tr>
</tbody>
</table>

*Note. WRMT-R = Woodcock Reading Mastery Test–Revised (Woodcock, 1987).
*Standard scores. *n = 59.
posttest scores used in the other analyses.

Table 3 shows the percentage of participants who scored above the 75th, 50th, and 30th percentiles and the students who scored below the 15th percentile on NWF and ORF in January compared to other first-grade students in their district. Figure 1 displays box plots comparing the performance on the NWF for the sample and the entire district in September and in January. Figure 2 displays a comparison of the performance on the ORF for the sample and the entire district in January. The dark line in the middle of the box plot represents the median. The top and bottom lines represent the 75th and 25th percentile scores, respectively.

According to these analyses, the participants’ performance was very similar to district averages. The mean NWF score for the sample in January was 59, whereas the mean score for the district was 58. The distribution of NWF scores was also very similar. The only difference was that the sample had fewer low-performing students than did the district (e.g., only 20% of the sample fell below the 30th percentile of the district). Finally, the growth of the sample between September and January was comparable to the growth of the district. In fact, it is striking how similar the performance of the sample was to the district between fall and winter. It appears almost as if the participants were a random sample of students chosen from the district instead of a group of children who were all in the bottom 25th percentile at the beginning of kindergarten.

The results were slightly different for ORF. The mean ORF score for the sample in January was 26, whereas the mean score for the district was 34. Similar to NWF, the sample had fewer low-performing students (e.g., 25% of the sample falling below the 30th percentile and 9% falling below the 15th percentile). However, the sample also had fewer high-performing students compared to the district, with only 30% of the students performing above the 50th percentile.

Returning to the larger question of how these students are doing, it seems accurate to characterize their overall performance as solidly in the average range. This characterization changes slightly, however, depending on the outcome examined and the standards they are measured against. These students look the best when they are compared to a national sample on a measure of decoding skill. This result is significant because researchers have argued that this type of nonword reading is the most rigorous indicator of well-developed alphabetic skills, which are most often lacking in students with RD (Perfetti, 1985; Torgesen et al., 1999). Participants also performed well on real word reading compared to the national sample and, again, on nonword reading compared to students in their school district.

Although less strong, student performance on the Passage Comprehension and ORF measures also fell within the average range compared to both national and local norms. Again, the performance of students in this study was somewhat different from the performance of students in other studies (Bus & IJzendoorn, 1999; Olson, Wise, Johnson, & Ring, 1997). For example, students between the ages of 8 and 10 who participated in an intervention study conducted by Torgesen et al. (2001) attained significant progress in word reading skills in comparison to a large normative sample and were able to maintain this level of performance over the course of a 2-year follow-up period. On the other hand, these students continued to lag far behind their peers in reading fluency.

Again, although the participants in the current study achieved acceptable levels on Passage Comprehension and ORF, these were relatively weaker areas for those students. It is possible that over time, if this trend continues, the increasing gap between reading fluency and word reading skills could become an area of concern for stu-

### TABLE 3

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group performance&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Individual performance in January</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>September</td>
<td>January</td>
</tr>
<tr>
<td>NWF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample&lt;sup&gt;b&lt;/sup&gt;</td>
<td>32.85</td>
<td>109.71</td>
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<tr>
<td>District&lt;sup&gt;c&lt;/sup&gt;</td>
<td>31.13</td>
<td>57.96</td>
</tr>
<tr>
<td>ORF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26.34</td>
<td>34.20</td>
</tr>
<tr>
<td>District&lt;sup&gt;d&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. NWF = Nonsense Word Fluency subtest of the Dynamic Indicators of Basic Early Literacy Skills (Kaminski & Good, 1996); ORF = Oral Reading Fluency (Deno, 1989).
<sup>a</sup>Raw scores. <sup>b</sup>n = 56. <sup>c</sup>n = 393. <sup>d</sup>n = 391.
Journal of Learning Disabilities

This possibility would be consistent with evidence suggesting that deficits in fluency and automaticity are a persistent challenge for students initially identified as at risk for RD (Torgesen et al., 2001; Wolf & Bowers, 1999).

Discussion

This study began with a question that has yet to be answered in the research literature: “Beginning reading intervention as inoculation or insulin?” In an attempt to respond to this question, this study was designed to specifically address a number of factors that could affect the enduring effects of beginning reading intervention. At this point, based on the results of this study, it is possible to offer a qualified, albeit wordy, answer.

Most students who are initially identified as at risk of experiencing reading difficulties at the beginning of kindergarten based on phonological deficits, and who attain high levels of phonological awareness and alphabetic skills after receiving a specialized kindergarten reading intervention, experience an inoculation effect with high-quality, code-based first-grade classroom reading instruction through February of first grade on a range of reading measures in comparison to local and national normative samples.

Moreover, the results of this study indicated that participants in a 25-hour supplemental intervention targeting phonological awareness and word reading skills did not affect the magnitude of this effect. Stated differently, even though the strong responders to kindergarten intervention who participated in this study did not benefit from a first-grade maintenance intervention, they did not need this intervention to continue to make progress in the general classroom reading program comparable to their average-achieving peers. These findings suggest a number of implications for practice, which are discussed in the following sections.

Importance of Kindergarten Reading Intervention

Torgesen (2000) calculated that three quarters of primary school students at risk of experiencing reading difficulties can catch up to their average-achieving peers through effective, comprehensive beginning reading interventions. Simmons et al. (2001) demonstrated that similar results can be attained with kindergarten students. This study extends these findings by suggesting that between 75% and 100% of those kindergarten students that catch up by the beginning of first grade can continue to make acceptable reading progress through February of first grade without additional intervention. This assertion is based on results showing that between 75% and 100% of all participants scored above the 30th percentile on all posttest measures compared to both national and local normative samples. In other words, between 56% and 75% of all students initially identified as at risk of experiencing reading difficulties at the beginning of kindergarten demonstrated average reading performance in the middle of first grade after only receiving intervention in kindergarten.

This finding highlights the critical importance and lasting effects of effective kindergarten intervention for many at-risk students and supports the self-teaching hypothesis of Share and Stanovich (1995; Share, 1995; Stanovich 1986). It is possible that because the at-risk participants in this study were able to establish strong phonological and alphabetic skills by the beginning of first grade, before a serious discrepancy developed between their skills and the skills of their peers, they were better positioned to develop subsequent skills at a rate comparable to these peers. Apparently, participants benefited from a similar number of successful encounters with connected text (i.e., self-teaching experiences) as their classmates within the general first-grade classroom reading program comparable to their average-achieving peers. These findings suggest a number of implications for practice, which are discussed in the following sections.
grade reading program, thus allowing them to keep pace in their reading development through the middle of first grade without further intervention. This interpretation is reinforced by the participants’ significant progress on measures of word identification, passage comprehension, and oral reading fluency. Intervention studies with older students have not found consistent positive results on these measures (Olson et al., 1997; Torgesen et al., 2001). This suggests that a window of opportunity may exist in kindergarten when intervention is differentially more effective or efficient than at other points in time (Bus & IJzendoorn, 1999; Simonsson, 1994).

**Importance of First-Grade Reading Instruction**

Most of the participants in this study were able to demonstrate growth in reading skills similar to their average-achieving peers between October and February of first grade without the support of additional intervention. It is important to note, however, that each of the elementary schools involved in this study implemented a research-validated, code-based core reading program in their first-grade classrooms (e.g., American Federation of Teachers, 1999). Furthermore, all of the schools had made significant efforts to improve beginning reading instruction over the course of several years. Through these efforts, schools were able to offer students reading instruction in the general education classroom that was much more coordinated and comprehensive than is typically found in schools (Coyne et al., 2001; Simmons et al., 2000).

Moreover, reading instruction provided in the first-grade classrooms was similar in design, delivery, and focus to the kindergarten intervention. Researchers have suggested that alignment between intervention provided to students experiencing reading difficulties and classroom instruction can support and strengthen student performance (O’Connor, 2000; Torgesen et al., 1999). It is likely, therefore, that the participants’ positive outcomes are related to the consistent, high-quality reading instruction that they received in their first-grade classrooms. The findings of this study reinforce the importance of carefully designed and implemented first-grade reading instruction, especially for students previously identified as at risk of experiencing reading difficulties.

**Need to Differentiate Intervention Support**

This study found that a large percentage of students who responded strongly to kindergarten intervention were able to make acceptable progress in first grade in a high-quality general classroom reading program. Moreover, these students did not benefit from taking part in a supplemental intervention designed to reinforce phonological and alphabetic skills.

On the other hand, a quarter of the students from the original kindergarten study conducted by Simmons et al. (2001) did not respond as strongly to intervention, did not meet criterion levels of reading-related skills at the beginning of first grade, and therefore were not included in this study. These students had contrasting performance profiles to the participants in this study. In fact, these students’ reading skills in first grade continued to lag behind their peers who had responded strongly to the kindergarten intervention. This was the case even though they were provided with ongoing systematic intervention in first grade that was similar in content and intensity to the kindergarten intervention (for a more detailed description of these students’ performance, see Simmons, Kame’enui, Stoolmiller, Coyne, & Harn, 2003). Moreover, approximately 9% (n = 5) of the participants in the present study were performing below the 15th
percentile compared to their peers on at least one posttest measure in February. Ideally, these students should have received more intensive intervention than was provided in either the general education classroom or the maintenance intervention.

The very different instructional needs of these groups of students in first grade, all of whom were initially identified as at risk at the beginning of kindergarten and received the 7-month kindergarten intervention, highlights the need to differentiate intervention support depending on students’ response to instruction (Berninger et al., 2002; O’Connor, 2000; Vellutino et al., 1996). For example, most first-grade reading interventions have focused on helping students develop phonological awareness and word reading skills (e.g., Foorman et al., 1998; Torgesen et al., 1999). Although this focus may be necessary for students who are still struggling to acquire beginning reading skills, the findings of this study suggest that it may not be an appropriate focus of intervention for students who have established a strong foundation in phonological and alphabetic skills.

It is important to note, however, that the participants in this study did demonstrate a relative weakness in the areas of reading comprehension and especially oral reading fluency. There is also a real possibility that these relative skill differences could increase over time without targeted attention (Torgesen et al., 2001; Wolf & Bowers, 1999). Providing strong responders to kindergarten intervention with first-grade support emphasizing the development of fluency and comprehension may be a more strategic use of time and resources.

Another way to differentiate intervention based on student needs is to vary the intensity of support. Again, after receiving kindergarten intervention, some students may require first-grade intervention at the same level of intensity or, indeed, at a greater level of intensity than they received in kindergarten. It appears, however, that strong responders to kindergarten intervention, similar to the participants in this study, would require less intensive intervention, if any at all, to continue to make acceptable progress in first grade with high-quality, code-based classroom reading instruction.

Conclusions

The results of this study support the hypothesis that some students at risk of experiencing reading difficulties who received intensive beginning reading intervention in kindergarten can benefit from an inoculation effect through the middle of first grade. Inoculation, in the context of this study, refers to the finding that most participants were able to demonstrate acceptable progress in first grade without additional intervention.

Although in this narrow sense inoculation is an appropriate description of this result, it may not offer the most complete explanation for student outcomes. Inoculation in its fullest sense suggests complete immunity against any later occurrence of a condition, in this case RD, regardless of exposure to any external or environmental conditions.

However, the participants in this study attained positive outcomes in an educational context defined by specific student, instructional, and methodological factors. It is possible that these students would have required additional intervention in first grade if one or more of these factors were not present. For example, students may not have been able to maintain critical phonological and alphabetic skills within the general classroom reading program if it had not included a strong code-based component. Moreover, this study only examined student progress through the middle of first grade. It is impossible to know what combination of educational factors would be present in future grades.

Because the inoculation effect found in this study was so dependent on the presence or absence of external factors, we suggest caution when using this term to characterize the effects of early intervention efforts in reading. Instead, perhaps it is time to move beyond the overly simplistic notion of beginning reading intervention as either inoculation or insulin and to focus on the complex combination of conditions that need to be in place to ensure that each individual student becomes a successful reader (Lyon & Moats, 1997).

These types of strategic instructional decisions, based on student performance, depend on reliable and valid indicators of reading progress (Deno, 1989; Good et al., 2001). Moreover, schools are complex host environments, and the complicated interactions that occur between teachers, curricula, and policies within a school make it very difficult to coordinate intervention efforts (Coyne et al., 2001). A schoolwide perspective toward reading instruction facilitates the delivery of integrated and responsive instruction across classrooms and grade levels that can best support students as they progress in their reading development (Simmons et al., 2000). The findings of this study reinforce the need to conceive of prevention and intervention efforts at this broader, schoolwide level.

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