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Learner Characteristics that Influence the Treatment Effectiveness of Early Literacy Interventions: A Meta-Analytic Review

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The purpose of this article was to systematically review the available research on learner characteristics that influence the treatment effectiveness of early literacy interventions. Meta-analytic procedures were applied to a total of 30 studies that met the inclusionary and exclusionary criteria. Mean average effect sizes were computed for seven primary learner characteristic categories: (1) rapid naming, (2) alphabetic principle, (3) phonological awareness, (4) problem behavior, (5) memory, (6) IQ, and (7) demographic. The primary learner characteristics that influenced the treatment responsiveness of early literacy interventions were, in order of magnitude, rapid naming, problem behavior, phonological awareness, alphabetic principle, memory, IQ, and demographics. With the exception of the demographic category, the obtained effect sizes for the primary learner characteristics were moderately large. The demographic primary learner characteristic (i.e., disability, ethnicity, grade-level status) of children was not statistically ($p < 0.05$) distinct from zero. The findings, limitations, and future research needs are discussed.

Children who struggle learning to read represent one of the most significant challenges facing general and special educators today. Indeed, improving reading outcomes is one of the cornerstones of the reauthorization of the Elementary and Secondary Education Act—No Child Left Behind legislation (2001). No Child Left Behind represents a commitment by the federal government to ensure that every child can read by the end of third grade and to the use of scientifically based reading instruction programs in the early grades. It is expected that a major benefit of this approach will be to reduce the number of children identified as needing remedial or special education services due to a lack of appropriate reading instruction in their early years. In this context, it is of interest to review the program of research on early literacy interventions to determine the magnitude and relative contribution of learner characteristics on treatment effectiveness.

A previous combined vote-counting and narrative review of the program of research on children who are nonresponders (i.e., fail to benefit from generally effective early literacy interventions) illuminated much about the learner characteristics that appear to influence the treatment effectiveness of early literacy interventions (Al Otaiba & Fuchs, 2002). The review included a total of 23 studies in which researchers described the learner characteristics of children who were nonresponders. The overall findings reported by researchers from the 23 studies indicated that early literacy interventions clearly benefit most students. Reported estimates, however, of the percentage of children who were nonresponders varied widely (i.e., 8–80 percent) across the studies. This high degree of variability may have been a function of several variables such as (1) the criteria used by researchers to operationally define nonresponders (see Al Otaiba & Fuchs, 2002 for descriptions of the criteria used by researchers to operationally define nonresponders), (2) characteristics of children in the samples, (3) effectiveness of the early literacy intervention, and/or (4) degree of treatment fidelity (Al Otaiba & Fuchs, 2002).

Phonological awareness deficits were the most prominent learner characteristic of children who were nonresponders. A majority of the researchers ($n = 21$) investigated the importance of phonological awareness to the acquisition of beginning reading skills. Of these 21 studies, a majority ($n = 16$) of the researchers reported that children who were nonresponders evinced phonological awareness deficits. The contribution, however, of phonological awareness deficits on children who were nonresponders appeared to be moderated if explicit instructional methods, rather than implicit ones, were used by the implementers (Al Otaiba & Fuchs, 2002).

Al Otaiba and Fuchs (2002) also reported that a number of other cognitive, behavioral, demographic, and orthographic learner characteristics may influence the treatment effectiveness of early literacy interventions. Researchers reported that children who demonstrated slow letter-naming speed, difficulty encoding, storing, and organizing phonological information in memory, and had IQ deficits were found to be nonresponders. Attention or problem behaviors of children also influenced children's responsiveness to early literacy interventions. Children who evinced problem behaviors appeared not to benefit from early literacy interventions even when they were delivered in a one-to-one instructional format (e.g., Vadasy, Jenkins, Antil, Wayne, & O'Connor, 1997). Demographic characteristics found to influence children's

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responsiveness to early literacy interventions included age, level of English proficiency, and parental education levels and occupation. Finally, orthographic processing problems appear to influence children's responsiveness to early literacy interventions.

It is clear that the review of the literature by Al Otaiba and Fuchs (2002) focused attention on the learner characteristics of children that influence the treatment effectiveness of early literacy interventions. Indeed, we found an additional group of studies in which researchers provided information on learner characteristics that influence treatment effectiveness conducted since the time frame covered in this previous research synthesis. We believe that a meta-analytic synthesis (Glass, McGaw, & Smith, 1981; Hedges & Olkin, 1985) of the literature aimed at determining the magnitude and relative contribution of learner characteristics on the treatment effectiveness of early literacy interventions can shed additional light on the findings reported by Al Otaiba and Fuchs (2002).

Thus, the primary purpose of the present research synthesis was to determine the magnitude and relative contribution of learner characteristics that influence the treatment effectiveness of early literacy interventions. We used meta-analytic techniques (Glass et al., 1981; Hedges & Olkin, 1985) to present average mean effect sizes within certain categories of learner characteristics. Because the relatively small number of studies in most categories virtually precluded the search for predictor variables such as type of dependent measure or study quality (e.g., treatment fidelity), we delimited our analyses to descriptive analyses of the average effect size estimators for categories of learner characteristics overall and study by study. We did not apply homogeneity tests or other statistical techniques (e.g., regression analyses) designed to identify predictor variables. Rather, we used average effect size estimators as a common metric to help the reader discern the magnitude and relative influence of learner characteristics on the treatment effectiveness of early literacy interventions. Researchers have used such delimited meta-analytic techniques in similar cases in which the depth and breadth of the program of research precludes the analyses of predictor variables (e.g., Rosenshine & Meister, 1994).

We used Z_r (Fisher z transformed correlation) effect size estimators (Hedges & Olkin, 1985). The primary advantage of such estimators over mean difference effect sizes is that the summary statistics from primary research studies may be in almost any form and need not contain all summary data necessary to compute mean difference effect sizes (e.g., means, standard deviations) (Glass et al., 1981; Hedges & Olkin, 1985). This allows for the inclusion of a larger number of primary studies in the meta-analysis. Additionally, Z_r effect size estimators provide a practical and conceptual understanding of the strength and relative magnitude of the influence of the learner characteristics on the treatment effectiveness of early literacy interventions. Interpretations, based on the interpretive framework for mean difference effect sizes developed by Cohen (1988), of the magnitude of Z_r effect size estimators are as follows: (1) 0.1 to 0.29 (small), 0.3 to 0.49 (moderate), and (3) >0.5 (large).

METHOD

Literature Identification

A two-stage process was used to identify studies. First, we obtained full copies of the 23 intervention studies included in the review of the literature by Al Otaiba and Fuchs (2002). These researchers followed a seven-step search process (see Al Otaiba & Fuchs, 2002 for a complete description): (1) identified list of relevant search terms (e.g., reading difficulties) using the Educational Resources Information Center's (ERIC's) thesaurus of descriptors; (2) entered the identified search terms (detailed below) in computer searches of the ERIC (1966–June 2000), PsychLit (1966–June 2000), and Child Educational Resources (1969–June 2000); (3) conducted ancestral searches of relevant studies of nonresponders; (4) searched pertinent books; (5) completed manual searches of 11 journals (1988 (or date of inception)–June 2000); (6) examined the abstracts to identify pertinent studies; and (7) scrutinized the methods sections of the identified studies to ensure that they described the children who were unresponsive to treatment.

Second, we used a three-step literature search strategy to identify studies that were published from June 2000 to November 2002. Computer searches (June 2000–November 2002) of ERIC, PsychLit, and Child Educational Resources were conducted. We used the same literature search terms as did Al Otaiba and Fuchs (2002): *reading difficulties, remedial reading, read,*[1] *beginning reading, reading readiness, emergent literacy, early interventions, training, phon, phonological awareness, phonemic awareness, at-risk, disadvantaged, low-ability, urban, learning disability, language disorder, language impairment, elementary education,* and *primary education*. The abstracts of all identified studies were studied to eliminate articles that did not meet the inclusion criteria (described below). Finally, the methods sections of these studies were scrutinized to ensure that they met the same inclusion criteria (detailed above) used by Al Otaiba and Fuchs (2002).

This search strategy produced 105 published reports for consideration: 23 studies included in the Al Otaiba and Fuchs (2002) and 82 additional studies published between June 2000 and November 2002. Complete reports for these articles were screened by one of the authors using the required inclusion criteria.

Inclusion Criteria

Inclusion criteria were chosen to ensure, to the extent possible, that the studies sampled would reflect the larger literature on learner characteristics that influence the treatment effectiveness of early literacy interventions. The inclusion criteria were also chosen to provide data on the magnitude and relative contribution of the relationship between learner characteristics and treatment effectiveness of early literacy interventions. Studies included in the meta-analysis had to meet six inclusion criteria. Please note that the first five

inclusion criteria paralleled exactly those used by Al Otaiba and Fuchs (2002).

1. Studies published in peer review journals. ERIC documents were excluded.
2. Participants ranged from preschool to third grade.
3. Participants included students at risk for reading disabilities (e.g., students with low ability, low phonological awareness, low income, disabilities, language disorders).
4. Interventions targeted early literacy. Studies investigating the effects of nonreading interventions (e.g., perceptual training) on reading outcomes were excluded.
5. Study outcomes addressed reading outcomes (e.g., changes in phonological awareness).
6. Researchers had to have reported quantitative information (e.g., beta weights, means and associated standard deviations, F statistic) necessary to compute at least one Z_r effect size estimator between a learner characteristic and an early literacy outcome.

Upon analysis of the complete articles, four of the articles included in the Al Otaiba and Fuchs (2002) study did not meet the inclusion criteria and were excluded from further review. Seventy-one of the 82 additional studies identified through the second search strategy were also excluded from review. Thus, 30 published studies presenting information on the influence of learner characteristics on the treatment effectiveness of early literacy interventions were the focus of subsequent analyses.

Data Analysis Strategy

We made several decisions during the literature review process based on commonly used meta-analytic literature review guidelines to reduce redundancy or overweights of estimates from interdependence in the research samples or measures (Cooper & Hedges, 1996; Glass et al., 1981; Rosenthal, 1995). First, we reviewed the studies to ensure independence in the samples. Each of the studies represented independent samples.

Second, in calculations of effect size estimates, average Z_rs were weighted by sample size according to procedures recommended by Hedges and Olkin (1985). The two primary forms of summary statistics used to compute Z_rs were correlational or predictive (e.g., Al Otaiba, 2001) and those used to test statistical significance (e.g., Foorman, Francis, Fletcher, Schatschneider, & Mehta, 1998). Studies using correlational or predictive summary statistics reported effect sizes, correlations, or beta weights. Studies using summary statistics to test statistical significance generally reported a t, F, or p value. Calculations of average unweighted Z_r were also conducted. All effect size estimates (e.g., d) were converted to r and subsequently to Z_r (see formula below). The Z_r transformation was used to reduce the effects of skewness associated with the sampling distribution of r (Hinkle, Wiersma, & Jurs, 1994). In instances where no means or standard deviations were provided, Z_rs were computed using F or t following the recommendations by Cooper and Hedges (1996) and Rosenberg, Adams, and Gurevitch (2000) and converted to r and subsequently Z_r (see formulas below). The MetaWin 2.0 (Rosenberg et al., 2000) statistical program was used to calculate all effect sizes and conversion to r. The formulas used to convert the summary statistics to a Z_r effect size were as follows.

t $\quad r = \sqrt{\dfrac{t^2}{t^2 + df}}$

F $\quad r = \sqrt{\dfrac{F}{F + df}}$

$$Z_r \frac{1}{2} \ln\left(\frac{1+r}{1-r}\right)$$

Finally, single average unweighted and weighted Z_r effect sizes were calculated for both primary learner characteristic (i.e., phonological awareness) and, if applicable, associated learner subcharacteristics (e.g., phonemic awareness) to reduce redundancy or overweights of estimates from the use of multiple intercorrelated measures. For a characteristic, for example, if researchers used several measures of the phonological awareness learner characteristic (e.g., rhyming, phoneme segmentation), we calculated a single within-study average Z_r effect size estimate for the contribution of the characteristic on treatment effectiveness. Additionally, we calculated a single within-study average Z_r effect size estimate for each of the subcharacteristics to provide a more revealing analysis of the learner subcharacteristics that influenced treatment effectiveness. For a subcharacteristic, for example, if researchers used several measures of phonemic awareness (e.g., onset sound, phoneme blending, phoneme segmentation), we calculated a single within-study average Z_r effect size for the contribution of the subcharacteristic on treatment effectiveness. We also calculated 95 percent confidence intervals for all the obtained Z_r effect sizes to provide an index with which to judge whether (1) the obtained effect sizes differed statistically from zero and (2) there were statistically significant differences in the relative magnitude of the influence of the primary learner characteristics and associated subcharacteristics. The descriptive statistics for meta-analysis of the primary learner characteristics and associated subcharacteristics are shown in Table 1.

Recorded Variables

Information on the authorship, number of participants, sample characteristics (i.e., age, gender, ethnicity, disability, SES, IQ, language when reported), treatment fidelity (if measured or not), characteristic and associated subcharacteristics, and average Z_r effect size(s) recorded from each study are presented in Table 2. The published reports included in the meta-analysis were distributed across the years 1976 to 2002. The number of studies published ranged from one in 1976 to five in 2000. All but one of the studies were published since 1990—a majority were published within the last five years. A total of 3,053 children served as participants. Sample sizes ranged from seven in two studies (Lane, O'Shaughnessy, Lambros,

TABLE 1
Descriptive Statistics for Primary Learner Characteristic/Subcharacteristic(s)

Characteristic/ Subcharacteristic	*Number of Studies*	*Unweighted Mean Z_r*	*95% CI*	*Weighted Mean Z_r*	*95% CI*	*N*
Rapid Naming	7	0.51	0.43 to 0.58	0.51	0.44 to 0.59	1,090
Problem Behavior	6	0.52	0.42 to 0.62	0.46	0.36 to 0.57	636
Phonological Awareness	17	0.47	0.42 to 0.52	0.42	0.37 to 0.48	1,677
Phonemic	13	0.39	0.33 to 0.45	0.37	0.30 to 0.43	1,120
Rhyming	4	0.74	0.58 to 0.90	0.53	0.40 to 0.67	557
Alphabetic Principle	18	0.35	0.30 to 0.41	0.35	0.29 to 0.40	1,573
Memory	11	0.31	0.25 to 0.37	0.31	0.25 to 0.37	1,429
Short term	8	0.30	0.23 to 0.37	0.30	0.23 to 0.38	1,114
Long term	3	0.33	0.11 to 0.55	0.33	0.08 to 0.57	315
IQ	8	0.30	0.23 to 0.38	0.26	0.18 to 0.34	944
Demographic	5	−0.01	−0.13 to 0.11	0.07	−0.04 to 0.19	584
Disability/retention	3	0.03	−0.20 to 0.27	0.10	−0.18 to 0.38	251
Ethnicity	1	0.10		0.10		285
Grade	1	−0.26		−0.25		48

Gresham, & Beebe-Frankenberger, 2001; Lane et al., 2002) examining the effects of early literacy interventions on children at risk of emotional and behavioral disorders, to 346 in a large-scale study (Schneider, Ennemoser, Roth, & Kuspert, 1999) of the effects of a comprehensive primary-level early literacy instruction program.

Most of the samples ($n = 29$) were young school-age children (K–3). The remaining sample included only preschool children (Fox & Routh, 1976). Researchers, with the exception of age, generally failed to provide rich descriptive information on the characteristics of the sample (see Table 1). For example, the ethnicity of the participants was reported in 60 percent of the samples ($n = 18$). Thus, with the exception of age, it is difficult to draw general conclusions regarding the characteristics of the samples studied by researchers. Six of the researchers measured and provided a quantitative report of treatment fidelity. The remaining 24 studies did not include a quantitative report of treatment fidelity.

A wide range of measures were used as reading outcome measures representing the range of characteristics and associated subcharacteristics addressed by researchers (e.g., phonological, alphabetic principle). The measures included both standardized (e.g., Woodcock Reading Mastery: Woodcock, 1987) and commonly used indicators of early literacy skills (e.g., rapid letter naming).

The descriptions of the measures reported by the researchers were reviewed and categorized through an inductive process by the authors of this review. This process consisted of the simultaneous coding and categorization of the descriptions of the independent measures provided by the researchers. A category was formed when at least three studies reported data on a primary learner characteristic. This inductive categorization process resulted in seven primary learner characteristic categories: (1) phonological awareness, (2) alphabetic principle, (3) rapid naming, (4) IQ, (5) memory, (6) problem behavior, and (7) demographic. The phonological awareness, memory, and demographic primary learner characteristics were further broken down into subcharacteristics, whereas the alphabetic principle, IQ, rapid naming, and problem behavior ones were not because of the limited number of studies and/or measures. The subcharacteristics associated with each of the three other primary learner characteristics were as follows: phonological (rhyming, phonemic), memory (short term, long term), and demographic (disability/retention, ethnicity, grade level). The measures for each characteristic and subcharacteristic and associated citation are detailed in the Appendix.

RESULTS

The number of Z_r effect sizes for each primary learner characteristic/subcharacteristic, mean Z_r effect sizes (unweighted and weighted), 95 percent confidence intervals, and total number of children contributing information to the effect size are presented in Table 1. There was considerable variation in the number of Z_r effect sizes per primary learner characteristic and subcharacteristic. The number of Z_r effect sizes for the characteristic and associated subcharacteristics ranged from 6 to 18 and 1 to 13, respectively. A majority of studies provided information on the contribution of the alphabetic principle ($n = 18$) primary learner characteristic on the treatment effectiveness of early literacy interventions. The total number of children per study represented by the Z_r effect sizes per primary learner characteristic (range = 584 to 1,677) and associated subcharacteristics also varied widely (range = 48 to 1,120).

The weighted mean Z_r effect sizes for the primary learner characteristics ranged from 0.07 (demographic) to 0.51 (rapid naming). With the exception of the IQ and demographic characteristics, moderate to large effect sizes were obtained for the primary learner characteristics. The primary learner characteristics, in order of magnitude, that predicted the treatment effectiveness of early literacy interventions were rapid naming ($Z_r = 0.51$), problem behavior ($Z_r = 0.46$), phonological awareness ($Z_r = 0.42$), alphabetic principle ($Z_r = 0.35$), memory ($Z_r = 0.31$), IQ ($Z_r = 0.26$), and demographic ($Z_r = 0.07$). Inspection of the 95 percent confidence intervals

TABLE 2
Descriptive Information and Average Correlations for Studies Included in the Meta-Analysis

Article	*N*	*Sample Characteristics*	*Treatment Fidelity*	*Characteristic/ Subcharacteristic(s)*	*Average Correlation*
Fox & Routh (1976)	40	Age: x = 4 SES: Middle IQ: Full Scale x = 112	No	*Alphabetic Principle*	0.20
Hurford (1990)	48	Age: Range = 7 to 9 Ethnicity: 100% Caucasian SES: Middle IQ: Full Scale > 90	No	*Demographics* Disability/retention Grade	−0.25 −0.25 −0.25
Ehri & Robbins (1992)	102	Age: Range = 5 to 7 SES: Middle	No	*Alphabetic Principle*	0.07
Peterson & Haines (1992)	48	Age: x = 5.83	No	*Phonological* Phonemic	0.26 0.26
O'Connor et al. (1993)	47	Age: Range = 4 to 6 Disability: All developmentally delayed	No	*Phonological* Rhyming Phonemic	0.78 0.78 0.78
O'Connor et al. (1996)	107	Age: Range = 5 to 7 Ethnicity: 52% African American; 46% Caucasian; 2% other IQ: Verbal x = 67	No	*Demographics* Disability/retention	0.26 0.26
Torgesen & Davis (1996)	100	Age: Range = 5 to 6 Gender: 50% male; 50% female Ethnicity: 73% African American; 27% Caucasian SES: Low IQ: Verbal x = 91	No	*Phonological* Phonemic *Alphabetic Principle* *Rapid Naming* *Memory* Short term Long term *IQ*	0.22 0.22 0.40 0.33 0.32 0.25 0.38 0.44
Vellutino et al. (1996)[a]	183	Age: Range = 5 to 8 SES: Middle Ethnicity: Caucasian IQ: > 90	No	*Phonological* Phonemic *Alphabetic Principle* *Rapid Naming* *Memory* Short term Long term *Problem Behavior*	0.24 0.24 0.35 0.39 0.27 0.26 0.28 0.23
Foorman et al. (1997)	114	Age: Range = 7 to 9 Ethnicity: 32% African American; 31% Hispanic SES: Low IQ: Full Scale Range = 88 to 99	No	*Phonological* Phonemic *Alphabetic Principle*	0.29 0.29 0.24
Fazio (1997)	32	Age: Range = 4 to 6 SES: Low IQ: Nonverbal Range = 85 to 115	No	*Phonological* Rhyming *Memory* Short term Long term	0.72 0.72 0.35 0.40 0.30
Uhry & Shepherd (1997)	12	Age: Range = 5 to 8 Gender: 5 females; 7 males Ethnicity: 83% Caucasian; 17% African American SES: Middle IQ: Full Scale > 90	No	*Phonological* Phonemic *Alphabetic Principle* *IQ*	0.39 0.39 0.47 0.49
Vandervelden & Siegel (1997)	30	Age: 5 to 6 SES: Low	No	*Phonological* Phonemic *Alphabetic*	0.18 0.18 0.42
Foorman et al. (1998)	285	Age: 1st & 2nd grades Gender: 61% male; 39% female Ethnicity: 60% African American; 20% Hispanic; 20% Caucasian SES: Low	No	*IQ* *Problem Behavior* *Demographics* Ethnicity	0.14 0.29 0.10 0.10
O'Connor et al. (1998)	96	Age: Range = 5 to 7 Ethnicity: 52% African American; 46% Caucasian; 2% other IQ: Verbal x = 67	No	*Demographics* Disability/retention	0.09 0.09

continued

TABLE 2
Continued

Article	*N*	*Sample Characteristics*	*Treatment Fidelity*	*Characteristic/ Subcharacteristic(s)*	*Average Correlation*
Hatcher & Hulme (1999)	124	Age: x = 7.5 IQ: Full Scale Range = 68 to 122	No	*Phonological* Phonemic *Memory* Short term	0.43 0.43 0.21 0.21
Lane (1999)	53	Age: 6.8 Gender: 59% male; 41% female Ethnicity: 72% Caucasian; 23% Hispanic; 5% Asian American	No	*Phonological* Phonemic *Alphabetic Principle* *Problem Behavior*	0.20 0.20 0.19 0.66
Schneider, Ennemoser, Roth, & Kuspert (1999)	346	Age: x = 5.58 Language: German	No	*Phonological* Rhyming *Rapid Naming* *Memory* Short term	0.39 0.39 0.50 0.32 0.32
Torgesen et al. (1999)	180	Age: Range = 5 to 6 Gender: 51% male; 49% female Ethnicity: 72% Caucasian; 26% African American; 1% Hispanic; 2% Asian American IQ: Verbal Range = 90.7 to 92.7	No	*Rapid Naming* *Memory* Short term *IQ* *Problem Behavior*	0.53 0.28 0.28 0.35 0.52
Gillon (2000)	91	Age: Range = 5 to 7.5 Ethnicity: 98% Caucasian; 2% New Zealand Maori Disability: 67% with spoken language impairment IQ: Nonverbal > 80 SES: Middle	No	*Alphabetic Principle*	0.18
O'Shaughnessy & Swanson (2000)	45	Age: Range = 5 to 8 Gender: 21 females; 24 males SES: Low Ethnicity: 64% Caucasian; 29% Hispanic; 4% African American; 2% Asian American IQ: Full Scale x = 89.9	Yes	*Phonological* Phonemic *Alphabetic Principle* *Memory* Short term *IQ*	0.46 0.46 0.50 0.11 0.11 −0.02
Vellutino, Scanlon, & Lyon (2000)	118	Age: Range = 5 to 8 Ethnicity: Primarily Caucasian SES: Middle IQ: Full Scale > 90	No	*IQ*	0.08
Allor, Fuchs, & Mathes (2001)	49	Age: x = 6.7 Gender: 53% female; 47% male SES: Middle Ethnicity: 61% Caucasian; 39% African American	Yes	*Rapid Naming*	0.47
Al Otaiba (2001)	104	Age: Kindergarten	Yes	*Phonological* Phonemic *Alphabetic Principle* *Rapid Naming* *Memory* Short term *Problem Behavior*	0.37 0.37 0.52 0.62 0.47 0.47 0.51
Center, Freeman, & Robertson (2001)	313	Age: x = 7.2 Gender: 49% female; 51% male SES: Middle	No	*Alphabetic Principle*	0.29
Chapman, Tunmer, & Prochnow (2001)	132	Age: 5	No	*Phonological* Rhyming Phonemic *Alphabetic Principle*	0.43 0.53 0.31 0.51
Fawcett et al. (2001)	36	Age: x = 7.6 SES: Low Ethnicity: African American IQ: Vocabulary Range = 94 to 102	No	*Alphabetic Principle*	0.32

continued

TABLE 2
Continued

Article	*N*	*Sample Characteristics*	*Treatment Fidelity*	*Characteristic/ Subcharacteristic(s)*	*Average Correlation*
Lane et al. (2001)	7	Age: x = 7.0 Gender: 2 females; 5 males Ethnicity: 4 Caucasian; 2 African American; 1 Hispanic	Yes	*Alphabetic Principle* *Problem Behavior*	0.32 0.42
Berninger et al. (2002)	128	Age: x = 7.7 Gender: 41% female; 59% male IQ: Verbal x = 94.2	Yes	*Phonological* Phonemic *Alphabetic Principle* *Rapid Naming* *IQ*	0.47 0.47 0.37 0.39 0.25
Hecht & Close (2002)	76	Age: Kindergarten SES: Low Ethnicity: African American IQ: Vocabulary Range = 94 to 102	No	*Alphabetic Principle* *IQ*	0.37 0.53
Lane et al. (2002)	7	Age: x = 6.9 Gender: 3 females; 4 males Ethnicity: 4 Caucasian; 2 African American; 1 Hispanic	Yes	*Alphabetic Principle* *Problem Behavior*	0.28 0.40

[a]Vellutino et al. reported correlations for executive functioning measures. These correlations were not included in this meta-analytic review because only Vellutino et al. reported correlations for executive functioning. The Z_r effect size for executive functioning on treatment effectiveness was 0.23.

for each weighted mean Z_r effect size reveals that the rapid naming, alphabetic principle, phonological awareness, problem behavior, and memory primary learner characteristics differed statistically from zero (see Table 1). In contrast, the obtained weighted mean Z_r effect size (0.07) for the demographic characteristic failed to differ statistically from zero.

The statistical equivalence of both weighted and unweighted mean Z_r effect sizes for primary learner characteristics were examined. Comparisons of the 95 percent confidence intervals for the primary learner characteristics reveal that the weighted mean Z_r effect size for rapid naming was statistically distinct from alphabetic principle, memory, demographics, and IQ. The weighted mean Z_r effect size for rapid naming was, however, statistically equivalent to phonological awareness and problem behavior. The weighted mean Z_r effect size for the demographic primary learner characteristic was statistically smaller than those for the remaining ones with the exception of IQ. Comparisons of the 95 percent confidence intervals of unweighted mean Z_r effect sizes and weighted mean Z_r effect sizes were conducted for each primary learner characteristic. The 95 percent confidence intervals of weighted Z_r effect sizes paralleled those of unweighted Z_r effect sizes for each primary learner characteristic with one exception. The phonological awareness characteristic was statistically distinct from alphabetic principle.

DISCUSSION

A previous review of the literature used a vote-counting procedure to integrate studies on the characteristics of nonresponders (Al Otaiba & Fuchs, 2002). Although this review of the literature illuminated much about learner characteristics that might contribute to the effects of early literacy interventions, we believed that a meta-analytic synthesis of the literature aimed at determining the magnitude and relative influence of learner characteristics on the treatment effectiveness of early literacy interventions would shed additional light on the findings. The primary purpose of the present research synthesis was to determine the magnitude and relative contribution of learner characteristics that influence the treatment effectiveness of early literacy interventions.

There are three principal findings that we would like to highlight. The first finding centers on the moderating effects of rapid naming, phonological awareness, problem behavior, alphabetic principle, memory, IQ, and demographic learner characteristics that influence the treatment effectiveness of early literacy interventions. Overall, in order of magnitude, rapid naming, phonological awareness, problem behavior, alphabetic principle, memory, and IQ appeared to predict the treatment effectiveness of early literacy interventions. Conversely, the demographic learner characteristics (disability/retention, ethnicity, grade level) did not appear to influence the treatment effectiveness of early literacy interventions. With the exception of demographic learner characteristics, these findings are generally consistent with those of Al Otaiba and Fuchs (2002). Those researchers reported that disability/retention, ethnicity, and grade appeared to be related to treatment responsiveness.

The second finding focuses on the statistical equivalence of ($p < 0.05$) mean Z_r effect size for rapid naming or serial processing speed and phonological awareness. Rapid naming and phonological awareness were more strongly related to treatment effectiveness than were alphabetic principle, memory, IQ, and demographic characteristics of children. This finding corroborates that of Al Otaiba and Fuchs, who indicated that rapid naming and phonological awareness were important correlates of treatment responsiveness. Our findings revealed, however, that the magnitude of rapid letter naming to treatment responsiveness was larger in comparison to a moderate correlation for phonological awareness. The statistical equivalence in the obtained effect sizes for

the rapid naming and phonological child characteristics is consistent with previous research that suggest that phonological processing deficits most commonly underlie reading problems (Bishop & Adams, 1990; Catts, 1993; Carnine, Silbert, & Kameenui, 1998; Lyon, 1995; Smith, Simmons, & Kameenui, 1998; Snow, Burns, & Griffin, 1998). Phonological processing deficits represent a combination of phonological and rapid-naming deficits (Torgesen, 2000).

The third finding centers on the relative strength of the correlation between the problem behavior characteristics of children and treatment responsiveness. Although the number ($n = 7$) of correlations contributing to this finding was relatively small, it is surprising that there appears to be no difference in the relative contribution of the problem behavior, rapid naming, and phonological characteristics of children to treatment responsiveness. Two areas of research converge to support our finding that children who demonstrate behavior problems may be nonresponsive. The first area centers on prevalence research conducted with children with emotional and behavioral disorders (EBD). Sixty to 100 percent of children with EBD evidence reading failure (Brier, 1995; Kauffman, 2001; Kauffman, Cullinan, & Epstein, 1987; Epstein, Kinder, & Bursuck, 1989; Scruggs & Mastropieri, 1986). The prevalence rates of reading problems tend to increase over time. For example, Brier (1995) found that the reading problems of children with EBD were stable or increased across the grades (Brier, 1995). The second area of research centers on the phonological processing skills of children with EBD. Approximately three out of every four young children with EBD have language deficits specific to phonological processing (Baker & Cantwell, 1985; Cohen, 2001). As with reading, prevalence rates of phonological processing skill deficits among children with EBD tend to be stable or increase over time. For example, researchers longitudinally tracked the phonological processing deficits of one sample of children with EBD ($n = 397$) beginning in kindergarten (Cantwell & Baker, 1980) and five years later (Cantwell & Baker, 1987). The prevalence rate of phonological processing deficits was large and increased over the grades.

LIMITATIONS AND FUTURE RESEARCH

It is important to understand these results in terms of the limitations of the present review of the literature. First, the number of studies that provided information on learner characteristics that influence the treatment effectiveness of early literacy interventions is relatively limited. Indeed, the small number of available studies in most categories of learner characteristics precluded the search for predictor variables in the present review (e.g., study quality). Fortunately, it appears that a growing number of researchers are reporting information on learner characteristics that influence the treatment effectiveness of early literacy interventions. Future research in the area of early literacy interventions should continue to identify learner characteristics that influence the treatment effectiveness of early literacy interventions.

Second, few researchers provided systematic information on treatment fidelity. Although a comparative analysis of studies in the present research synthesis in which researchers reported treatment fidelity data with those that did not does not reveal a substantial difference (see Table 1), it is critical that researchers begin to document treatment fidelity. Without procedures and methods for documenting the implementation of an intervention, it is difficult to attribute outcomes to a given treatment. Future research should systematically measure treatment implementation. There are several aspects to treatment implementation that need to be taken into consideration when defining ideal treatment implementation: treatment integrity, treatment diffusion, treatment differentiation, dosage, and other services. "Treatment integrity is concerned with both the accuracy and consistency with which independent variables constituting the treatment (as opposed to subject characteristics) are implemented" (Gresham, MacMillan, Beebe-Frankenberger, & Bocian, 2000, p. 198). Treatment differentiation refers to the extent to which the interventions in the experimental and comparison conditions differ. It is possible that some reading interventions in the comparison condition might have elements that are common to the experimental intervention (Bond, Evans, Salyers, Williams, & Kim, 2000). Treatment diffusion refers to the amount of "experimental" treatment received by individuals in the control group (Calsyn, 2000). Considering the potential overlap in the phonological awareness and beginning reading skills that are part of most early literacy instructional programs, researchers should assess whether the early literacy program provided to the comparison group is either similar to or influenced or contaminated by the presence of the experimental intervention. Dosage refers to the amount and type of intervention received by each student in the treatment and comparison groups in recognition that some students need more treatment than others (Calsyn, 2000). Dosage would be critical to determine the extent to which children in the experimental group received the early literacy intervention.

Third, with regard to study quality, our criterion was publication in a peer-reviewed journal. Exclusion of dissertations, professional presentations, and ERIC documents was one way to address the need for some standard of quality (peer review in this case). However, within the sample of articles that passed peer review, there were a wide range of strengths and weaknesses that we overlooked. The limited number of studies in particular areas did not enable us to examine if there were significant interactions among study characteristics and the strength of the obtained effect sizes. Such analyses would illuminate, for example, if the type and intensity of the early literacy intervention used by researchers had an influence on the obtained effect sizes. Such questions can be addressed in the future as researchers begin to provide more detailed analyses and information on learner characteristics that predict the treatment effectiveness of early literacy interventions.

Finally, the lack of information presented about participant samples limits the conclusions and inferences that can be drawn from a review of the literature on learner characteristics that influence the treatment effectiveness of early literacy interventions. Researchers provided little information on the participants. Our results represent a relatively undefined and diffuse set of participant samples. Identifying learner characteristics as well as other factors that contribute to the treatment effectiveness of early literacy interventions may lead to the development of specialized interventions. Fortunately, a program of research has identified a wide range of antecedent child, family, and sociological etiological

factors and academic achievement deficits that may predict the treatment effectiveness of early literacy interventions (see the report *Risk Factors for Academic and Behavioral Problems at the Beginning of School* published by the National Institute of Mental Health for a complete description of the risk factors, available at http://www.nimh.nih.gov). Specifically, the factors include:

1. *Antecedent Child Factors*
   a. Low birth weight
   b. Prenatal and neonatal medical problems
   c. Temperament
   d. Inattention, hyperactivity, and impulsivity
   e. Cognitive deficits
2. *Antecedent Family Factors*
   a. Parent-child relationships
   b. Family adversity (i.e., family composition, maternal depression, family cohesion)
   c. Maternal education level
3. *Antecedent Sociological Factors*
   a. Limited English experience
   b. Minority status
   c. Socioeconomic status.

Investigations to identify learner characteristics and other antecedent factors could substantially advance our understanding of how to improve the treatment effectiveness of early literacy interventions.

NOTE

1. Adding an asterisk to this term provides a root word search of electronic databases. The same is true of the term "phon."

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APPENDIX

Dependent Measures Associated with Each Learner Characteristic/Subcharacteristic

Phonological Awareness

1. Rhyming

- Analogical Transfer Task (measures the ability to take advantage of orthographic analogies when reading words containing common rime spelling units) (Greaney, Tunmer, & Chapman, 1997): Chapman, Tunmer, & Prochnow, 2001.
- Curriculum-Based Measures—Rhyming (researcher-developed measures that required children to recognize and produce rhyme): O'Connor, Jenkins, Leicester, & Slocum, 1993.
- Rhyme Detection Task (Bradley & Bryant, 1983): Fazio, 1997.
- Sound Categorization Task (Bradley & Bryant, 1985): Schneider, Ennemoser, Roth, & Kuspert, 1999.

2. Phonemic

- Curriculum-Based Measures—Blending (blending tasks that required children to blend continuous stretched words, and/or blend words divided into onset rime and blend words with all sounds separated): Fox & Routh, 1976; O'Connor, Jenkins, Leicester, & Slocum, 1993.
- Curriculum-Based Measures—Phonemic Recognition (initial phoneme recognition, final phoneme recognition, complex phoneme recognition, and/or deletion and substitution): Al Otaiba, 2001; Hatcher & Hulme, 1999; Vandervelden & Siegel, 1997.
- Test of Phonological Awareness (TOPA; Torgesen & Bryant, 1993): Lane, 1999; Torgesen & Davis, 1996.
- Roswell-Chall Auditory Blending Test (Chall, Roswell, & Blumenthal, 1963): Uhry & Shepherd, 1997.
- Illinois Test of Psycholinguistic Abilities (ITPA; Kirk, MacCarthy, & Kirk, 1968): Uhry & Shepherd, 1997.
- Synthesis and Analysis Tests in the Torgesen-Wagner Battery (Wagner, Torgesen, & Rashotte, 1994): O'Shaugnessy & Swanson, 2000.
- Phoneme Deletion Task (PDT; Calfee, 1977): Chapman, Tunmer, & Prochnow, 2001.
- Sound Matching Task (SMT; adapted from Bryant, Bradley, MacLean, & Crossland, 1989): Chapman, Tunmer, & Prochnow, 2001.
- Phoneme Segmentation Task (PST; Tunmer, Herriman, & Nesdale, 1988): Chapman, Tunmer, & Prochnow, 2001.

Alphabetic Principle

- Curriculum-Based Measures—Segmenting: Al Otaiba, 2001; Fox & Routh, 1976; Lane et al., 2001; O'Connor, Jenkins, Leicester, & Slocum, 1993.
- Woodcock Reading Mastery Tests—Revised (WRMT-R; Woodcock, 1987): Lane, 1999; O'Shaugnessy & Swanson, 2000; Uhry & Shepherd, 1997; Vellutino et al., 1996.
- Woodcock Johnson Tests of Achievement—Revised (Woodcock & Johnson, 1990): Foorman et al., 1997; Hecht & Close, 2002.
- Curriculum-Based Measures—Spelling: Ehri & Robbins, 1992.

- Wechsler Individual Achievement Test (WIAT; Wechsler, 1992): Uhry & Shepherd, 1997.
- Test of Phonological Awareness (Torgesen & Bryant, 1993): Lane, 1999; Torgesen & Davis, 1996.
- Wide Range Achievement Test (WRAT; Wilkinson, 1995): Hecht & Close, 2002.
- Word Reading (adapted from Ehri & Wilce, 1980): Vandervelden & Siegel, 1997.
- Fingerpoint Reading (adapted from Ehri & Sweet, 1991): Vandervelden & Siegel, 1997.
- Word Learning (adapted from Ehri & Wilce, 1980): Vandervelden & Siegel, 1997.
- The Neale Analysis of Reading Ability—Revised (Neale, 1988): Gillon, 2000.
- Burt Word Reading Test—New Zealand Revision (Gilmore, Croft, & Reid, 1981): Gillon, 2000.
- Ready to Read Word Test (Clay, 1993): Gillon, 2000.
- Letter Identification Task (Clay, 1993): Gillon, 2000.
- Reading Freedom Diagnostic Reading Test (Calder, 1992): Gillon, 2000
- Passage Reading Test (PRT; Deno, Mirkin, & Chiang, 1982): Center, Freeman, & Robertson, 2001.
- The Expressive Word Attack Skills Test—Revised (EWAS; Macquarie University Special Education Centre, 1991): Center, Freeman, & Robertson, 2001.
- The Developmental Spelling Test (DST; Tangel & Blachman, 1995): Center, Freeman, & Robertson, 2001.
- The Diagnostic Reading Test (Waddington, 1988): Center, Freeman, & Robertson, 2001.
- Dynamic Indicators of Basic Early Literacy Skills—Nonsense Word Fluency (DIBELS-NWF; Kaminski & Good, 1996): Lane et al., 2001.
- Curriculum-Based Measures—Correct Words Per Minute (CWPM; Shinn, 1989): Lane et al., 2001; O'Shaugnessy & Swanson, 2000.
- Wechsler Objective Reading Dimensions (WORD; Wechsler, 1993): Fawcett et al., 2001.
- Diagnostic Survey—Letter Identification (Clay, 1985): Chapman, Tunmer & Prochnow, 2001.
- Dynamic Indicators of Basic Early Literacy Skills—Oral Reading Fluency (DIBELS-ORF; Kaminski & Good, 1996): Lane et al., 2002.

Memory

1. Short-Term Memory

- Researcher-Developed Measures—Sentence Imitation, Delayed Recall of Words and/or Digit Span Test: Al Otaiba, 2001; Fazio, 1997; Schneider et al., 1999; Torgesen et al., 1999; Torgesen & Davis, 1996; Vellutino et al., 1996.
- Wechsler Intelligence Scale for Children—Revised—Digit Span (WISC-R; Wechsler, 1974): Vellutino et al., 1996.
- Test of Language Development—Primary:2—Sentence Imitation (TOLD-P2; Newcomer & Hammill, 1991): Vellutino et al., 1996.
- The Wechsler Intelligence Scale for Children, Third Edition—Digit Span (Wechsler, 1991): O'Shaugnessy & Swanson, 2000.
- Rhyming Words (assesses recall of similar-sounding words) (Swanson, 1992, 1996): O'Shaugnessy & Swanson, 2000.
- Sentence Span (assesses auditory recall of each word at the end of a set of unrelated declarative sentences 7 to 10 words in length) (Swanson, 1992): O'Shaugnessy & Swanson, 2000.
- Recall of Designs Test (measures short-term visual memory) (Hulme, 1979): Hatcher & Hulme, 1999.

2. Long-Term Memory

- Researcher-Developed Measures—Naming Rate for Digits and/or Immediate Recall: Fazio, 1997; Torgesen & Davis, 1996; Vellutino et al., 1996.

IQ

- The Wechsler Intelligence Scale for Children, Third Edition (Wechsler, 1991): Berninger et al., 2002; O'Shaugnessy & Swanson, 2000; Uhry & Shepherd, 1997.
- Stanford-Binet: Fourth Edition (Thorndike, Hagen, Sattler, & Delaney, 1986): Hecht & Close, 2002; Torgesen et al., 1999; Torgesen & Davis, 1996.
- Wechsler Preschool and Primary Scale of Intelligence—Revised (WPPSI-R; Wechsler, 1989): Uhry & Shepherd, 1997; Vellutino et al., 1996.
- Wechsler Intelligence Scale for Children—Revised (WISC-R; Wechsler, 1974): Foorman et al., 1998; Vellutino, Scanlon, & Lyon, 2000.

Rapid Naming

- Researcher-Developed Measures (i.e., rapid color naming, rapid object naming, and/or rapid letter naming): Al Otaiba, 2001; Schneider et al., 1999; Torgesen et al., 1999; Torgesen & Davis, 1996.
- Rapid Automatized Naming (RAN; Wagner, Torgesen, & Rashotte, 1994; Wolf, Bally, & Morris, 1986): Allor, Fuchs, & Mathes, 2001; Berninger et al., 2002.
- Boston Naming Test (a confrontational naming task that requires the child to label line-drawings of objects) (Kaplan, Goodglass, & Weintraub, 1983): Torgesen et al., 1999; Vellutino et al., 1996.
- Rapid Naming Tests (Denckla & Rudel, 1976a, 1976b): Vellutino et al., 1996.

Behavior

- Multi-Grade Inventory for Teachers (Agronin, Holahan, Shaywitz, & Shaywitz, 1992): Foorman et al., 1998; Torgesen et al., 1999.

- Achenbach System of Empirically Based Assessment: Al Otaiba, 2001.
- Total Disruptive Behavior (TDB; Walker & Severson, 1992): Lane et al., 2001; Lane et al., 2002.
- Negative Social Interactions (NSI; Walker & Severson, 1992): Lane et al., 2001; Lane et al., 2002.
- Social Skills Rating System (SSRS; Gresham & Elliott, 1990): Lane, 1999; Lane et al., 2002.

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