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How Often and How Much?
Intensity of Print Referencing Intervention

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This article describes the current state of evidence regarding treatment intensity of print referencing intervention. Although studies of print referencing intervention demonstrate overall net positive impacts for children's emergent literacy development, researchers have yet to identify explicitly how often children should experience print referencing for these positive impacts to occur. Six print referencing intervention studies are identified in the literature and reviewed for differences in how often and how much print referencing intervention is delivered. Using the framework set out by S. F. Warren, M. E. Fey, and P. J. Yoder (2007), this article specifically discusses and compares variations in 5 treatment intensity variables (dose, dose form, dose frequency, total intervention duration, and cumulative intervention intensity) for the 6 studies of print referencing intervention. Effect-size estimates suggest a trend toward moderate effects of more intensive print referencing intervention and large effects for relatively less intensive print referencing intervention. This trend however is likely confounded by other contextual, individual, and treatment intensity factors. Therefore, suggestions for ongoing research exploring the differential effects of intensity of print referencing intervention are presented. **Key words:** *dose*, *emergent literacy*, *intervention*, *print*, *treatment intensity*

YOUNG CHILDREN'S knowledge about print is an important precursor of their later reading skills, particularly in word recognition (see meta analyses by Hammill, 2004, and the National Early Literacy Panel, 2008). In fact, the predictive relationship between print knowledge at an early age and later word recognition outcomes is consistently positive and moderate in strength (Hammill, 2004). Given the importance of children's print knowledge to their future reading achievement, educational professionals consider this skill to be a high-priority emergent literacy instructional target (Cabell, McGinty, Breit, & Justice, 2007; Lonigan, 2006). Its relevance as a potential intervention target for children with language difficulties is even more pronounced, as data indicate that the print knowledge of these children lags significantly behind typically developing peers (e.g., Justice, Bowles, & Skibbe, 2006).

Many intervention approaches have been shown to be successful in improving print knowledge in a range of children. Variations in intervention include drill and practice (Justice, Chow, Michel, Flanigan, & Colton, 2003), use of specific curricula (Fischel et al., 2007), mediated writing (Aram & Biron, 2004), and use of instructional software (McGivern et al., 2007). In this article, we focus on one instructional strategy that has consistently exhibited positive impacts on children's print

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Table 1. Overview of key treatment intensity variables

Variable	Definition	Print referencing intervention example
Dose	The number of times a strategy or technique is presented within an intervention session	9 verbal references to print during one book reading session (e.g., "Show me an uppercase letter T on this page.")
Dose form	The delivery mechanism for presenting teaching episodes	Shared book reading
Dose frequency	How often the intervention is delivered daily or weekly	2 times per week
Total intervention duration	The complete length of time the intervention is delivered	12 weeks
Cumulative intervention intensity	The numerical result of multiplying the values from dose, dose frequency, and total intervention duration	216 teaching episodes

Note. Adapted from "Differential Treatment Intensity Research: A Missing Link to Creating Optimally Effective Communication Interventions," by S. F. Warren, M. E. Fey, and P. J. Yoder, 2007, *Special Issue: Language and Communication, 13*, 70–77.

knowledge, namely print referencing intervention (Justice & Ezell, 2000, 2002).

Print referencing intervention refers to an interactive style of reading in which adults highlight specific features of print in storybooks through verbal comments, questions, or requests as well as through nonverbal gestures, such as tracking the print when reading (Justice, Pullen, & Pence, 2008). This strategy has documented efficacy when implemented by classroom teachers, parents, and speech–language pathologists with typically developing children as well as with children exhibiting developmental risk factors such as economic disadvantage (Justice, Kaderavek, Fan, Sofka, & Hunt, 2009) and language impairment (Lovelace & Stewart, 2007). Despite overall positive group effects associated with print referencing intervention, considerable variability in child outcomes exists within these studies. One potential explanation (among others) for this variability may be differences in the more nuanced aspects of this intervention, such as treatment intensity, which has varied largely across studies. Therefore, in this article, we examine intensity as one feature of print referencing intervention.

Treatment intensity in print referencing intervention studies is examined from the framework described by Warren, Fey, and Yoder (2007). According to Warren et al., *treatment intensity* is defined as ". . .the product of rate [of teaching episodes] per minute or hour, the number of hours of intervention per specified time period (e.g., a day or a week), and the full length of the intervention in weeks, months or years. . ."(p. 71). Furthermore, Warren et al. suggest that researchers and practitioners embrace the following five variables and terms to describe treatment intensity: dose, dose form, dose frequency, total intervention duration, and cumulative intervention intensity. Table 1 describes each of these treatment intensity variables and provides an example related specifically to print referencing intervention.

To explore the dimension of treatment intensity within the print referencing literature, we conducted an informal search of the PsycINFO and ERIC databases for the years 1999 through 2009. Key search terms

Table 2. Treatment intensity characteristics of print referencing intervention studies

Study	Participants	Dose	Dose form (book reading)	Dose frequency	Total duration	Cumulative intervention intensity
Ezell et al. (2000)	4 children with communication disorders	5 verbal references	One-on-one, home	4 readings per week	5 weeks	100 teaching episodes
Justice and Ezell (2000)	28 typically developing children	6 verbal references	One-on-one, home	4 readings per week	4 weeks	96 teaching episodes
Justice and Ezell (2002)	30 children from economically stressed homes	9 verbal references	Small-group, classroom	3 readings per week	8 weeks	216 teaching episodes
Justice, Kaderavek, et al. (2009)	106 children from economically stressed homes	4 verbal references	Whole-group, classroom	4 readings per week	30 weeks	480 teaching episodes
Justice, Skibbe, et al. (2009)	29 children with language impairments	9 verbal references	One-on-one, home	4 readings per week	12 weeks	432 teaching episodes
Lovelace and Stewart (2007)	5 children with language impairments	20 verbal references	One-on-one, classroom	2 readings per week	13 weeks	520 teaching episodes

Note. The values reported for dose are estimated on the basis of analysis of research reports.

entered into the databases included "emergent literacy" or "early literacy," "storybook" or "book reading," and "print." The databases returned a total of 113 articles (89 from PsycINFO; 24 from ERIC). Inclusion criteria for the current article consisted of (a) treatment studies, (b) studies that delivered treatment within the context of storybook reading, and (c) treatment studies targeting only print knowledge outcomes in young children. Treatments conducted during storybook reading that included other emergent literacy targets such as phonological awareness or vocabulary in addition to print knowledge were excluded so as to provide a clear picture of the influence of treatment intensity solely with regard to print referencing. Application of these criteria resulted in five published print referencing intervention articles (Ezell, Justice, & Parsons, 2000; Justice & Ezell, 2000, 2002; Justice, Kaderavek, et al., 2009; Lovelace & Stewart, 2007). In addition, we added one publication in review from two of this article's authors (Justice, Skibbe, McGinty, Piasta, & Petrill, 2009). This created a total of six print referencing intervention studies to examine.

Although treatment intensity was not the original intent of these articles, we have extracted and coded these studies for each intensity variable, using Warren and colleagues' (2007) framework (see Table 2). These studies vary in strength of evidence to include one observational study without controls (Ezell et al., 2000), one experimental study involving single-subject design (Lovelace & Stewart, 2007), and four nonrandomized controlled trials (Justice & Ezell, 2000, 2002; Justice, Kaderavek, et al., 2009; Justice, Skibbe, et al., 2009). In addition, each study reports child outcome data with regard to one or several areas of print knowledge.

Print knowledge is a multidimensional construct that describes children's knowledge about the forms and functions of written symbols in their environment. Three interrelated dimensions of development

comprise print knowledge: print concepts, alphabet knowledge, and emergent writing (Cabell, McGinty, & Justice, 2007). Current research on children's print knowledge indicates that what children know about print is influenced by a number of factors such as genes (e.g., Petrill et al., 2007; Petrill, Deater-Deckard, Thompson, DeThorne, & Shatschneider, 2006), socioeconomic status (e.g., Dickinson, McCabe, Anastasopoulos, Peisner-Feinberg, & Poe, 2003), and language status (e.g., Cabell, Justice, Zucker, & McGinty, 2009; Justice et al., 2006; Skibbe et al., 2008). Furthermore, research shows that treatments that include explicit print-focused instructions, such as print referencing intervention, positively affect children's understanding of print despite the presence of risk factors (e.g., Fischel et al., 2007; Gray, 2007; Justice et al., 2003). Implementation of print referencing interventions, however, has been highly variable in terms of treatment intensity. To analyze the role of intensity across these studies, we discuss each of the treatment intensity variables, using the framework defined by Warren et al. (2007), as each relates to studies of print referencing interventions. We begin our discussion with dose form because it is a consistent factor across the six studies reviewed in this article.

DOSE FORM

Dose form refers to the "delivery mechanism" for a teaching episode. Print referencing intervention most typically uses the delivery mechanism of shared book reading. Shared book reading is the dose form used in the six studies reviewed in this article.

Shared book reading is a natural and meaningful activity frequently practiced within homes. Studies of adults interactively sharing books with children show that this context fosters emotional attachment (Bus, Belsky, van Ijzendoorn, & Crnic, 1997; Bus & van Ijzendoorn, 1997), oral language skills (Lonigan & Whitehurst, 1998; Sénéchal, LeFevre, Thomas, & Daley, 1998; Whitehurst et al., 1994), and familiarity with decontextualized language (Snow, Burns, & Griffin, 1998). Given the authenticity of shared book reading and centrality of text to the experience, this context offers ideal opportunities in which to talk about print.

Studies of print referencing intervention include particular consideration of the book and print characteristics of storybooks selected for shared book reading. For example, Lovelace and Stewart (2007) selected books for their study examining gains in print awareness in children with language impairments according to several book features, such as brightly colored illustrations and inclusion of the title, author's name and illustrator's name on the book. In contrast, Ezell et al. (2000) selected books on the basis of large print as well as interactive features such as lift-the-flaps and predictable text. In other studies, Justice and Ezell (2000, 2002), Justice, Kaderavek, et al. (2009), and Justice, Skibbe, et al. (2009) described selection of storybooks for their studies of print referencing intervention based on print features and print saliency. Print saliency refers to the unique ways in which print is embedded and used within books and illustrations. Examples of print-salient features in storybooks include the use of speech bubbles and font changes.

Including print-salient storybooks during print referencing intervention is important because research demonstrates that a significant increase in children's visual attention to print occurs in relation to levels of print saliency (Justice & Lankford, 2002; Justice, Skibbe, Canning, & Lankford, 2005). Specifically, research examining children's visual attention during book reading shows that children seldom focus on the book's print; instead, their attention generally focuses on the illustrations (Justice et al., 2008). In contrast, when children look at a print-salient storybook, they spend more time looking within "print zones" (Justice et al., 2005). Interestingly, children's visual attention to print can be altered with adult support. Eye movement analysis indicates that when adults implement a print referencing style of reading in which they verbally and nonverbally reference print,

children's fixations on print increase significantly (Justice et al., 2008).

Books selected for print referencing intervention also vary in relation to book genre and story theme. Books chosen for print referencing intervention most frequently consist of fictional genre stories. For example, stories such as *My Backpack* (Bunting, 2005) and *If You Give a Mouse a Cookie* (Numeroff, 1985) have been reported within the literature. In some studies, alphabet and informational books have also been represented. Examples of these types of books include *Animal Action ABC* (Pandell, 2003) and *Rumble in the Jungle* (Andreae, 2002). In relation to story theme, storybooks selected for print referencing intervention typically address familiar themes for pre-school-aged children, such as feelings (e.g., *The Way I Feel;* Cain, 2000), food (e.g., *Growing Vegetable Soup*; Ehlert, 1990), and animals (e.g., *In the Small, Small Pond*; Fleming, 1993). Although slight variations in exact titles of storybooks exist across studies, researchers generally report criteria for book selection (e.g., colorful illustrations, print saliency, fictional story, age appropriate topic) that show them to be comparable across studies. Aspects of print saliency, book genre, and book theme are important for researchers to consider and specify so that teaching episodes within a treatment protocol can be compared and analyzed reliably.

DOSE

Dose refers to the number (e.g., ratio, total count) of teaching episodes delivered during a single intervention session (Warren et al., 2007). A print referencing intervention session consists of two categories of teaching episodes: (1) nonverbal references to print and (2) verbal references to print. The nonverbal print referencing category includes behaviors such as tracking the print with a finger while reading and pointing to specific letters within words. Behaviors considered within the verbal print referencing category consist of comments, questions, and requests related to aspects of print such as "I see a letter S on this page." The adult's goal during both nonverbal and verbal teaching episodes is to explicitly increase the child's attention to and engagement with print. Only two of the six studies reviewed, however, provided information about adult's use of nonverbal references to print; therefore, this discussion on dose of print referencing intervention focuses on the category of verbal teaching episodes only.

Explicit verbal teaching episodes are needed during book reading because—without training—adults rarely comment or ask questions about print (Ezell et al., 2000). Rather than focusing on print, adults' utterances tend to focus on the content of the story or address the behavior of the child (Hammett, Van Kleeck, & Huberty, 2003). Fortunately, studies of print referencing intervention show that with only modest levels of instruction, adults can learn to include references to print during shared storybook interactions (Justice & Ezell, 2000). Even more importantly, research shows that trained adults who read with a print-referencing style facilitate children's understanding of and engagement with print (Justice & Ezell, 2000, 2002).

A common finding, however, in all studies of print referencing intervention to date involves the heterogeneity of intervention implementation. While adult participants demonstrate high fidelity to the intervention at the level of basic execution, results suggest that participants vary the specific number of times they verbally reference print while book reading. In the context of intensity of intervention, it is very likely that this dose variation impacts print referencing intervention outcomes.

Print referencing intervention research typically describes minimum guidelines in the number of teaching episodes that must occur within each session. For example, in Justice, Skibbe, et al. (2009), researchers instructed parents to reference print verbally at least nine times during a book reading session. In Justice, Kaderavek, et al. (2009), researchers

instructed teachers to reference print a minimum of four times per book reading session. Although print referencing intervention is explicit and systematic, it is not scripted, and generally only the minimum number of teaching episodes is provided. As such, adults are somewhat free to vary in the number of teaching episodes they deliver during a book reading session.

In one study of shared home reading with typical preschoolers, parents varied in the number of times they verbally commented, questioned, or made requests about print. Some parents asked as few as 49 questions about print per minute or less whereas other parents asked as many as 2 or more questions about print per minute ($M = 1.25$, $SD = 0.76$; Justice & Ezell, 2000). Although studies of print referencing intervention generally show that children make significant improvements in some areas of print knowledge as a result of taking part in print referencing reading sessions, it is unclear whether differences in dose, such as those described in the studies above, may be associated with child outcomes.

DOSE FREQUENCY

According to Warren et al., dose frequency refers to the number of times an intervention is delivered daily and weekly. Studies of print referencing intervention have reported significant gains in children's print knowledge for shared book reading sessions scheduled two (Lovelace & Stewart, 2007), three (Justice & Ezell 2002), and four (Ezell et al., 2000; Justice & Ezell, 2000; Justice, Kaderavek, et al., 2009; Justice, Skibbe, et al., 2009) per week. Among these studies, group sizes varied from one-on-one (Ezell et al., 2000; Justice & Ezell, 2000; Justice, Skibbe, et al., 2009; Lovelace & Stewart, 2007) to small group (Justice & Ezell, 2002), and to whole classroom (Justice, Kaderavek, et al., 2009) book reading sessions. Even with this variability, the body of research reported here consistently demonstrated net positive effects of print referencing intervention on children's print knowledge outcomes, irrespective of dose frequency.

Despite overall gains noted in the print referencing literature in child print knowledge at the group level, individual children in the above-mentioned studies varied in their print knowledge growth. Some participants made quite modest gains, whereas other children demonstrated large gains in a relatively short time period (see Justice & Ezell, 2002; Lovelace & Stewart, 2007). Intervention research has yet to consider explicitly how the more nuanced aspects of print referencing intervention, such as dose frequency, affects individual children and explains variability in intervention outcomes. For instance, children with severe language impairment who hypothetically make significant but small gains in print knowledge may benefit from more frequent weekly sessions of print referencing intervention. On the other hand, children from low-income households, but without language impairment, may demonstrate satisfactory gains with less frequent print referencing intervention. Consequently, it is difficult to draw from this body of work specific guidance or recommendations for practitioners regarding optimal intervention dose frequency. Given the importance of understanding how children respond differentially to interventions, we are currently investigating the effects of two dose frequencies of classroom-based print referencing intervention, namely delivery per two reading sessions per week versus four sessions per week; results will be forthcoming in future reports.

TOTAL INTERVENTION DURATION

The print referencing intervention literature reports variations in the total duration of intervention. Researchers have examined the effects of print referencing intervention in general education classrooms. In one study, researchers conducted 24 small-group reading sessions over an 8-week period in a Head Start setting (Justice & Ezell, 2002) and 13 one-on-one reading sessions over a 13-week period in a targeted enrollment early

learning center (Lovelace & Stewart, 2007). In yet another study, classroom teachers have implemented 120 whole-class reading sessions conducted over 30 weeks (Justice, Kaderavek, et al., 2009).

Home book reading interventions also have varied in duration. Parents have conducted 20 one-on-one print referencing sessions over 5 weeks (Ezell et al., 2000), 16 one-on-one sessions over 4 weeks (Justice & Ezell, 2000), and 48 one-on-one print referencing sessions over 12 weeks (Justice, Skibbe, et al., 2009). Across the classroom and home-based studies, the total duration of print referencing interventions has ranged from as little as 1 month (4 weeks) to close to one full academic year (30 weeks). Similar to the above descriptions regarding dose and dose frequency, general findings across studies report positive child outcomes in print knowledge, regardless of the differences in intervention duration. However, it is likely that there is an optimal intervention duration. Print referencing intervention that is continued overly long may offer little additional benefit to children's knowledge concerning print. In contrast, a minimal duration may fail to demonstrate positive child outcomes.

Group size also is a consideration when evaluating the impact of total intervention duration. It is plausible that an interaction between the size of the treatment group and the total length of the intervention exists. For example, children in one-on-one and small groups may demonstrate more print growth over time than children who receive the intervention in a large-group setting over the same amount of time. Hypothetically, certain group sizes may receive additional benefits of print referencing intervention when provided for a prescribed duration. To illustrate, there could be potential for children who receive print referencing intervention in a one-on-one setting for 5 weeks to perform higher on measures of print knowledge than children who receive the same intervention over 5 weeks in small groups even though both groups show improvements in print knowledge following the intervention.

CUMULATIVE INTERVENTION INTENSITY

Warren and colleagues define *cumulative intervention intensity* as "the product of dose, dose frequency, and total intervention duration" (p. 72). Therefore, cumulative intervention intensity approximates an overall amount of treatment intensity. Studies implementing print referencing intervention demonstrate a range of cumulative intervention intensities from 96 teaching episodes over 4 weeks (Justice & Ezell, 2000) to 520 teaching episodes over 13 weeks (Lovelace & Stewart, 2007). For specific populations of children, cumulative intervention intensity has included 96 sessions for children who are typically developing; 216 and 480 teaching episodes for children from backgrounds of economic disadvantage; and 100, 432, and 520 teaching episodes for children with language impairments. Given the range of cumulative intervention intensities, it is unclear from these studies the relationship between specific total treatment amounts and child-level factors. In addition, it is logical to hypothesize that in terms of learning, a greater cumulative intervention intensity may exert an observable and clinically important treatment effect that maintains long after treatment is discontinued, compared to a less intense treatment schedule that results in clinically unimportant short-term effects. In the future, studies that directly examine different amounts of cumulative intervention intensity and the associated long-term impacts of the intervention may be useful for examining the ways in which variations in treatment intensity change print referencing intervention's effects.

CONCLUSION

Although generally good effects have been demonstrated for print referencing intervention, very little is known about the more nuanced contributions of dose form, dose, dose frequency, total intervention duration, and cumulative intervention intensity. This informal review of six print referencing intervention

Table 3. Effect-size estimates of print referencing intervention studies

Study	Print knowledge outcome measures	Statistical significance	Effect-size estimate
Justice and Ezell (2000)	Print concepts	Yes	1.23
	Alphabet knowledge	No	—
	Words in print	Yes	1.23
	Word segmentation	Yes	0.57
	Print recognition	No	—
Justice and Ezell (2002)	Print concepts	No	—
	Alphabet knowledge	Yes	0.50
	Words in print	Yes	1.67
	Print recognition	Yes	2.31
	Literacy terms	No	—
	Orientation/discrimination	No	—
Justice, Kaderavek, et al. (2009)	Print concepts	Yes	0.50
	Alphabet knowledge	Yes	0.56
	Name writing	Yes	0.42
Justice, Skibbe, et al. (2009)	Print concepts	Yes	0.80
	Alphabet knowledge	No	—

studies revealed considerable variability in how much and how often researchers, parents, and classroom teachers have delivered and implemented print referencing intervention. As a result, this variability makes it difficult to drawn any firm conclusions about treatment intensity. However, in an effort to provide some preliminary deductions regarding treatment intensity of print referencing intervention across studies, calculations of effect-size estimates for the studies reviewed are presented in Table 3. Effect-size estimates represent a useful measure for making comparisons across studies because of the standardized nature of the descriptive statistic, which represent standard deviation units (e.g., an effect-size estimate of 0.5 = one half of a standard deviation unit). An effect size may be considered small if it ranges up to 0.30, moderate if it ranges between 0.50 and 0.79, and large if it is greater than 0.80 (Cohen, 1988).

Table 3 presents effect-size estimates for four of the six studies reviewed in this article. Because effect-size estimates are calculated as mean group differences, only studies using an experimental design with a treatment and control group meet the requirements for this analysis (for methodological issues in using traditional effect-size measures in single subject and single group designs, see Campbell, 2004). In all four studies, calculated effect-size estimates utilize the available data reported in the published reports. For the present purposes, all effect-size estimates represent the amount of *gain* on specific treatment outcomes compared across recipients of print referencing intervention as compared to those in control/comparison groups. Effect-size estimates are oftentimes used to compare only posttest scores; however, this can be problematic when the compared groups differ at pretest, which is more likely when subject pools are small. Therefore, for our purpose, we use effect-size estimates to compare the average amount of gain across studies as attributable to participation in print-referencing intervention. Importantly, it should be noted that exact measures of the print knowledge outcome variables differed across studies, and that sample sizes differed as well.

Visual inspection of these effect-size estimates suggests substantial variability in effects attributable to this intervention approach. For instance, the most-intense intervention (Justice, Kaderavek, et al., 2009), in which children received an estimated 480 teaching episodes (in large-group classroom-based settings), had the most modest effect-size estimates, whereas the least-intensive intervention (Justice & Ezell, 2000), in which children received an estimated 96 teaching episodes (in one-on-one home-based settings), had quite large effect-size estimates. As these descriptive data show, it is likely the case that intensity of intervention interacts significantly with other setting-level characteristics, such as how many children are participating in the intervention. At the same time, we can presume that certain child-level factors are influential as well, such as a child's a priori level of print knowledge when entering the intervention. Intensity is one facet of intervention that, while likely influential, undoubtedly interacts with a range of other aspects of intervention, including setting- and child-level characteristics. Future research exploring these factors may make more firm conclusions possible.

In sum, it is likely that specific aspects of intensity optimally enhance child outcomes and that optimal intervention intensity differs according to individual characteristics. Therefore, research is needed to explore differential effects of intensity; studies should systematically address each treatment intensity variable described by Warren et al (2007). Perhaps comparison studies of print referencing intervention, in which all factors are held constant except for a specific treatment variable, such as dose frequency, may offer more insight into the specific ways in which print referencing intervention exerts its effects. In addition, future print referencing treatment intensity research should explore the interaction between aspects of treatment intensity (e.g., dose × dose frequency) and individual differences. Conceivably, intensity of instruction may be configured differently for different sizes of treatment groups, different populations of children, or children with more severe needs.

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