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To Read or Not to Read: A Meta-Analysis of Print Exposure From Infancy to Early Adulthood

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This research synthesis examines whether the association between print exposure and components of reading grows stronger across development. We meta-analyzed 99 studies ($N = 7{,}669$) that focused on leisure time reading of (a) preschoolers and kindergartners, (b) children attending Grades 1–12, and (c) college and university students. For all measures in the outcome domains of reading comprehension and technical reading and spelling, moderate to strong correlations with print exposure were found. The outcomes support an upward spiral of causality: Children who are more proficient in comprehension and technical reading and spelling skills read more; because of more print exposure, their comprehension and technical reading and spelling skills improved more with each year of education. For example, in preschool and kindergarten print exposure explained 12% of the variance in oral language skills, in primary school 13%, in middle school 19%, in high school 30%, and in college and university 34%. Moderate associations of print exposure with academic achievement indicate that frequent readers are more successful students. Interestingly, poor readers also appear to benefit from independent leisure time reading. We conclude that shared book reading to preconventional readers may be part of a continuum of out-of-school reading experiences that facilitate children's language, reading, and spelling achievement throughout their development.

Keywords: meta-analysis, home literacy environment, print exposure checklist, comprehension and technical reading and spelling development, 2- to 21-year age range

Popular media, governments, schools, and parents all encourage children to read in their leisure time. There is a widely held assumption that exposure to print makes us smarter and helps promote success in life. Is, however, this assumption supported by scientific evidence? Does reading for pleasure make us better and faster readers, more knowledgeable and even better speakers? How do the language and reading abilities of frequent readers differ from those of nonreaders at each stage of development? To the best of our knowledge, there are no previous attempts that address these questions by synthesizing the evidence available across developmental levels.

Individual differences in print exposure are already present before any formal education, as parents vary in how often they read storybooks to their young children (Baker, Scher, & Mackler, 1997; Bus, 2001; Dickinson & McCabe, 2001; Heath, 1982; Mistry, Biesanz, Chien, Howes, & Benner, 2008; Raviv, Kessenich, & Morrison, 2004; Scheele, Leseman, & Mayo, 2010). We can regard parent–child book sharing as part of a continuum of leisure time reading experiences that facilitate and influence reading skills throughout development. It seems plausible that variation in exposure to fiction books, magazines, comic books, and newspapers during leisure time increases with age. During the primary grades, children are mainly introduced to narrative texts, whereas their encounters with texts shift toward expository and technical texts from fourth grade onward, as they must read to acquire knowledge in different content areas (RAND Reading Study Group, 2002). Reading assignments for college and university students also include more nonfiction textbooks than narrative texts. Reading fiction books and the like, therefore, increasingly becomes a voluntary choice that entails additional and independent reading practice and, therefore, is likely to distinguish frequent and motivated readers from infrequent readers. Furthermore, because cognitive processing is enriched as a function of involvement, and because narratives are more likely than expository texts to stimulate imagination and to be personally relevant and/or emotionally engaging, the reading of fiction may especially support consolidation and extension of knowledge about word forms and word meanings (Hakemulder, 2000; Harding, 1962; Mar, 2004; Oatley, 1999). Reading narrative texts as a leisure time activity may therefore have a different impact on reading skills across various ages and educational levels. This meta-analysis focuses on the role of print exposure during leisure time in reading development from infancy to early adulthood.

In essence, reading is the cognitive process of understanding speech that is written down. Young children form basic concepts about the connections between spoken and written words, leading to word recognition and familiarity with the spelling of words (Castles & Coltheart, 2004; Ziegler & Goswami, 2005). Initially, children develop alphabet knowledge (i.e., knowledge of letter names and how letters relate to sounds in spoken words), phonological processing skills (i.e., how words consist of separable

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sounds and the ability to manipulate phonemes), and orthographic processing skills (i.e., how to identify meaningful or frequently occurring parts in written words). These lower order basic reading skills are considered to be the most time-constrained skills: After a period of rapid growth, a ceiling is reached in the early primary grades (Paris, 2005; Paris & Luo, 2010). Likewise, technical reading and spelling skills may follow a similar time-constrained developmental trajectory, although it takes longer to reach mastery in word reading accuracy and fluency and in spelling words correctly. From early on, word reading ability may depend not only on basic reading skills but also on oral language skills such as vocabulary (e.g., Dickinson, McCabe, Anastasopolous, Peisner-Feinberg, & Poe, 2003; Oullette, 2006; Sénéchal & Cornell, 1993; Stanovich, 1986). As the ultimate goal of reading is reading for understanding, across development reading proficiency is less determined by technical reading skills and is more dependent on sophisticated vocabulary, background knowledge, and intelligence (e.g., Aarnoutse, van Leeuwe, Voeten, & Oud, 2001; Hoover & Gough, 1990; Hulslander, Olson, Willcutt, & Wadsworth, 2010; Nation & Snowling, 2004; National Reading Panel, 2000; Storch & Whitehurst, 2002; Vellutino, Tunmer, Jaccard, & Chen, 2007).

In the current study, we address the claim that technical reading and spelling skills, as well as reading comprehension, are honed not only through direct instruction but also through print exposure. Furthermore, we examine whether leisure time reading exerts an increasing impact on reading proficiency with growing age. The association between reading as leisure activity and the acquisition of reading skills may be an example of spiral causality or reciprocal causation (see Stanovich, 1986). When children enjoy reading books as a leisure time activity, they read more often, which in turn improves both technical reading and spelling skills and reading comprehension, motivating children to continue reading (Cunningham, Stanovich, & West, 1994; Kush, Watkins, & Brookhart, 2005). As a result of increasing individual differences in leisure time reading, we expect the relationship between print exposure and reading skills to strengthen across years of education.

Taking into account that technical reading and spelling skills have a relatively narrow window of learning and that only skills such as oral language and reading comprehension can be assessed at all ages (Paris & Luo, 2010), we conducted separate meta-analyses in three consecutive age groups: (a) preschoolers and kindergartners, (b) children in Grades 1–12, and (c) undergraduate and graduate students attending college or university. We related print exposure to the following outcome domains: oral language (in particular expressive and receptive vocabulary), reading comprehension, and more general achievement measures such as intelligence and academic achievement tests (e.g., eligibility test for university) as indicators of the *comprehension component*; and basic reading skills (alphabet knowledge, phonological processing, orthographic processing), word recognition (word identification, word attack), and spelling as indicators of the *technical reading and spelling component*.

Print Exposure and Comprehension

Book Sharing With Preconventional Readers

Book reading is often seen as one of the most important activities for developing the knowledge required for eventual success in reading (Commission on Reading, National Academy of Education, 1985; Samuelsson et al., 2005). Establishing a book reading routine before the age of 2 is thought to provide children with a variety of rich linguistic input that stimulates their language development and lays the basis for continued, frequent print exposure (Duursma, 2007; K. L. Fletcher & Reese, 2005; Lyytinen, Laakso, & Poikkeus, 1998; Raikes et al., 2006). The metaphor of a snowball is used to illustrate how book sharing relates to language comprehension: As language develops due to book sharing, children's interest in books grows, thereby promoting linguistic exchanges with their caregivers that further refine word knowledge, syntax, and other aspects of language (Neuman, 2001; Raikes et al., 2006). Furthermore, starting to share books early is likely to optimize the quality of reading in the long term, as frequent reading interactions may have the capacity to extend parents' knowledge of and sensitivity toward their children's linguistic and cognitive competencies (K. L. Fletcher & Reese, 2005). Such sensitive, high-quality interactions are likely to make reading more enjoyable for parent and child and to lead to an increase in reading frequency, thereby increasing the likelihood for learning new language and expanding comprehension skills (Bus & van IJzendoorn, 1988; P. F. de Jong & Leseman, 2001). In line with the snowball metaphor, we may expect a reciprocal effect in which comprehension skills develop as a result of exposure to books and in which comprehension determines whether children are exposed to book sharing.

Previous meta-analyses have supported the hypothesis that home literacy activities from an early age contribute substantially to young children's language and reading comprehension (Bus, van IJzendoorn, & Pellegrini, 1995; Mol, Bus, de Jong, & Smeets, 2008; National Center for Family Literacy, 2008). Children who have had storybooks read to them frequently—and who have parents who read themselves and own many books—enter school with larger vocabularies and more advanced comprehension skills than their peers who grow up in poorer home literacy environments. A meta-analytic approach proceeds in a statistically rigorous way to analyze numerical results of studies with comparable outcome domains and variations in study characteristics (e.g., children's first language, mean age, socioeconomic status; see Bus, van IJzendoorn, & Mol, in press). Effect sizes, quantitative indexes of relations among variables, are used to compare and communicate the strength of the summarized research findings (Hedges, 2008). To ease interpretation, effect sizes can be converted into a binominal effect size display, which demonstrates the change in success ratio that can be attributed to the main variable of interest such as shared book reading (Rosenthal, 1991). For example, outcomes of the Bus et al.'s (1995) meta-analysis indicate that 64% of the children who are read to will be the more proficient readers at school compared with only 36% of children who are not exposed to books. This meta-analytic evidence is based not only on correlational studies but also on experimental and longitudinal research that allows for stronger causal inference. Therefore we could argue that book sharing makes a significant difference in children's lives by promoting knowledge and skills that are needed in order to learn how to read and by stimulating a positive attitude toward reading.

In a more recent set of studies than were included in Bus et al. (1995), the hypothesis was tested that book reading may in particular affect vocabulary acquisition, a central element of text comprehension (e.g., Dickinson & McCabe, 2001; Verhallen & Bus, 2010; Whitehurst & Lonigan, 1998). Children may learn more new words during reading than during other interactions with language, such as during mealtime and playtime, because children's books contain 3 times as many low-frequency words as television shows or adults' conversations with children (Hayes & Ahrens, 1988). Furthermore, caregivers may ask questions about pictures, difficult words, and story events, and give informative feedback on children's answers during book sharing, boosting story comprehension and language development (e.g., Collins, 2010; De Temple & Snow, 2003; Mol, Bus, & de Jong, 2009; Mol et al., 2008; Whitehurst et al., 1988). Whether book reading results in receptive word learning (i.e., comprehending its meaning) as well as expressive word learning (i.e., producing the word) is still in debate. Some reading researchers show that expressive vocabulary may be promoted especially when children are challenged by caregivers to actively repeat or label words (Ard & Beverly, 2004; Coyne, McCoach, Loftus, Zipoli, & Kapp, 2009; Penno, Wilkinson, & Moore, 2002; Sénéchal, 1997).

The present meta-analysis of print exposure in preconventional readers is an update as well as a critical replication. Research syntheses thus far may have systematically underestimated the effects of book sharing because studies assessed children's print exposure through self-report questionnaires. Parents are likely to overestimate the time they spend reading to their young children when they highly value book reading (DeBaryshe, 1995), which may reduce variance in questionnaire responses and attenuate the correlation between book reading frequency and comprehension measures. To test the impact of social desirability biases, we applied a cross-validation approach in order to directly compare studies using traditional self-report questionnaires with studies assessing parents' familiarity with children's book titles as measured by a print exposure checklist. The latter measure is more objective; it may reveal stronger correlations with language and story comprehension.

Independent Text Reading by Conventional Readers

Frequent exposure to texts broadens knowledge that enables readers to become more proficient in reading comprehension (e.g., Hirsch, 2003). In addition to general knowledge of the world, advanced levels of oral language skills are required for successful text comprehension. Independent text reading seems the most promising activity to develop such language skills; written texts not only contain a variety of words and complex sentence structures, but also provide context information that supports the readers' ability to infer meaning of unknown vocabulary (Nagy, 1988; Nagy & Herman, 1987). However, readers need background knowledge as well as a mental lexicon that covers at least 95% of the words in a text to understand its content and to be able to guess unfamiliar words from context (Carver, 1994; Hsueh-chao & Nation, 2000; Laufer, 1989). In line with a meta-analysis that showed that proficient readers and students in the upper grades have the greatest chance of incidental vocabulary acquisition (Swanborn & de Glopper, 1999), readers with smaller vocabularies are most likely to experience problems with understanding and learning vocabulary from age-appropriate texts.

When children lack background knowledge and vocabulary and therefore do not succeed in comprehending text, they become less eager to read and, as a result, show stagnation in their reading comprehension skills, vocabulary size, and general knowledge base (Kush et al., 2005). Such a negative causal spiral could explain why reading development tapers off toward the end of fourth grade, when students are no longer learning to read by practicing relatively easy texts but must instead read to learn from subject matter textbooks (Chall, 1983). Fourth-grade students are faced with texts that demand considerable oral language skills and efficient reading strategies to understand the content and to expand the knowledge base necessary to succeed in school (Hirsch, 2003; Juel, 2006; Vellutino et al., 2007). In contrast, an upward causal spiral may occur in proficient readers, who are more likely to have pleasurable reading experiences and who choose to read more often, resulting in continued improvements in language skills, background knowledge, and reading comprehension.

Differences in levels of print exposure may result in increasing interindividual achievement differences over time for frequent readers versus infrequent readers, which is sometimes termed the "Matthew effect" (Bast & Reitsma, 1998; Foster & Miller, 2007; Stanovich, 1986). Such an achievement gap is likely to widen in particular for unconstrained skills such as oral language and reading comprehension, because learning new words and their meanings from context has few upper bounds. In other words, oral language and reading comprehension skills will continue to develop over the life span (Paris, 2005). Consequently, even among more proficient readers, individual differences in oral language skills, reading comprehension, and (possibly) intelligence and academic achievement would be posited to increase as a function of print exposure (Stanovich, West, & Harrison, 1995; West, Stanovich, & Mitchell, 1993). We expect, therefore, that the correlations between print exposure and these unconstrained skills will get stronger as the number of years of education increases. Here, too, we try to avoid the negative bias of self-report data by focusing on print exposure measures that are least sensitive to social desirability.

Print Exposure and Technical Reading and Spelling

Book Sharing and Basic Reading Skills

Children's storybooks may offer an incentive for the development of knowledge about print, letters, and sounds in preconventional readers, because storybook illustrations are mostly accompanied by the written text that parents can read aloud (Sulzby, 1985; Teale & Sulzby, 1986). Eye-tracking research shows that illustrations attract more visual attention than print (Evans & Saint-Aubin, 2005; Justice, Pullen, & Pence, 2008; Justice, Skibbe, Canning, & Lankford, 2005), but the proportion of time that children spend looking at the text during shared storybook reading increases from kindergarten to fourth grade and is greatest when the difficulty level of the text is within children's reading proficiency level (Roy-Charland, Saint-Aubin, & Evans, 2007). The youngest preconventional readers may pay barely any attention to print features in storybooks because they need all their working memory capacity to interpret the illustrations and to link the story content with the illustrations. Older children with more advanced basic knowledge about stories are more likely to notice and process print in storybooks even without their attention being drawn to print by their caregivers (M. T. de Jong & Bus, 2002; Evans, Saint-Aubin, & Landry, 2009; Neuman, 2001). We expect, therefore, a reciprocal relation between book sharing and basic reading skills, as storybooks promote the independent acquisition of print knowledge but only when some print knowledge is available.

Independent Text Reading and Technical Reading and Spelling

In narrative texts, words are presented in a relevant context, which may not only stimulate knowledge about the meaning of words but also improve word reading skills in conventional readers (e.g., Krashen, 1989; Stanovich, 1986). Frequent encounters with words in context are assumed to strengthen basic reading skills and to lead to new connections between written word forms and syntactic and semantic information (Bowers, Davis, & Hanley, 2005; Ehri & Roberts, 1979; Pecher, Zeelenberg, & Wagenmakers, 2005). Apart from instructing and/or practicing single words, we suggest that text reading has at least two additional advantages. Not only is reading words more motivating when words are embedded in engaging stories (Guthrie & Wigfield, 1999), but the syntactical and semantic context can also be used to guess at less familiar words and to store, connect, and enrich associations between word forms and contextual information (Nation, 2008; Perfetti & Hart, 2002).

Basic reading skills. When children encounter unknown words while reading text, they follow the relatively slow *graphophonological route*. Beginning readers sound out individual letters and blend them into pronunciations that approximate real words (Ehri, 1998). They thereby improve lower order reading skills via alphabet knowledge and phonological and orthographic processing of words. The self-teaching hypothesis predicts that applying letter-to-sound rules enables the acquisition of orthographic representations of novel words through independent print exposure (Jorm & Share, 1983; Share, 1995, 1999). As such basic reading skills typically evolve from nonexistent to fully acquired to automatic command in a restricted time span (Paris, 2005), we expect that the development of basic skills may benefit from print exposure especially in the primary grades. Poor readers seem to gain less word-specific knowledge from the same amount of print exposure than skilled readers (e.g., Breznitz, 1997; Ehri & Saltmarsh, 1995; Ehri & Wilce, 1979; Reitsma, 1983; Share & Shalev, 2004), and as a result, they take longer to master these constrained skills. Because poor readers will still vary in their basic reading skills, whereas their peers with age-appropriate reading abilities are much more similar, the correlations between print exposure and basic reading skills are expected to be strongest for groups of poorer readers.

Word recognition. More advanced readers may increasingly process sound patterns of frequently occurring letter clusters and recognize the meaning of the blend (Ehri, 1998). In opaque languages such as English and French, applying letter-to-sound rules according to the graphophonological route is often not sufficient, because connections between letters or letter clusters and sounds are inconsistent (Goswami, Ziegler, Dalton, & Schneider, 2001; Patel, Snowling, & de Jong, 2004). Instead, advanced readers in such languages use the *lexicosemantic route,* in which characteristics of the visual word form are directly associated with the word's meaning (e.g., Paulesu et al., 2000; Seymour, Aro, & Erskine, 2003). Low levels of print exposure are thought to delay the development of both the graphophonological and lexicosemantic routes that are required for adequate and fluent word recognition (Stanovich, Siegel, & Gottardo, 1997).

Reading words in context may be relevant especially for the development of orthographic representations of recurrent letter clusters (e.g., *–ight*), morphological patterns (e.g., *–ed*), or even higher order structures (e.g., whole words) that enable processing words through the lexicosemantic route (e.g., Ehri, 1998). Each exposure to a word embedded in a text sets down an "episodic trace" that relates word form information to the context in which the word occurred (e.g., pictures, events, sentences, other words). The episodic traces will be renewed each time the reader is confronted with the word form, further enhancing the quality of the lexical representation and contributing to the comprehension of the text that contains the word (see Nation, 2008; Shaywitz & Shaywitz, 2008). Because of an imbalance in print exposure levels among children, individual differences in the availability of episodic traces are likely to increase over time: Children who do not read much in their leisure time have lower quality representations of word forms, and hence their development of word recognition is less advanced compared with frequent readers who repeatedly encounter word forms in a variety of contexts.

Spelling. The self-teaching hypothesis suggests that as a result of repeated encounters with words in written text, orthographic representations of word parts or complete words also contribute to writing skills (Cunningham, Perry, Stanovich, & Share, 2002; Share & Shalev, 2004). Children initially overrely on phonetics when spelling dictated words, but as their development progresses they gradually move to strategies that incorporate sound, orthographic patterns, and semantics (Berninger et al., 2002; Bourassa & Treiman, 2001; Sadoski, Willson, Holcomb, & Boulware-Gooden, 2004–2005). The complexity of English spelling and the lack of systematic teaching of morpheme-spelling rules in schools have led to the hypothesis that competent spellers infer spelling knowledge by reading and not from training of spelling rules (Krashen, 1989; Nunes & Bryant, 2009). As even adults who are proficient in writing make spelling errors, we expect that spelling is less time-constrained than basic reading skills and word recognition, so its association with print exposure is likely to continue to become stronger with increasing years of education. For poor readers, however, it takes longer to acquire letter-to-sound rules, which may interfere with learning word spellings, even when their amount of print exposure is comparable to that of more proficient readers (Ehri & Saltmarsh, 1995; Share & Shalev, 2004).

Reciprocal Causation?

Because of the correlational nature of the bulk of studies into print exposure, four possible interpretations of the association between reading abilities and print exposure may arise (e.g., Moore & McCabe, 2006). First, print exposure might be a causal factor in enhancing reading ability. For instance, book sharing is thought to support school readiness (e.g., Duursma, 2007; Wood, 2002) and the acquisition of conventional reading skills in the primary grades (e.g., Connor, Son, Hindman, & Morrison, 2005; Melhuish et al., 2008; Molfese, Modglin, & Molfese, 2003). Second, print exposure may be largely a consequence of children's reading ability. Low-achieving readers may not perceive reading as a rewarding experience, which might result in less print exposure, whereas better readers are likely to have positive experiences with reading, which may be an incentive for reading as a leisure activity (e.g., Koolstra, van der Voort, & van der Kamp, 1997; Leppänen, Aunola, & Nurmi, 2005). Third, the association may be spurious due to lurking or hidden third variables, which are positively related to both reading skills and reading volume. A fourth possibility seems most plausible: Print exposure is both a consequence of reading ability and a contributor to further reading development, and the association may in fact be based on reciprocal causation (e.g., Bast & Reitsma, 1998; Harlaar, Dale, & Plomin, 2007). Overall, if print exposure makes a difference in children's (academic) lives, it may be expected that oral language skills, reading comprehension, basic reading skills, word recognition, spelling, and intelligence relate to the amount and frequency of reading for pleasure. Because more skilled readers are more likely to enjoy reading as a leisure time activity, they will choose to read more frequently, which, in turn, will improve knowledge of word forms and semantics and enhance vocabulary size and text comprehension abilities.

As long as children are unable to read conventionally, they need caregivers to help them bridge the gap between the world of the book and their own world (Bus, 2003). When children enter school and are no longer solely dependent on their caregivers for their print exposure, their home environment is still thought to explain achievement differences in the classroom (Alexander, Entwisle, & Olson, 2007; Cooper, Nye, Charlton, Lindsay, & Greathouse, 1996). However, the degree to which children evoke and select their own leisure time reading environment changes with development: As children mature, they may become more active creators of their own environments by seeking out stimulating experiences that are compatible with their abilities and interests. For children in preschool and kindergarten, their parents' behaviors will be the most critical element in determining their print exposure (e.g., Forget-Dubois et al., 2009), whereas for older children, their comprehension and technical reading and spelling skills will become more and more influential in whether they choose to read as a leisure activity, and the influence of their environment is likely to decrease (e.g., Harlaar et al., 2007; Petrill, Deater-Deckard, Schatschneider, & Davis, 2005). As children are not all equally attracted to reading fiction books, magazines, and the like, it seems probable that individual differences in leisure time print exposure increase as children advance through the educational system.

Measurement of Print Exposure

The main inclusion criterion for the present meta-analysis was the administration of a print exposure checklist: an unobtrusive measure that is thought to be an objective proxy of reading volume (Stanovich, 2000; Stanovich & West, 1989). Print exposure checklists follow a quick-probe logic in which titles of popular novels or names of best-selling authors function as probes into a person's literacy environment. The checklist can be adjusted to measure out-of-school reading in any age group by excluding titles or authors prominent in the school curriculum (e.g., Barker, Torgesen, & Wagner, 1992; Bråten, Lie, Andreassen, & Olaussen, 1999; Cunningham & Stanovich, 1997). Foils—fake items of nonexisting titles or author names—are added to correct for guessing. It is assumed that a parent, child, or student who reads frequently will know more about literature and, therefore, will recognize more correct items than a respondent who reads less often (Allen, Cunningham, & Stanovich, 1992; Sénéchal, LeFevre, Hudson, & Lawson, 1996; West et al., 1993). Furthermore, the checklist is thought to reflect the attitude toward and familiarity with the domain of literature (Allen et al., 1992; Cunningham et al., 1994).

In previous qualitative (e.g., Evans & Shaw, 2008; Scarborough & Dobrich, 1994; Teale, 1981) and quantitative research syntheses (Bus et al., 1995), self-report questionnaires were included as the chief indicators of young children's exposure to print. Such questionnaires, however, are likely to suffer from a social desirability bias (DeBaryshe, 1995). In addition, many items are open to ambiguous interpretations and require retrospective time judgments (e.g., "How frequently have you read to your child in the past week?"). A parent might count the sharing of five books in one sitting before bedtime as five sessions, whereas another parent will report this as only one reading episode (Sénéchal et al., 1996). The literature even provides examples of parents who counted reading a word on a wrapper as a reading session (e.g., van Lierop-Debrauer, 1990). Print exposure checklists are thought to avoid these measurement issues and provide more objective insights in children's home literacy environment (Sénéchal et al., 1996).

We expect that the impact of measurement method will be greatest among parents of preconventional readers who may feel most inclined to overestimate their book reading frequency. With the media, pediatricians, and schools emphasizing that an early start with sharing storybooks ensures children's academic success, a questionnaire on book reading practices may feel like a "parental quality" test. Reporting that you do not manage to read daily is like admitting that you do not want to optimally prepare your child for school. In the set of studies on preconventional reading children, we therefore applied a cross-validation approach to test the impact of the expected bias. We compared two independent sets of studies that differed in the method they used to measure children's home literacy environment but that were comparable in their main study characteristics. That is, we matched each study in which parents completed a print exposure checklist with a study that used a self-report questionnaire to assess young children's home literacy environment on characteristics such as sample size, children's mean age, home language, and socioeconomic status. We expect that the self-report studies will replicate the main finding in earlier syntheses that about 8% of the variance in young children's language and reading comprehension is related to shared book reading (Bus et al., 1995; Scarborough & Dobrich, 1994). As print exposure checklists are likely to be less biased, we expect that such checklists will reveal stronger correlations with outcome measures than self-report questionnaires.

The Current Study

The meta-analysis presented here consisted of three steps. First, studies in which parents of preschoolers and/or kindergartners completed a print exposure checklist were matched to studies that administered a self-report questionnaire. Second, we meta-analyzed studies linking print exposure to comprehension and technical reading and spelling skills of children attending Grades 1–12. Third, as individual differences are predicted to increase until adulthood, we tested effect sizes for the relation between print exposure and all outcome domains within a set of studies on undergraduate and graduate students. In both groups of conventional readers (i.e., beyond preschool and kindergarten), we contrasted effects of print exposure in poorer readers against those found in their higher achieving peers. Specifically, we focused on the following hypotheses:

Hypothesis 1: At all educational levels, indicators of the comprehension component (oral language, reading comprehension, or general achievement measures) as well as indicators of technical reading and spelling skills (basic reading skills, word recognition, or spelling) will be associated with print exposure.

Hypothesis 2: For unconstrained skills such as oral language and reading comprehension, correlations with print exposure are expected to become stronger with increasing grade levels, because readers who have pleasurable reading experiences choose to read more often.

Hypothesis 3: Constrained technical reading and spelling skills may remain correlated with print exposure for a longer period in lower ability readers than in children with age-appropriate reading abilities.

Hypothesis 4: For preconventional readers, effect sizes found in studies based on self-report questionnaires will be smaller than effect size estimates based on print exposure checklists.

Method

Search Strategy and Inclusion Criteria

We entered into databases, such as PsycINFO, ERIC, and ProQuest Dissertations and Theses, several combinations of the following keywords: *print exposure*, *(title/author/magazine) recognition or checklist*, *home literacy environment*, *shared/joint/parent–child book reading*, *reading frequency*, *free voluntary reading*, *leisure time reading*, *reading development*, *reading ability*, *oral language*, *preschool*, *kindergarten*, *primary/elementary/middle/high school*, and/or *(college or university) students*. In addition, we read the method sections of articles that cited Cunningham and Stanovich (1990, 1991), Sénéchal et al. (1996), or Stanovich and West (1989) to check whether these citing studies used a (adapted) version of their print exposure checklists. We further extended our search by examining the reference lists of our included studies. As an additional check, we selected some representative journals (i.e., *Journal of Educational Psychology*, *Journal of Research in Reading*, *Reading Research Quarterly*, *Reading and Writing*, *Scientific Studies of Reading*, *Journal of Literacy Research*, and *Journal of Early Childhood Literacy Research*) and hand-searched journal issues from January 2004 to December 2008. We encountered no studies that we had not detected in our initial searches.

The selected articles had to meet the following inclusion criteria: (a) a print exposure checklist had been administered, in which book titles, names of authors, and/or magazine titles were listed; (b) respondents were parents of either 2- to 6-year-old preconventional readers, school-aged children attending Grades 1–12, or undergraduate or graduate students (studies assessing adults such as university staff were included only when the majority of the sample consisted of college or university students); (c) child outcome measures comprised oral language and/or reading ability tests and were administered in the same (school) year as the checklist (studies that included only general measures, such as a selection test for high school, were excluded, as were studies that did not include an oral language measure in the group of preconventional readers); and (d) the correlations or means and standard deviations provided reflected the association between a print exposure checklist and comprehension or technical reading and spelling outcomes and could be transformed into a Fisher's z effect size. There were no restrictions on study design or on participants' language or country, as long as the article did not report a case study and was written in English, French, Dutch, or German. All (published or unpublished) articles, dissertations, and conference contributions were retrieved before January 2009.

We excluded print exposure studies that reported no child outcomes or outcomes other than comprehension and technical reading and spelling skills, such as science tests or social ability tasks (e.g., Bråten et al., 1999; Burgess, 2005; Castles, Datta, Gayan, & Olson, 1999; Chomsky, 1972; Curry, Parrila, Stephenson, Kirby, & Catterson, 2004; Korat & Schiff, 2005; Lee & Krashen, 1996; Long & Prat, 2002; Mar, Oatley, Hirsh, dela Paz, & Peterson, 2006; Pavonetti, Brimmer, & Cipielewski, 2002–2003; Radloff, 2008; Stainthorp & Hughes, 2000), studies in which the checklist and the outcome measures were not administered within the same school year (e.g., Harlaar et al., 2007; Hood, Conlon, & Andrews, 2008; Shatil & Share, 2003; Stainthorp, 1997), and studies in which the participants were too old to meet our inclusion criteria (e.g., Lee, Krashen, & Tse, 1997; Stone, Fisher, & Eliot, 1999; West et al., 1993). Studies were also excluded when the respondents were teachers (e.g., McCutchen et al., 2002), kindergarten children (e.g., Bulat, 2005), or the parents of school-aged children (e.g., McGrath et al., 2007). Because mothers read most to the child, we used maternal data over paternal if both were reported (e.g., Symons, Szuszkiewicz, & Bonnell, 1996). Attempts to locate the dissertation by Daly (2000), studying print exposure in 8- to 11-year-old children from Northern Ireland, were unsuccessful.

When multiple, independent samples were included within one article, we treated them as separate studies (Byrne, Fielding-Barnsley, Ashley, & Larsen, 1997; Ecalle & Magnan, 2008; Grant, Gottardo, & Geva, 2008; Grant, Wilson, & Gottardo, 2007; McBride-Chang, Manis, Seidenberg, Custodio, & Doi, 1993; Sears, Siakaluk, Chow, & Buchman, 2008; Stanovich & West, 1989), or we selected the subsamples that met the inclusion criteria (Ecalle & Magnan, 2008; Sénéchal & LeFevre, 2002; Stanovich et al., 1995; Wolforth, 2000). The data from Burns and Blewitt (2000); Davidse, de Jong, Bus, Huijbregts, and Swaab (2010); Grant et al. (2008); Masterson and Hayes (2007); and van der Kooy-Hofland, Kegel, and Bus (in press) were obtained by e-mailing the authors.

To cross-validate the print exposure checklist in the group of preconventional readers, we matched the studies in which parents filled in a print exposure checklist with studies that administered only a self-report questionnaire about parents' literacy resources and/or activities. Because correlations are influenced by sample size (Lipsey & Wilson, 2001; Moore & McCabe, 2006), we searched databases and abstracts for studies with comparable samples. For each print exposure study included, we then tried to find a match on four main characteristics: sample size, children's mean age, home language, and socioeconomic status. Except for one study with 24 English-speaking preschool children from India (Kalia, 2007), we were able to match each of the 15 studies with a comparable counterpart (see Tables 1 and 2). This cross-validation approach gave us the unique opportunity to study differential effects of two measurement methods independently.

Coding Process

Two independent coders completed a standard coding scheme per study, comprising (a) year of publication, (b) publication status (published in peer-reviewed journal, unpublished, dissertation), (c) continent (Asia, Australia, Europe, North America) and specific country, (d) design (cross-sectional and/or longitudinal, [quasi-] experiment), (e) sample size and number of male and female participants, (f) mean age and age range, (g) socioeconomic status (low, ≥ middle), (h) school type (preschool, kindergarten, elementary/middle/high school [specify grade number], undergraduate, graduate, combination), (i) ability level (lower ability, age-appropriate, higher ability), (j) language learners (first, second), (k) print exposure checklist characteristics (language, number of [real and fake] items, composition procedure, scoring, Cronbach's alpha), (l) home literacy questionnaire (administered: yes, no; content of questions), (m) type and names of outcome measures (standardized, unstandardized), and (n) correlation (bivariate, partial). Two coders coded 75% of all studies included. The intercoder agreement for both study characteristics and outcome variables ranged between 77% and 100% across meta-analyses, resulting in an overall average mean of 94.5% (κ = .96, range: .65–1.00). All discrepancies between coders were settled in discussion, and consensus scores were used.

Because it can be assumed that standardized measures are more reliable and valid than unstandardized measures, we first treated standardized and unstandardized measures separately to check for differences in correlations with print exposure. Unconstrained skills such as oral language were assessed by standardized measures such as the Peabody Picture Vocabulary Test or vocabulary subtests from the Metropolitan Achievement Test and the Nelson–Denny Reading Test. Vocabulary checklists (i.e., ticking off actual words in a list that also includes nonexistent words) were treated as unstandardized. Reading comprehension was predominantly measured by standardized tests that had children read short passages and answer multiple-choice or open-ended questions or fill in missing words in a cloze task: the Stanford Diagnostic Reading Test, Iowa Tests of Basic Skills, Neale Analysis of Reading Ability, Nelson–Denny Reading Test, Woodcock–Johnson Passage Comprehension, Peabody Individual Achievement Test, or Stanford Early School Achievement Test. Constrained skills such as alphabet knowledge (e.g., naming letters), phonological processing (e.g., choosing one out of two pseudowords that can be pronounced as a real word), and orthographic processing (e.g., pick the correct spelling from two choices that sound alike) were mostly measured by unstandardized tests and were treated as components of basic reading skills. Word recognition tests were separately coded as word identification (e.g., the ability to identify words in isolation correctly) and word attack (e.g., reading aloud pseudowords and/or exception words), which were measured by standardized tests such as the Woodcock–Johnson, Woodcock Reading Mastery Test, or Test of Word Reading Efficiency. Spelling was assessed by standardized tests such as the Wide Range Achievement Test, or by unstandardized experimental tasks such as writing dictated words. Error rates were preferred; reading speed measures or decision latencies were excluded. We also coded measures of IQ (i.e., Raven, Wechsler Intelligence Scale for Children, Stanford–Binet) and indicators for academic achievement such as grade point average and American College Testing and Scholastic Assessment Test scores.

Meta-Analytic Procedures

All correlations between a print exposure checklist and any outcome variable were inserted into the computer program Comprehensive Meta-Analysis (Borenstein, Hedges, Higgins, & Rothstein, 2005) and transformed into Fisher's z effect sizes for further analyses, because the variance of z' is approximately constant, whereas the variance of the correlation follows an asymmetrical distribution (Borenstein, Hedges, Higgins, & Rothstein, 2009). To ease interpretation of the Results section, Fisher's z summary estimates were transformed back into a correlation with the formula $r = \tanh(z')$ (Lipsey & Wilson, 2001). In general, a Fisher's z value of .10 (r = .10) can be interpreted as a small effect size, .31 (r = .30) as moderate, and .55 (r = .50) as large (Cohen, 1988).

For studies that did not report bivariate Pearson rs, we converted the provided statistics into Fisher's z values. A p value of .10 was entered and converted into a weighted correlation for studies that only reported that an association was not significant. Kalia (2007), however, reported the range of nonsignificant correlations, so we entered p = .50 for all nonsignificant values to estimate a conservative correlation in the lower end of that range. Studies in which partial correlations (k = 11), converted F and t tests (k = 4), or means and standard deviations (k = 8) were provided were scattered through all outcome measures and did not influence the results when we analyzed the data without them.

To compare the effect sizes of print exposure for different outcome domains (oral language, reading comprehension, general achievement, basic reading skills, word recognition, spelling), we treated each outcome domain as an independent correlate (see Bus et al., in press). When a study used multiple tests to measure one outcome domain, we averaged the effect sizes within that study to ensure that each study contributed only one effect size to the analysis of that domain so that each had an equal impact on the summary estimate of each domain. For oral language, reading comprehension, and spelling skills, our stepwise approach included (a) aggregating effects of standardized and unstandardized tests into two separate composites and (b) if both were available, combining the standardized and unstandardized composites to create an overall composite per study. As basic reading skills were mostly measured by unstandardized tests and word recognition and general achievement by standardized tests, we did not distinguish standardized from unstandardized composites in these analyses. For each study that assessed more than one indicator of lower order technical reading skills, we (a) created separate composites of alphabet knowledge, phonological processing, and orthographic processing per study and (b) integrated these indicators into a basic reading skills composite. Likewise, combined effects for word

Table 1
Moderators and Outcomes per Parent–Child Print Exposure Study in Meta-Analysis 1: Preschool and Kindergarten Children

Study	Publication status	Continent (country)	First language	N[a]	% male	School type[b]	Age (months)		SES[c]	Outcome[d]	Fisher's z (SE)[e]			
							M	Range			CAR + CTR	AAR	No. books	RFreq
Aram (2005)	Published	Asia (Israel)	Other	41	46	K	65.59		Low	Oral (EV)		.18 (.16)	.39 (.16)	
										Basics (PP + OP)	.51 (.09)	.37 (.08)	.46 (.08)	
Burns & Blewitt (2000)	Unpublished	North America (United States)	English	59		P	36		≥ Middle	Oral (RV)	.22 (.13)			
Davidse et al. (2010)	Unpublished	Europe (Netherlands)	Other	118	52	P	54.52	51–57	≥ Middle	Oral		.21 (.07)		.14 (.08)
										Basics (OP)		.15 (.10)		.18 (.11)
Evans et al. (2000)	Published	North America (Canada)	English	66		K	71	65–80	≥ Middle	Oral (RV)	.21 (.13)			
										Basics (AK + PP)	.22 (.07)			
Farver et al. (2006)	Published	North America (United States)	Other	122	47	P	45	39–49	Low	Oral (RV)	.24 (.09)			.26 (.09)
Foy & Mann (2003)	Published	North America (United States)	English	40	43	P + K	58.32	48–74.4	≥ Middle	Oral (EV)	.06 (.16)			
										Basics (AK + PP)	.09 (.10)			
Frijters et al. (2000)	Published	North America (Canada)	English	92	54	K	68.50	63–76	≥ Middle	Oral (RV)	.41 (.11)		.46 (.11)	.24 (.11)
										Basics (AK + PP)	.30 (.08)		.19 (.08)	.36 (.08)
Gest et al. (2004)	Published	North America (United States)	English	76	59	P + K	62.01		Low	Oral	.56 (.12)			.44 (.12)
										Basics (PP)	.26 (.12)			.29 (.12)
Kalia (2007)	Published	Asia (India)	English	24		P	44.29	40–49	≥ Middle	Oral	.52 (.15)			.15 (.15)
										Basics (AK + PP)	.46 (.13)			.15 (.15)
Sénéchal (2000)	Published	North America (Canada)	Other	80	46	K	60	48–71	≥ Middle	Oral (RV)	.20 (.08)	.09 (.12)	.17 (.11)	.03 (.11)
Sénéchal et al. (1996; Study 1)	Published	North America (Canada)	English	117	54	P + K	52	40–69	≥ Middle	Oral (RV)	.45 (.07)	.44 (.09)	.35 (.09)	.24 (.09)
Sénéchal et al. (1996; Study 2)	Published	North America (Canada)	English	47	66	P + K	49	33–70	≥ Middle	Oral (RV + EV)	.45 (.08)	.32 (.11)	.30 (.11)	.19 (.11)
Sénéchal et al. (1998)	Published	North America (Canada)	English	110	58	K	60	47–79	≥ Middle	Oral	.37 (.07)	.25 (.07)		
										Basics (AK + PP + OP)	.30 (.04)	.27 (.04)		
Sénéchal et al. (2008)	Published	North America (Canada)	English	106	46	P	56		≥ Middle	Oral	.31 (.07)	.29 (.07)		
										Basics (PP)	.35 (.10)	.27 (.10)		
Symons et al. (1996)	Published	North America (Canada)	English	39	51	K	72		≥ Middle	Oral (RV)		.38 (.17)		
										Basics (PP + OP)		.27 (.12)		

Note. Only aggregated effect sizes per outcome domain are provided here. See Table 6 for weighted combined effect sizes on separate outcome variables.
[a] The sample size for the meta-analysis can be smaller based on the data available to calculate Fisher's z'. [b] School type: preschool (P), kindergarten (K). [c] SES = socioeconomic status: dichotomous split in low SES versus ≥ middle = middle and/or high SES. [d] Outcome: Oral = oral language composite; Oral (EV) = oral language composite comprises expressive vocabulary; Oral (RV) = oral language composite comprises receptive vocabulary; Oral (RV + EV) = oral language composite comprises both receptive and expressive vocabulary measures; Basics = basic reading skills composite, comprising alphabet knowledge (AK), phonological processing (PP), and/or orthographic processing (OP). [e] Transformed association (Fisher's z) between Outcome and Child-Author Recognition and Child-Title Recognition Test (CAR + CTR), Adult-Author Recognition Test (AAR), number of books at home (No. books; single item) and reading frequency (RFreq; single item).

Table 2
Moderators and Outcomes for the Matched Set of Self-Report Studies in Meta-Analysis 1, in Which Each Row Corresponds to the Row of the Print Exposure Study in Table 1 That the Self-Report Study Is Matched to

Study	Publication status	Continent (country)	First language	N[a]	% male	School type[b]	Age (months) M	Age (months) Range	SES[c]	Outcome[d]	Fisher's z (SE)[e] HLE-comp	Fisher's z (SE)[e] RFreq
Korat et al. (2007)	Published	Asia (Israel)	Other	47	45	K	71.08		Low	Basics	.24 (.16)	
Deckner et al. (2006)	Published	North America (United States)	English	55	47	P	42	42–44	≥ Middle	Oral (RV + EV)	.47 (.11)	
										Basics (AK)	−.05 (.11)	
van der Kooy-Hofland et al. (in press)	Unpublished	Europe (Netherlands)	Other	101	59	K	64.46	60–72	≥ Middle	Oral		.17 (.07)
										Basics (PP)		.17 (.10)
Stephenson et al. (2008)	Published	North America (Canada)	English	61	49	K	69.84		≥ Middle	Oral (RV)	.09 (.13)	.18 (.13)
										Basics (AK + PP)	.18 (.08)	.28 (.09)
Reese et al. (1999)	Book chapter	North America (United States)	Other	121		K			Low	Oral (EV)	.26 (.13)	
										Basics	.14 (.07)	.08 (.10)
Skibbe et al. (2008)	Published	North America (United States)	English	52	52	P	54.02	48–61	≥ Middle	Basics (AK)	.26 (.10)	
Roth et al. (2002)	Published	North America (United States)	English	66	58	K	66	62–75	≥ Middle	Oral	.41 (.05)	
										Basics (AK + PP)	.22 (.06)	
Roberts et al. (2005)	Published	North America (United States)	English	72	46	P	63		Low	Oral (RV + EV)	.41 (.08)	.20 (.08)
										Basics (AK)	.46 (.13)	.15 (.13)
No match												
Sénéchal (2006)	Published	North America (Canada)	Other	90	38	K	72		≥ Middle	Oral (RV)	.20 (.11)	
										Basics (AK + PP)	.05 (.08)	
Kelman (2007)	Unpublished[f]	North America (United States)	English	91	43	P + K	61.36	36–71	≥ Middle	Oral (RV)	.21 (.11)	.18 (.11)
										Basics (AK + PP)	.20 (.06)	.18 (.06)
Chaney (1994)	Published	North America (United States)	English	43	51	P	44	33–50	≥ Middle	Oral	.37 (.08)	
										Basics (AK + PP)	.31 (.15)	
Burgess (2002)	Published	North America (United States)	English	96	52	P + K	60.10	48–70	≥ Middle	Oral (RV + EV)	.30 (.07)	.14 (.07)
										Basics (AK + PP)	.26 (.03)	
										Basic (PP)		.17 (.10)
Constantine (2005)	Unpublished[f]	North America (United States)	English	101	56	P + K	57.83	48–69	≥ Middle	Oral	.29 (.10)	.17 (.10)
										Basics	.21 (.10)	.17 (.10)
Sonnenschein et al. (1996)	Unpublished	North America (United States)	English	34		K	70.08		≥ Middle	Oral (EV)	.52 (.19)	
										Basics (AK + PP)	.40 (.13)	

Note. Only aggregated effect sizes per outcome domain are provided here. See Table 6 for weighted combined effect sizes on separate outcome variables.
[a] The sample size for the meta-analysis can be smaller based on the data available to calculate Fisher's z'. [b] School type: preschool (P), kindergarten (K). [c] SES = socioeconomic status: dichotomous split in low SES versus ≥ middle = middle and/or high SES. [d] Outcome: Oral = oral language composite; Oral (EV) = oral language composite comprises expressive vocabulary; Oral (RV) = oral language composite comprises receptive vocabulary; Oral (RV + EV) = oral language composite comprises both receptive and expressive vocabulary measures; Basics = basic reading skills composite, comprising alphabet knowledge (AK), phonological processing (PP), and/or orthographic processing (OP). [e] Transformed association (Fisher's z) between Outcome and composite of Home Literacy Environment Questionnaire (HLE-comp) and reading frequency (RFreq; single item). [f] Dissertation.

identification and word attack were first calculated and then aggregated into a word recognition composite that reflects higher order or conventional technical reading skills. As far as the articles had not presented a composite for the print exposure checklists, we merged the title and author recognition test per outcome domain within the sample of preschool and kindergarten children, and the title, author, and magazine recognition tests for the children in Grades 1–12.

Samples were coded as "lower ability" when it was explicitly stated that students were reading disabled, had special-educational needs, or were in the lower third of a distribution that was based on a large set of students. Studies comprising second-language learners who were not tested in their first language were also treated as lower ability. When groups of students were matched on a reading ability measure, the skill on which the groups were selected to differ was treated as the outcome variable. For example, Ricketts, Nation, and Bishop (2007) matched 15 poor and 15 skilled reading comprehenders on age, nonverbal ability, and decoding level and administered an author recognition test. We transformed the checklist means and standard deviations of both groups into a Fisher's *z* and treated reading comprehension as the outcome variable, because the groups had been selected to differ significantly on reading comprehension. Because we analyzed both word recognition and reading comprehension as separate outcome variables, we had to exclude one subgroup in Leach, Scarborough, and Rescorla (2003) that showed combined deficits in word-level and reading comprehension skills. For all moderators and aggregated outcomes per study, see Tables 3 and 4.

To estimate the mean effect size, we applied the conservative random-effects model in which studies are weighted by the inverse of their variance, and, in addition, within-study error and between-study variation in true effects are accounted for (Borenstein et al., 2009). A combined effect, the precision of which is addressed by the 95% confidence interval (CI), is considered significant if the CI does not include zero. Differences between estimates are interpreted as significant when the CIs do not overlap. To avoid lack of power in the detection of meaningful differences across subgroups (Hedges & Pigott, 2004), we interpreted a significant $Q_{\text{between}}(df)$ value for moderator analyses only if the smallest subgroup contained a minimum of four studies (see Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2003; Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007).

Because studies with significant findings are more likely to be published and, therefore, are more likely to be included in a meta-analysis than unpublished studies, we examined whether the results were moderated by publication status. To the extent that the subgroups could be contrasted, published studies did not reveal significantly different correlations than unpublished studies: preconventional readers (matched set), $Q(1)_{\text{HLE-comp*Basics}} = 3.27$, $p > .05$; college and university students, $Q(1)_{\text{ART*Oral}} = 1.42$, $p > .05$, $Q(1)_{\text{MRT*Oral}} = 1.71$, $p > .05$, $Q(1)_{\text{ART*Word rec}} = 1.23$, $p > .05$. As another indicator, we calculated Rosenthal's fail-safe number, which reflects the number of missing studies with null effects that would have to be retrieved and included in the analyses before the *p* value becomes nonsignificant (Borenstein et al., 2009). Because effects can be negligible but still significant, we also inspected funnel plots to address the potential impact of a publication bias. We reported adjusted effect sizes based on the trim-and-fill approach if there appeared to be asymmetry around the point estimate (Duval & Tweedie, 2000a, 2000b). In the current meta-analyses, 23 out of 79 summary point estimates had to be adjusted slightly, with a maximum of three imputed studies to the left of the mean ($M_{\text{adjustment } z'} = -.03$, range: $-.01$ to $-.09$). Overall, standardized *z* values fell within the range of -3.26 to 3.26 for all effect sizes ($p < .001$), implying that no outliers were present.

Results

The results of the meta-analyses are presented in six sections. First, we report study and sample characteristics. Second, we explore interrelations between measurement methods of print exposure in all age groups. In other words, we examine whether print exposure checklists correlated with scores on self-report questionnaires that contained items such as reading frequency, the number of books at home, and activity preferences (e.g., "I would rather read than listen to music of my choice"). In three subsequent subsections, we present correlations between print exposure and comprehension and technical reading and spelling outcomes for (a) preschool and kindergarten children, (b) children attending Grades 1–12, and (c) undergraduate and graduate students. Across these three subsections, the effect sizes of oral language and reading comprehension are reported first, followed by the effect sizes of technical reading and spelling skills such as basic reading skills, word recognition, and spelling. In addition, results of metaregressions and moderator analyses are presented. In the sixth and final section, longitudinal studies are reviewed to examine the plausibility of reciprocal causation.

For reasons of clarity, we report which mean effect sizes differed significantly from other mean effect sizes (i.e., the 95% CIs do not overlap) without mentioning the specific CIs in the text. These details as well as weighted combined effect sizes for the separate outcome variables of each domain can be found in Tables 5–8.

Descriptive Statistics

Ninety-nine studies ($N = 7{,}669$) met our inclusion criteria, of which 81 were published in peer-reviewed journals. Specifically, 29 studies comprised preschool and kindergarten children ($n = 2{,}168$), 40 studies targeted children attending Grades 1–12 ($n = 2{,}792$), and 30 studies included undergraduate and graduate students ($n = 2{,}709$). Most respondents resided in North America ($k_{\text{P+K}} = 24$, $n = 1{,}837$; $k_{\text{Gr1–12}} = 27$, $n = 1{,}889$; $k_{\text{U+G}} = 24$, $n = 2{,}219$), were first-language learners ($k_{\text{P+K}} = 26$, $n = 1{,}777$; $k_{\text{Gr1–12}} = 33$, $n = 2{,}368$; $k_{\text{U+G}} = 30$, $n = 2{,}709$), and were tested in English ($k_{\text{P+K}} = 21$, $n = 1{,}448$; $k_{\text{Gr1–12}} = 36$, $n = 2{,}515$; $k_{\text{U+G}} = 29$, $n = 2{,}690$). Information on socioeconomic status or parental education levels was available only for the youngest group of preconventional readers: Thirteen out of 15 homes in which the print exposure checklists were administered, and 11 out of the 14 matched studies, could be classified as middle to high socioeconomic status.

Correlations of Print Exposure Checklists and Home Literacy Questionnaires

Parents of preschoolers and kindergartners completed a child-title recognition test to assess familiarity with titles of children's story-

Table 3
Moderators and Outcomes per Study for Meta-Analysis 2: Grades 1–12

Study	Publication status	Continent (country)	Language checklist	N[a]	% male	Age (M, years)	Grade[b]	Ability level[c]	Checklist[d]	Fisher's z (SE)[e] Oral	Comp	Basics	Word rec	Spelling	IQ
Allen et al. (1992)	Published	North America (United States)	English	63	60	10.58	5	2	A + TRT	.44 (.08)	.57 (.10)				
Barker et al. (1992)	Published	North America (United States)	English	87	49	9.42	3	2	TRT			.18 (.09)	.17 (.08)		.09 (.11)
Byrne & Fielding-Barnsley (1995)	Published	Australia	English	115	52	8.02	2	2	TRT		.20 (.09)		.19 (.07)		
Byrne et al. (1997, Study 1)	Book chapter	Australia	English	33			3	1	TRT			.39 (.18)			
Byrne et al. (1997, Study 2)	Book chapter	Australia	English	28			4	1	TRT			.55 (.20)			
Cain et al. (2000)	Published	Europe (United Kingdom)	English	25			2	1 vs. 2	ART		.17 (.20)				
Cipielewski & Stanovich (1992)	Published	North America (United States)	English	98	53	10.04	4–5	2	A + TRT		.50 (.11)	.25 (.08)			
Compton (2002, Study 1)	Published	North America (United States)	English	32		11.3 vs. 11.6	5–6	1 vs. 2	TRT				.66 (.16)		
Compton (2002, Study 2)	Published	North America (United States)	English	32		8.6 vs. 8.8	3	1 vs. 3	TRT				.26 (.17)		
Cunningham & Stanovich (1990)	Published	North America (United States)	English	80	47	9.58	3–4	2	TRT			.17 (.21)	.39 (.11)		.17 (.11)
Cunningham & Stanovich (1991)	Published	North America (United States)	English	134	46	11.17	4–6	2	TRT	.50 (.09)		.32 (.09)	.59 (.09)	.58 (.09)	.32 (.09)
Cunningham & Stanovich (1993)	Published	North America (United States)	English	26	62	6.92	1	2	TRT			.04 (.12)	.59 (.17)	.70 (.15)	
Cunningham & Stanovich (1997)	Published	North America (United States)	English	27	56	16.75	11	2	A + MRT	.87 (.23)	.68 (.20)				.32 (.20)
Cunningham et al. (2001)	Published	North America (United States)	English	39	51	9.42	3	1	TRT				.59 (.12)		
Ecalle & Magnan (2008, Study 1)	Published	Europe (France)	Other	57		6.20	1	2	A + T + MRT			.01 (.11)	.21 (.14)	.19 (.14)	−.06 (.14)
Ecalle & Magnan (2008, Study 2)	Published	Europe (France)	Other	60		8.34	2–3	2	A + T + MRT	.23 (.13)			.37 (.13)	.45 (.13)	
Ecalle & Magnan (2008, Study 3)	Published	Europe (France)	Other	60		10.49	4–5	2	A + T + MRT	.56 (.13)			.54 (.13)	.39 (.13)	
Echols et al. (1996)	Published	North America (United States)	English	157	54	10.58	4–6	2	A + TRT	.49 (.14)				.54 (.06)	
Goff et al. (2005)	Published	Australia	English	180		10.17	3–5	2	TRT	.39 (.08)	.44 (.08)		.30 (.08)		
Grant et al. (2008, Study 1)	Unpublished[f]	North America (Canada)	English	26	46	8.83	3	1	TRT	.17 (.21)	.66 (.21)	.40 (.21)	.56 (.09)		
Grant et al. (2008, Study 2)	Unpublished[f]	North America (Canada)	English	24	42	8.83	3	1	TRT	.58 (.22)	.62 (.22)	.29 (.22)	.47 (.10)		
Grant et al. (2008, Study 2)	Unpublished[f]	North America (Canada)	English	18	56	8.63	3	2	TRT	.41 (.26)	.14 (.26)	.07 (.26)	−.13 (.12)		
Griffiths & Snowling (2002)	Published	Europe (United Kingdom)	English	59		12.17	Large	1	A + TRT				.26 (.19)		
Kail et al. (1999)	Published	North America (United States)	English	168	49	10.20	Large	2	A + MRT		.83 (.08)		.91 (.08)		

(*table continues*)

Table 3 (*continued*)

Study	Publication status	Continent (country)	Language checklist	N[a]	% male	Age (M, years)	Grade[b]	Ability level[c]	Checklist[d]	Fisher's z (SE)[e] Oral	Comp	Basics	Word rec	Spelling	IQ
Kim & Krashen (1998)	Published	Asia (Korea)	English	103	0		High	2	A + MRT	.68 (.07)					
Leach et al. (2003, Study 1)	Published	North America (United States)	English	44	55	10.50	4–5	1 vs. 2	TRT		.07 (.15)				
Leach et al. (2003, Study 2)	Published	North America (United States)	English	60	45	10.50	4–5	1 vs. 2	TRT				.17 (.13)		
Lynch (2004)	Unpublished[g]	North America (United States)	English	56	45		2	2	TRT		.23 (.15)		.34 (.15)		
McBride-Chang et al. (1993, Study 1)	Published	North America (United States)	English	36	69	12.90	5–9	1	TRT	.21 (.18)	.76 (.18)	.60 (.18)	.46 (.13)		.27 (.18)
McBride-Chang et al. (1993, Study 2)	Published	North America (United States)	English	49	49	12.40	5–8	2	TRT	.50 (.15)	.33 (.15)	.19 (.15)	.36 (.15)		.39 (.15)
McBride-Chang & Chang (1995)	Published	Asia (China)	Other	100	59	11.00	5		TRT	.47 (.11)	.30 (.11)				
McBride-Chang & Chang (1996)	Published	North America (United States)	English	126	41		Large	2	TRT	.46 (.09)		.35 (.09)	.56 (.09)		
McDowell et al. (1993)	Published	North America (United States)	English	158	48	8.17	2	2	TRT		.10 (.08)	.10 (.08)	.13 (.08)	.14 (.08)	.02 (.08)
McQuillan & Au (2001)	Published	North America (United States)	English	24	42	17.50	11	2	A + MRT		.55 (.15)				
McQuillan (2006)	Published	North America (United States)	English	133	52		9–12	1	ART	.46 (.09)					
Ricketts et al. (2007)	Published	Europe (United Kingdom)	English	30	27	10.07 vs. 9.99	Primary	1 vs. 2	ART		.09 (.18)				
Sénéchal & LeFevre (2002)	Published	North America (Canada)	English	45	51	6.42	1	2	TRT	.58 (.15)	.42 (.15)	.26 (.09)	.58 (.11)	.40 (.15)	
Shankweiler et al. (1996)	Published	North America (United States)	English	86		15.17	9	1	MRT	.69 (.11)	.44 (.11)	.39 (.11)		.63 (.06)	
Spear-Swerling (2006)	Published	North America (United States)	English	61	48	8.62	3	2	TRT		−.09 (.13)				
Stuart (2004)	Published	Europe (United Kingdom)	English	53		7.40	2	1	ART			.34 (.13)			

Note. Only aggregated effect sizes per outcome domain are provided here. See Table 7 for weighted combined effect sizes on separate outcome variables.
[a] The sample size for the meta-analysis can be smaller based on the data available to calculate Fisher's z'. [b] Exact grade (range), if not provided: Large = large range; Primary = primary school; High = high school. [c] Ability level: 1 = lower abilities, 2 = age-appropriate abilities, 1 vs. 2 = lower versus age-appropriate abilities, 1 vs. 3 = lower versus high abilities. [d] Checklist: ART = Author Recognition Test; TRT = Title Recognition Test; MRT = Magazine Recognition Test; A + TRT = Author and Title Recognition Test; A + MRT = Author and Magazine Recognition Test; A + T + MRT = Author, Title, and Magazine Recognition Test. [e] Transformed association (Fisher's z) between checklist and oral language composite (Oral), reading comprehension (Comp), basic reading skills composite of alphabet knowledge, phonological processing, and/or orthographic processing (Basics), word recognition composite of word identification and/or word attack (Word rec), word spelling (Spelling), and IQ. [f] Conference contribution. [g] Dissertation.

Table 4
Moderators and Outcomes per Study for Meta-Analysis 3: Undergraduate and Graduate Students

Study	Publication status	Continent (country)	Language checklist	N[a]	% male	Age (M, years)	Student type[b]	Ability level[c]	Checklist[d]	Fisher's z (SE)[e] Oral	Comp	Basics	Word rec	Spelling	IQ	Acad ach
Acheson et al. (2008)	Published	North America (United States)	English	99		20.30	U	2	ART							.30 (.08)
									MRT							.03 (.08)
Beech (2002)	Published	Europe (United Kingdom)	English	110	18	20.20	U	2	ART	.65 (.07)		.08 (.06)		.46 (.10)		
Burt & Fury (2000)	Published	Australia	English	100	49	19.90	U	2	ART	.46 (.10)	.29 (.10)			.35 (.11)		
Burt (2006)	Published	Australia	English	112	30	19.80	U	2	ART			.25 (.06)		.44 (.10)		
Chateau & Jared (2000)	Published	North America (Canada)	English	64			U	2	ART			.42 (.13)	.35 (.10)			
Grant et al. (2007, Study 1)	Published	North America (Canada)	English	17	24	18.29	U	2	ART	.87 (.27)	.45 (.27)					
									MRT	.18 (.27)	.27 (.27)					
Grant et al. (2007, Study 2)	Published	North America (Canada)	English	13	54	21.33	U	1	ART	.56 (.32)	.33 (.32)					
									MRT	.81 (.32)	.79 (.32)					
Hall et al. (1996)	Published	North America (United States)	English	97	18		U	2	ART							.66 (.10)
									MRT							.60 (.10)
Holmes & Ng (1993)	Published	Australia	English	36	19		U	1 vs. 3	ART					.76 (.17)		
Holmes & Castles (2001)	Published	Australia	English	52	17	18.83	U	1 vs. 3	ART					.15 (.14)		
Kennedy (1996)	Unpublished[f]	North America (Canada)	English	72	52	20.70	U	2	ART	.76 (.12)	.66 (.12)	.22 (.08)	.32 (.11)			
Krashen & Kim (1998)	Published	North America (United States)	English	45	27		U + G	2	ART	1.05 (.15)						
									MRT	.85 (.15)						
Lewellen et al. (1993)	Published	North America (United States)	English	70			U	1 vs. 2	ART	.61 (.26)				.38 (.12)		.59 (.12)
									MRT	.39 (.20)				.13 (.12)		.50 (.12)
Lundquist (2004)	Unpublished[f]	North America (United States)	English	63	46		U	1 vs. 3	ART	.66 (.13)	.22 (.13)	.22 (.13)	.22 (.13)	.22 (.09)		.27 (.13)
									MRT	.55 (.13)	.22 (.13)	.22 (.13)	.27 (.13)	.22 (.09)		.47 (.13)
Martin-Chang & Gould (2008)	Published	North America (Canada)	English	171	16		U	2	ART	.62 (.08)	.69 (.08)					.16 (.08)
Masterson & Hayes (2007)	Unpublished[g]	Europe (United Kingdom)	English	80		24.10	S + E	2	ART	.71 (.11)	.28 (.11)			.65 (.11)		
Osana et al. (2007)	Published	North America (Canada)	English	112	46	23.70	U	2	ART	.79 (.10)	.28 (.10)				−.10 (.10)	.13 (.10)
Rodrigo et al. (1996)	Published	North America (United States)	Other	19			S + E	2	ART	.97 (.25)						
Sears et al. (2008, Study 1)	Published	North America (Canada)	English	75			U + G	2	ART				.21 (.08)			
Sears et al. (2008, Study 2)	Published	North America (Canada)	English	76			U + G	2	ART				.48 (.11)			
Siddiqui et al. (1998)	Published	North America (Canada)	English	133	32	25.80	U + G	2	ART + MRT							.38 (.09)
Stanovich & West (1989, Study 1)	Published	North America (United States)	English	61	16		U	2	ART					.50 (.13)		
									MRT					.05 (.13)		
Stanovich & West (1989, Study 2)	Published	North America	English	180	37		U	2	ART		.38 (.08)	.32 (.04)	.46 (.06)	.45 (.08)		
									MRT		.30 (.08)	.03 (.04)	.20 (.05)	.11 (.08)		
Stanovich & Cunningham (1992)	Published	North America	English	300	38		U	2	ART	.73 (.04)	.60 (.06)			.56 (.06)	.31 (.06)	
									MRT	.64 (.04)	.52 (.06)			.39 (.06)	.41 (.06)	
Stanovich & Cunningham (1993)	Published	North America (United States)	English	268	34		U	2	ART		.47 (.06)				.31 (.06)	.34 (.06)
									MRT		.47 (.06)				.30 (.06)	.20 (.06)

(*table continues*)

Table 4 (*continued*)

Study	Publication status	Continent (country)	Language checklist	N[a]	% male	Age (M, years)	Student type[b]	Ability level[c]	Checklist[d]	Fisher's z (SE)[e] Oral	Comp	Basics	Word rec	Spelling	IQ	Acad ach
Stanovich et al. (1995)	Published	North America	English	133	28	19.10	U	2	ART	.74 (.09)						.42 (.09)
									MRT	.44 (.09)						.41 (.09)
West & Stanovich (1991)	Published	North America	English	90	24		G	2	ART	.24 (.11)						.03 (.11)
									MRT	.29 (.11)						.10 (.11)
Wolforth (2000, Study 1)	Unpublished[f]	North America (Canada)	English	20	35		U + G	1	ART	.59 (.24)			.16 (.17)	.16 (.24)	.16 (.24)	
									MRT	.16 (.24)			.16 (.17)	.16 (.24)	.16 (.24)	
Wolforth (2000, Study 2)	Unpublished[f]	North America (Canada)	English	21	48		U + G	1	ART	.55 (.24)			.35 (.20)	.16 (.24)	.69 (.24)	
									MRT	.16 (.24)			.29 (.17)	.16 (.24)	.16 (.24)	
Wolforth (2000, Study 3)	Unpublished[f]	North America (Canada)	English	20	40		U + G	2	ART	.16 (.24)			.47 (.27)	.16 (.24)	.16 (.24)	
									MRT	.16 (.24)			.16 (.17)	.16 (.24)	.16 (.24)	

Note. Only aggregated effect sizes per outcome domain are provided here. See Table 8 for weighted combined effect sizes on separate outcome variables.
[a] The sample size for the meta-analysis can be smaller based on the data available to calculate Fisher's z'. [b] Student type: undergraduate (U), graduate (G), students and employees (S + E). [c] Ability level: 1 = lower abilities, 2 = age-appropriate abilities, 1 vs. 2 = lower versus age-appropriate abilities, 1 vs. 3 = lower versus high abilities. [d] Checklist: ART = Author Recognition Test; MRT = Magazine Recognition Test. [e] Transformed association (Fisher's z) between checklist and oral language composite (Oral), reading comprehension (Comp), basic reading skills composite of phonological and/or orthographic processing (Basics), word recognition composite of word identification and/or word attack (Word rec), word spelling (Spelling), IQ, and academic achievement indicators as grade point average and Scholastic Assessment Test and American College Testing scores (Acad ach). [f] Dissertation. [g] Conference contribution.

books (k = 13, n = 980), a child-author recognition test that lists authors of children's storybooks (k = 7, n = 576), and/or an adult-author recognition test comprising authors of adult fiction (k = 8, n = 658). Children in Grades 1–12 mostly completed a title recognition test (k_{TRT} = 32, n = 2,311; k_{ART} = 14, n = 1,087; k_{MRT} = 7, n = 394), whereas undergraduate and graduate students all completed an author recognition test (k_{TRT} = 1, n = 80; k_{ART} = 30, n = 2,709; k_{MRT} = 17, n = 1,630). Overall, print exposure checklists contained more true items than foils ($M_{\text{total items}}$ = 51.94, SD = 29.78; range: 8–150; $M_{\text{\% true items}}$ = 60.65%, SD = 10.35) and showed good mean reliabilities (Cronbach's α = .75–.89). As can be seen in Table 5, parents' knowledge of adult fiction correlated rather strongly with their knowledge of children's literature (r = .48, $p < .001$). Within the set of students, the author recognition test correlated strongly with the magazine recognition test (r = .60, $p < .001$).

A small subset of studies also administered a self-report home literacy environment questionnaire (k_{P+K} = 10, n = 783; k_{Gr1-12} = 5, n = 445; k_{U+G} = 8, n = 770) and/or an activity preference questionnaire with forced-choice questions that contrasted reading as well as television with other leisure time activities (k_{P+K} = 0; k_{Gr1-12} = 2, n = 90; k_{U+G} = 5, n = 634). With parents as respondents, the number of books at home was significantly more strongly related to knowledge of children's literature (r = .46, $p < .001$) than a single item about the frequency of shared book reading (r = .22, $p < .001$) as appeared from nonoverlapping 95% CIs. The correlations between undergraduate and graduate students' print exposure checklist scores and activity preference scores for reading were significantly higher for the author recognition test (r = .45, $p < .001$) than for the magazine recognition test (r = .24, $p < .001$). In the same vein, the author recognition test (r = .38, $p < .001$) was more strongly related to the home literacy composite than the magazine recognition test (r = .25, $p < .001$). Interestingly, a preference for television viewing correlated negatively with a students' score on the author recognition test (r = −.18, $p < .05$).

Meta-Analysis 1: Preschool and Kindergarten Children

In the set of 2- to 6-year-old children (M_{age} = 56.95 months, SD = 10.40), the correlation between oral language skills and print exposure checklists of children's literature was moderate (k = 12, r = .34, $p < .001$). An additional 478 nonsignificant studies would be needed to transform this significant result into a nonsignificant effect size (see Table 6, which presents fail-safe numbers for the effect sizes presented hereafter). Similar, moderate correlations were found for receptive (k = 9, r = .33, $p < .001$) and expressive vocabulary skills (k = 4, r = .35, $p < .001$).

To compare these effect sizes with a matched set of studies in which only a home literacy self-report questionnaire was administered, we calculated the weighted average with a composite of home literacy questions and the frequency of shared book reading as a single item in 14 studies that resembled the print exposure studies in terms of number of children, mean age, home language, and socioeconomic status. First, the correlations between oral language and the home literacy composite in matched studies (k = 11, r = .32, $p < .001$) were significantly stronger than the correlations with the frequency of shared book reading in matched studies (k = 6, r = .16, $p < .01$). Within the set of print exposure studies, the same pattern was present when comparing the effect

Table 5
Interrelations Between Print Exposure Checklists and Home Literacy Questionnaires Across Meta-Analyses

Variable	Children's literature (CAR + CTR)						Adult fiction (AAR)					
	k	Fisher's z	95% CI	Q	I^2	N fail-safe	k	Fisher's z	95% CI	Q	I^2	N fail-safe
Preschool and kindergarten												
Adult fiction (AAR)	4	.52***	[.32, .72]	14.06**	78.66	13						
Frequency reading to child	8	.22***	[.14, .30]	8.9	21.36	66	4	.14	[−.00, .28]	4.5	33.27	2
Number of books at home	5	.50***	[.42, .58]	1.46	0.00	172	4	.36***	[.25, .47]	0.25	0.00	35
	Author Recognition Test (ART)						Magazine Recognition Test (MRT)					
Grades 1–12												
MRT	3											
HLE-composite	5	.23**	[.06, .39]	16.49**	75.74	34						
Undergraduate and graduate students												
MRT	14	.70***	[.59, .81]	36.79***	67.39	1,662						
HLE-composite	6	.40***	[.34, .47]	4.54	0.00	178	5	.25***	[.16, .34]	9.4	0.83	66
Activity preference												
Reading	5	.48***	[.38, .57]	4.93	18.82	139	4	.24***	[.15, .34]	1.12	0.00	16
Television	4	−.18*	[−.34, −.02]	5.41	44.59	9	3					

Note. Nonsignificant Qs imply homogeneity (df = k − 1); I^2 reflects the degree of inconsistency among studies. CAR + CTR = Child-Author Recognition and Child-Title Recognition Tests; AAR = Adult-Author Recognition Test; k = number of studies; CI = confidence interval; HLE = home literacy environment.
* $p < .05$. ** $p < .01$. *** $p < .001$.

sizes for print exposure checklists on children's literature with a single question about parent–child reading frequency ($k = 8$, $r = .21$, $p < .001$), whereas parents' estimation of the total number of books at home ($k = 5$, $r = .32$, $p < .001$) revealed almost identical correlations with oral language as print exposure checklists. Second, when we contrasted the matched self-report studies with the set of print exposure studies, the home literacy composite revealed similar combined effect sizes with oral language to the set of print exposure studies. In sum, both composite scores of children's home literacy environment and print exposure checklists are related moderately to oral language.

Print exposure showed a moderate effect size for basic reading skills as well ($k = 8$, $r = .29$, $p < .001$), and the 95% CI showed overlap with the CI of oral language. The set of matched studies revealed small correlations with the basic reading composite ($k_{\text{HLE-comp}} = 13$, $r = .18$, $p < .001$; $k_{\text{RFreq}} = 7$, $r = .18$, $p < .001$), and these were significantly smaller than for oral language, given nonoverlapping CIs (see Figure 1).

Unfortunately, it was not possible to study age effects by contrasting preschool and kindergarten children or entering M_{age} into a metaregression, because seven studies included large, overlapping age ranges. Outcomes of print exposure studies that were carried out by Sénéchal and colleagues (Sénéchal, 2000; Sénéchal et al., 1996, 1998, 2008), who carried out nearly half of all studies with the checklist for children's literature ($k = 5$), did not significantly differ from studies from other research groups, $Q_{\text{Oral}}(1) = .20$, $p > .05$.

Meta-Analysis 2: Grades 1–12

For children between 6.2 and 17.5 years of age ($M_{age} = 10.23$ years, $SD = 2.61$), the effect sizes between print exposure and all outcome measures ranged between .15 and .45. Standardized and unstandardized tests revealed comparable results, and are presented as a composite here (see Table 7 for separate estimates and fail-safe numbers).

Overall, print exposure was moderately related to oral language skills ($k = 18$, $r = .45$, $p < .001$) and reading comprehension ($k = 21$, $r = .36$, $p < .001$). Second, moderate effect sizes for word recognition ($k = 24$, $r = .38$, $p < .001$) and spelling ($k = 9$, $r = .42$, $p < .001$) differed significantly from the smaller summary estimates that were found for basic reading skills ($k = 18$, $r = .23$, $p < .001$). The 95% CIs for oral language skills, word recognition, and spelling did overlap, whereas oral language did significantly differ from basic reading skills. In addition, IQ ($k = 8$, $r = .15$, $p < .05$) seemed to be affected significantly less by print exposure than oral language, reading comprehension, word recognition, and spelling.

To test whether the effect sizes between print exposure and outcome measures would be higher as a function of age, we conducted metaregression analyses by entering mean age as a continuous variable. The random model (method of moment) metaregression was significant for oral language ($Q_{\text{model}} = 5.31$, $p < .05$, $B_{\text{slope}} = .04$), basic reading skills ($Q_{\text{model}} = 7.63$, $p < .01$, $B_{\text{slope}} = .03$), and IQ ($Q_{\text{model}} = 9.48$, $p < .01$, $B_{\text{slope}} = .06$), implying (if longitudinal reasoning could be applied to these cross-sectional data) that children gain .04, .03, and .06 points, respectively, each year as they get older, which will result in an increase of .36–.72 standard deviations in the course of 12 years. Furthermore, the slopes of reading comprehension ($Q_{\text{model}} = 2.92$, $p = .09$, $B_{\text{slope}} = .04$) and spelling skills ($Q_{\text{model}} = 3.22$, $p = .07$, $B_{\text{slope}} = .04$) approached significance, whereas there was no such a trend for word recognition ($Q_{\text{model}} = .09$, $p > .50$). Because a small number of studies might bias the results of regressions (Borenstein et al., 2009), we also conducted moderator analyses in which we categorized children's grades into primary (Grades 1–4), middle (Grades 5–8), and high school (Grades 9–12). It should be

Table 6
Effect Sizes Between Print Exposure and Language and Basic Reading Outcomes for the Checklist Studies and the Matched Self-Report Questionnaire Studies in Preschool and Kindergarten

Variable	Oral			Basic reading skills			
	Oral	RV	EV	Basics	AK	PP	OP
Print exposure studies							
Checklist							
Children's literature (CAR + CTR)							
k	12	9	4	8	5	8	2
z′	.35***	.34***	.36***	.30***	.26***	.28***	
95% CI	[.27, .42]	[.26, .43]	[.22, .51	[.22, .38]	[.18, .36]	[.21, .36]	
Q	19.13	11.84	5.29	13.29	2.80	6.49	
I^2	42.48	32.41	37.23	47.31	0.00	0.00	
N fail-safe	478	224	29	222	35	102	
Adult fiction (AAR)							
k	8	6	3	5	1	4	4
z′	.27***	.29***		.27***		.27***	.20
95% CI	[.20, .33]	[.19, .39]		[.21, .34]		[.17, .36]	[−.01, .40]
Q	7.20	8.14		2.77		0.40	10.62*
I^2	2.72	26.5		0.00		0.00	71.74
N fail-safe	123	62		73		25	12
HLE Questionnaire							
Frequency reading to child							
k	8	7	2	4	2	3	1
z′	.21***	.19***		.28***			
95% CI	[.13, .29]	[.11, .28]		[.18, .39]			
Q	7.72	3.45		2.66			
I^2	9.28	0.00		0.00			
N fail-safe	60	25		22			
Number of books at home							
k	5	4	2	2	1	2	1
z′	.33***	.34***					
95% CI	[.24, .43]	[.22, .46]					
Q	3.72	3.58					
I^2	0.00	16.22					
N fail-safe	52	35					
Matched studies							
HLE Questionnaire							
Composite Scale							
k	11	8	6	13	10	6	0
z′	.33***	.35***	.33***	.18***	.19***	.21***	
95% CI	[.27, .40	[.22, .48	[.22, .43	[.12, .24]	[.10, .28]	[.15, .27]	
Q	12.94	15.64*	3.29	29.08*	28.85*	4.44	
I^2	22.69	55.24	0.00	34.88	48.30	0.00	
N fail-safe	372	119	60	287	162	49	
Frequency reading to child							
k	6	5	3	7	3	4	0
z′	.16**	.15**		.18***		.17**	
95% CI	[.10, .22]	[.06, .24]		[.11, .24]		[.07, .26]	
Q	0.68	0.94		2.33		0.10	
I^2	0.00	0.00		0.00		0.00	
N fail-safe	28	9		37		7	

Note. Nonsignificant *Q*s imply homogeneity ($df = k - 1$); I^2 reflects the degree of inconsistency among studies. Oral = oral language composite: RV = receptive vocabulary, EV = expressive vocabulary; Basics = basic reading composite: AK = alphabet knowledge, PP = phonological processing, OP = orthographic processing; CAR + CTR = Child-Author and Title Recognition Tests; AAR = Adult-Author Recognition Test; *k* = number of studies; CI = confidence interval; HLE = home literacy environment.
* $p < .05$. ** $p < .01$. *** $p < .001$.

noted that studies assessing high school students could be included only in the analysis for oral language, as the other skills were not typically assessed for them. Significant grade differences were present for oral language, $Q(2) = 11.81$, $p < .01$ ($k_{\text{primary}} = 6$, $r = .36$, $p < .001$; $k_{\text{middle}} = 7$, $r = .44$, $p < .001$; $k_{\text{high}} = 4$, $r = .55$, $p < .001$), and word recognition, $Q(1) = 4.34$, $p < .05$ ($k_{\text{primary}} = 16$, $r = .31$, $p < .001$; $k_{\text{middle}} = 5$, $r = .48$, $p < .001$), but did not appear for basic reading skills, $Q(1) = 2.18$, $p > .05$, and reading comprehension, $Q(1) = 2.29$, $p > .05$. In short, the correlations between print exposure and oral language were progressively

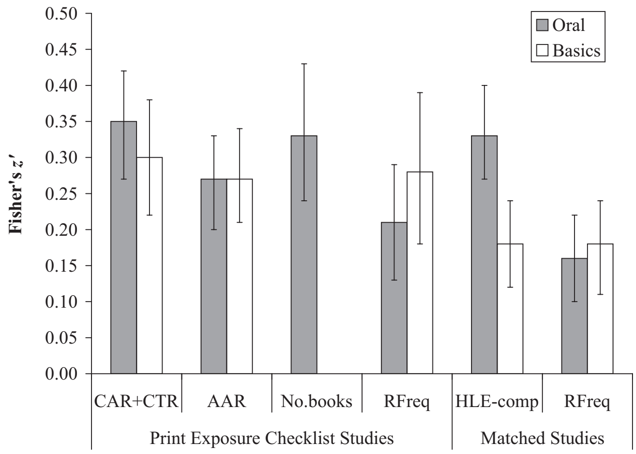

Figure 1. Effect sizes and 95% confidence intervals of oral language and basic reading skills in preschool and kindergarten for various home literacy indicators within print exposure checklist studies and the matched set of studies. CAR + CTR = Child-Author and Child-Title Recognition Test; AAR = Adult-Author Recognition Test; No. books = number of books at home (single item); RFreq = reading frequency (single item); HLE-comp = composite of Home Literacy Environment Questionnaire.

stronger at higher levels of education. This pattern also seemed to emerge for technical reading skills and IQ from primary to middle school.

We also contrasted studies that contained children with age-appropriate abilities with studies that tested children with lower reading abilities. In line with our third hypothesis, no ability-level differences were detected for unconstrained skills such as oral language, $Q(1) = 1.14$, $p > .05$, and reading comprehension, $Q(1) = 0.01$, $p > .05$. However, the correlations between print exposure and basic reading skills were significantly stronger for children with lower ability levels ($k = 7$, $r = .39$, $p < .001$) than for children with age-appropriate reading abilities ($k = 11$, $r = .20$, $p < .001$), $Q(1) = 9.57$, $p < .01$. Such a distinction was not detected for word recognition, $Q(1) = 0.57$, $p > .05$.

Meta-Analysis 3: Undergraduate and Graduate Students

In the set of 30 studies comprising college and university students ($M_{age} = 21.00$ years, $SD = 2.32$), 17 included both author and magazine recognition tests to measure print exposure. Overall, author recognition tests showed stronger correlations with all outcome variables than the magazine recognition tests: Ninety-five percent CIs did not overlap for spelling outcomes and hardly showed any overlap for the other skills (see Table 8). In this section, therefore, we focus on author recognition checklists as the indicator of print exposure. We did not detect any significant differences between standardized and unstandardized tests, so we present only composites.

Oral language skills showed strong correlations with print exposure ($k = 18$, $r = .58$, $p < .001$), yielding a significantly stronger association than the moderate effect size found for reading comprehension ($k = 11$, $r = .41$, $p < .001$), as no overlap was detected between 95% CIs. Technical reading and spelling skills were small to moderately related to print exposure ($k_{Basics} = 6$, $r = .24$, $p < .001$; $k_{Word\ rec} = 9$, $r = .34$, $p < .001$; $k_{Spelling} = 14$, $r = .40$, $p < .001$). Academic achievement scores on the Scholastic Assessment Test or American College Testing and grade point average showed a moderate effect size ($k = 10$, $r = .30$, $p < .001$), whereas IQ was related to print exposures with a small effect size ($k = 6$, $r = .18$, $p = .05$). The effect sizes of technical reading and spelling skills and general achievement measures were significantly smaller than the correlation between print exposure and oral language skills. Thus, in line with our second hypothesis, oral language skills were more strongly related to print exposure than technical reading and spelling skills. The correlation between print

Table 7
Effect Sizes for the Print Exposure Checklists (Author, Title, and Magazine Recognition Tests) and All Outcome Measures for Meta-Analysis 2: Grades 1–12

Variable	k	Fisher' z	95% CI	Q	I^2	N fail-safe
Oral language	18	.49***	[.42, .56]	25.13	32.34	1,339
Standardized tests	11	.43***	[.36, .50]	8.94	0.00	332
Unstandardized tests	11	.55***	[.44, .66]	18.59*	51.59	535
Reading comprehension	21	.38***	[.27, .50]	88.35***	77.36	994
Basic reading skills	18	.23***	[.16, .29]	31.82	30.95	341
Alphabet knowledge	2					
Phonological processing	14	.22***	[.14, .29]	18.98	31.52	152
Orthographic processing	6	.34***	[.21, .46]	4.74	0.00	52
Word recognition	24	.40***	[.30, .50]	122.79***	81.27	1,936
Word identification	22	.42***	[.32, .53]	99.91***	77.98	1,815
Word attack	9	.22***	[.11, .33]	15.33	34.24	68
Spelling	9	.45***	[.32, .58]	32.97***	75.73	459
Standardized tests	3					
Unstandardized tests	7	.48***	[.37, .59]	10.78	44.34	261
General achievement						
IQ	8	.15*	[.03, .26]	15.47	44.82	26

Note. Nonsignificant Qs imply homogeneity ($df = k - 1$); I^2 reflects the degree of inconsistency among studies. k = number of studies; CI = confidence interval.
* $p < .05$. *** $p < .001$.

Table 8
Effect Sizes for Print Exposure Checklists and All Outcome Measures for Meta-Analysis 3: Undergraduate and Graduate Students

	Author recognition test						Magazine recognition test					
Variable	k	Fisher's z	95% CI	Q	I^2	N fail-safe	k	Fisher's z	95% CI	Q	I^2	N fail-safe
Oral language	18	.66***	[.57, .74]	38.25**	55.55	2,581	11	.46***	[.32, .59]	27.36**	63.45	409
Standardized tests	12	.67***	[.58, .75]	15.08	27.07	1,102	8	.48***	[.32, .63]	14.01	50.05	225
Unstandardized tests	7	.56***	[.37, .76]	46.85***	81.04	455	4	.43***	[.19, .66]	12.58**	76.15	53
Reading comprehension	11	.44***	[.33, .55]	31.93***	68.68	644	6	.41***	[.30, .53]	10.43	52.04	168
Basic reading skills	6	.24***	[.15, .33]	12.32*	59.43	105	2					
Phonological processing	5	.19***	[.11, .27]	7.11	25.65	38	2					
Orthographic processing	5	.26***	[.15, .37]	8.16	50.98	54	1					
Word recognition	9	.35***	[.26, .43]	9.89	19.10	178	5	.20***	[.13, .28]	0.87	0.00	21
Word identification	8	.39***	[.28, .51]	12.13	42.27	158	4	.24***	[.12, .35]	0.55	0.00	9
Word attack	6	.36***	[.29, .44]	5.34	6.43	107	2					
Spelling	14	.42***	[.33, .51]	26.75*	51.40	651	8	.20**	[.08, .31]	12.76	45.15	38
Standardized tests	9	.43***	[.33, .54]	14.26	43.89	265	7	.25***	[.15, .35]	7.8	23.07	42
Unstandardized tests	9	.37***	[.27, .46]	12.67	36.86	220	4	.06	[−.03, .15]	3.85	0.00	1
General achievement												
IQ	6	.18*	[.00, .35]	25.01**	73.92	43	5	.34***	[.26, .42]	3.67	0.00	46
Academic achievement	10	.31***	[.21, .41]	21.56*	62.90	211	8	.28***	[.14, .42]	26.17**	73.28	111

Note. Nonsignificant Qs imply homogeneity ($df = k - 1$); I^2 reflects the degree of inconsistency among studies. k = number of studies; CI = confidence interval.
* $p < .05$. ** $p < .01$. *** $p < .001$.

exposure and reading comprehension outperformed the correlation for basic reading skills (i.e., nonoverlapping 95% CIs) but not for word recognition and spelling.

Only one of the moderators that could be tested revealed significant group differences in any of the outcome measures. That is, the effect sizes for students with age-appropriate or higher spelling skills were significantly stronger ($k = 8$, $r = .45$, $p < .001$) compared with studies that included students with a lower ability ($k = 6$, $r = .29$, $p < .001$), $Q(1) = 4.86$, $p < .05$. This pattern did not appear to be present for oral language, $Q(1) = 0.19$, $p > .05$.

Reciprocal Causation?

When all age groups are included across meta-analyses, the strength of the correlation between print exposure and oral language showed an increase (see Figure 2), whereas the correlations with reading comprehension and technical reading and spelling skills were stable, although they did increase within the set of primary and middle school children. The cross-sectional nature of these studies and variation in spread of scores on skills at different points of mastery, however, stopped us from drawing definite conclusions about print exposure as a consequence of reading ability and as a contributor to further reading growth (i.e., about a causal spiral). The number of longitudinal studies including print exposure checklists was too small to test predictive paths with the meta-analytic approach, but inspection of longitudinal outcomes makes causality more plausible. For children who were followed into elementary school, some researchers did not find predictive relations (e.g., Evans, Shaw, & Bell, 2000; Spear-Swerling, 2006), but others did. For instance, storybook exposure in preschool and/or kindergarten significantly explained variance of reading comprehension (6%) and word attack (6%) in first grade but not second grade (Roth, Speece, & Cooper, 2002), reading at the end of third grade (4%; Sénéchal & LeFevre, 2002), and reading comprehension in fourth grade (4%; Sénéchal, 2006). Aram (2005) entered the home literacy environment composite in kindergarten as a first step in predicting second-grade skills, explaining 20% of the variance in reading comprehension, 12% in orthographic processing, 16% in spelling, and 12% in text reading fluency, respectively.

Children's own report of print exposure at the end of first grade accounted for 6% of the variance in their third-grade reading, after controlling for children's basic reading skills at the beginning of first grade (Sénéchal & LeFevre, 2002). In the same vein, print exposure in third grade contributed to reading comprehension in fifth grade after controlling for third-grade reading comprehension (7%–11%; Cipielewski & Stanovich, 1992). Print exposure in fourth to sixth graders explained 8% of oral language and 2% in spelling scores

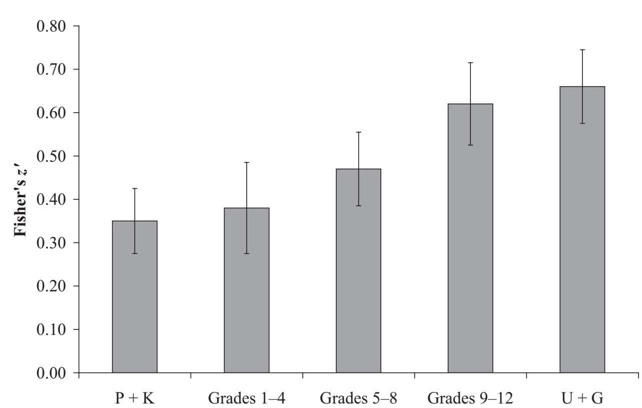

Figure 2. Effect size estimates and 95% confidence intervals for associations between print exposure and oral language across years of education. P + K = preschool and kindergarten children; U + G = undergraduate and graduate students.

1.5 years later (Echols, West, Stanovich, & Zehr, 1996). Conversely, two longitudinal studies have shown that print exposure can be predicted by earlier comprehension and technical reading skills. First, reading comprehension and word identification in first grade accounted for 10%–12% of the variance in 11th-grade print exposure, as did first-grade oral language for 7% and first-grade IQ (5% of the variance predicted), after 11th-grade reading comprehension was taken into account (Cunningham & Stanovich, 1997). Third-grade as well as fifth-grade reading comprehension predicted 11th-grade print exposure as well (22% and 15%, respectively). Second, a variety of basic reading skills, word recognition, and spelling tests in Grades 1 and 2 correlated significantly with third-grade print exposure, ranging between .40 and .72 (Cunningham, Perry, & Stanovich, 2001).

Discussion

We performed a series of meta-analyses on 99 studies (N = 7,669) that focused on leisure time reading of preschoolers and kindergartners, children attending Grades 1–12, and college and university students. The main findings are consistent with a developmental model of reading comprehension and technical reading and spelling, in which print exposure is considered to be a driving force in shaping literacy. In short, it is posited that an early start of shared book reading sets in motion a causal spiral, in which print exposure stimulates language and reading development, which, in turn, stimulates the quantity of print exposure (K. L. Fletcher & Reese, 2005). For conventional readers, this reciprocal mechanism results in growing interindividual differences in print exposure that increase with years of education, as more skilled readers will choose to read more and the keener readers will show better comprehension and technical reading and spelling skills (Bast & Reitsma, 1998; Cunningham et al., 1994). Although the meta-analytic results presented here are largely cross-sectional, precluding a strong stance supporting such a cascading model, the stronger associations between print exposure and several key components of reading skills from infancy to early adulthood are consistent with such a perspective.

Overall, print exposure as inferred from checklists that assess familiarity with book titles and authors or magazines appears to be an important correlate of reading comprehension and technical reading and spelling skill development. During their development, children who choose to read books in their leisure time have larger vocabularies, better reading comprehension, and better technical reading and spelling skills than peers who do not read as frequently. As is displayed in Figure 3, the meta-analyses revealed that in the group of 2- to 6-year-old children, print exposure is related, at moderate strength, with both oral language and basic reading skills. Second, for children in Grades 1–12, the moderate effect sizes regarding associations of print exposure with oral language and reading comprehension are comparable to parallel effect sizes found for word recognition and spelling and are significantly stronger than for basic reading skills. Third, the comprehension component (also including academic achievement) and the technical reading and spelling component are moderately to strongly related to print exposure for college and university students, with the effect size for oral language skills the largest of all. In the group of school-aged and university students, print exposure is also related to intelligence, although effect sizes are small.

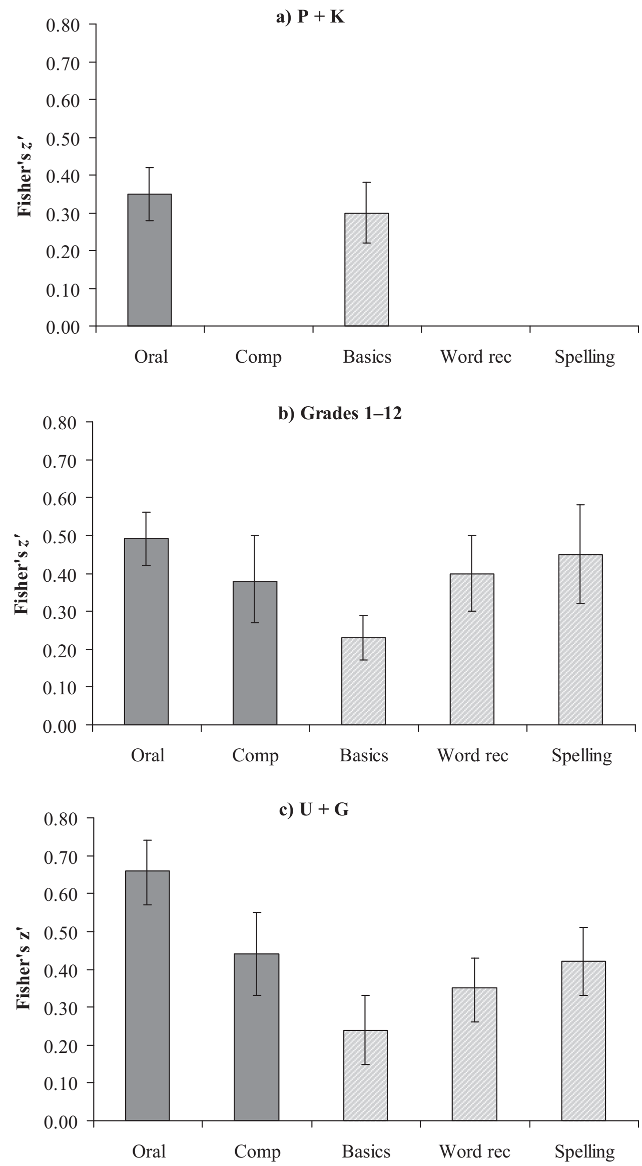

Figure 3. Effect sizes for the comprehension component (dark bars) and technical reading and spelling component (lighter, striped bars) and 95% confidence interval for studies on (a) preschool and kindergarten (P + K) children, (b) Grades 1–12, and (c) undergraduate and graduate students (U + G). Oral = oral language; Comp = reading comprehension; Basics = basic reading skills; Word rec = word recognition.

Crucially, when we approach our findings from a developmental perspective, the pattern of associations with print exposure was stronger across the age span from early childhood to young adulthood for oral language. Print exposure explains 12% of the variance in preschoolers' and kindergartners' oral language skills, 13% in primary school, 19% in middle school, 30% in high school, and 34% at undergraduate and graduate level. The correlation with print exposure also appears to become stronger for technical reading skills and intelligence from primary school to middle school. In addition, print exposure explains significantly more variance in the basic reading skills of schoolchildren with lower reading abilities (15%) than in their peers with age-appropriate reading abilities (4%). Although these outcomes do not permit conclusions about causality, the pattern of findings as well as a qualitative review of longitudinal studies suggests that spiral causality is a plausible interpretation of our findings.

Book Sharing With Preconventional Readers

In line with the snowball metaphor (Raikes et al., 2006), we found that book sharing is associated not only with the development of comprehension but also with technical reading skills that are needed for an easy start at school (see Foster & Miller, 2007). Interestingly, the meta-analysis reveals effects of children's home literacy experiences that are almost identical to those reported in a previous quantitative meta-analysis comprising 33 studies between 1951 and 1993 (Bus et al., 1995). In Bus et al.'s (1995) meta-analysis, the combined effect size was .32 for oral language and .28 for reading skills versus .34 and .29, respectively, in the current data, which covers studies between 1994 and 2009. Even though the earlier meta-analysis included only studies with self-report questionnaires (vs. print exposure checklists in the current meta-analysis), it is striking that exposure to storybooks explained about 10%–12% of children's language and 8% of children's basic reading skills in each investigation. Because effect sizes were comparable for receptive and expressive vocabulary measures, print exposure seems equally effective for language comprehension and language use. Due to insufficient numbers of pertinent studies, we could not test the hypothesis that the association between print exposure and basic reading skills was strongest for kindergartners with more print knowledge, who are more inclined to pay attention to print independently (M. T. de Jong & Bus, 2002; Evans et al., 2009).

As oral language and basic reading skills seem to be linked to home environments that familiarize children with books and other reading materials, we see no reason to argue about the recommendation that parents start a reading routine early in children's development. Most longitudinal studies also support the expectation that such a routine prevents preconventional readers from experiencing difficulties with understanding print and language in books later on (Aram, 2005; Roth et al., 2002; Sénéchal, 2006; Sénéchal & LeFevre, 2002). The additional finding that parents' knowledge of adult fiction accounts for 7% of children's oral language and basic reading skills is in line with the notion of intergenerational transmission of literacy. That is, if reading is a source of pleasure in their own lives, parents are more inclined to read to their children and engage them in stories (Bus, Leseman, & Keultjes, 2000).

Independent Text Reading

Comprehension. The syntheses of print exposure studies revealed moderate to strong effect sizes for oral language and moderate effect sizes for reading comprehension, whereas somewhat smaller effect sizes were found for more distant indicators of the comprehension component such as intelligence and indicators of academic achievement like grade point average and American College Testing and Scholastic Assessment Test scores. We argue that a model of reciprocal causation best fits the development of the comprehension component. Developing a reading habit depends not only on environmental factors such as the availability of books at home but also on readers' language and comprehension skills (Stanovich, 1986; Stanovich, Cunningham, & West, 1998). The model predicts that the strength of the correlation between print exposure and language and reading comprehension increases with age, and is strongest for students in college or university who are most likely to be "their own masters" in terms of choosing their leisure time activities.

The comparisons of effect sizes in separate meta-analyses as well as a metaregression in Grades 1–12 are consistent with this model of reciprocal causation in particular for oral language. We found a moderate correlation between print exposure and oral language in preschool, kindergarten, primary, and middle school children versus a strong correlation for high school students and undergraduate and graduate students. Impressively, in the development from early childhood to early adulthood, leisure time reading becomes increasingly more important for language. In early adulthood, 34% of the variance of oral language skills was explained by students' print exposure. We found a similar pattern for intelligence across primary to middle school. Apparently, more intelligent children are more interested in book reading; fiction books cover a huge diversity of topics and thereby provide other perspectives, problems, and/or insights than children might encounter in daily life (Hakemulder, 2000), potentially boosting performance on intelligence tests. More studies are needed, however, that follow children and students longitudinally to learn more about the processes that explain *how* reading might make us smarter. Apart from the range of cognitive variables as studied in this meta-analysis, future studies should also take into account individual differences in broader cognitive, motivational, socio-emotional, and environmental factors such as general cultural knowledge, interest in reading, skills of empathy and social understanding, and the development of reading routines among other leisure time activities (e.g., computer use and television).

We expected that effect sizes for the association between print exposure and reading comprehension would also increase with educational level, because readers' background knowledge expands and their reading strategies get more sophisticated with development (Paris, 2005). However, effect sizes for reading comprehension remained fairly consistent in all age groups. It may be too early to conclude that our findings are in contrast to the model of reciprocal causation, because the comprehension measures seem to have limitations that are likely to influence the effect sizes of print exposure within and across educational levels.

First, reading comprehension tests with relatively brief texts may be easier to complete successfully for older students as compared with younger children, leading to ceiling effects in the oldest age groups that limit the strength of the correlations with print exposure. Second, the expected differences between age groups may not have been captured, because the comprehension measures seem to assess different skills in younger and older readers (Cain & Oakhill, 2006; J. M. Fletcher, 2006; Keenan, Betjemann, & Olson, 2008). For example, variation in response formats may have masked differences between age groups: Multiple-choice and open-ended questions, which often require integration of text elements, were mainly used in studies on undergraduate and graduate students, whereas relatively easier cloze tasks (“Which alternative word fits best in the sentence?”), which depend more on children’s word reading abilities and sentence comprehension, were more often applied in schoolchildren. Furthermore, it was impossible to rule out that test scores reflect more general test-taking strategies than reading comprehension (e.g., Ozuru, Rowe, O’Reilly, & McNamara, 2008). Third, most reading comprehension tests may not measure skills that are specific to the comprehension of novels such as following a multilayered plot and multiple characters throughout hundreds of pages of text as well as understanding complex figures of speech (i.e., metaphors, irony; Duke, 2010). In contrast, texts in contemporary comprehension tests often comprise brief passages in a variety of genres (e.g., argumentative, expository, narrative) that cover a wide range of topics.

Technical reading and spelling. Although instruction is considered to play a main role in learning to read texts with increasing accuracy and fluency (National Reading Panel, 2000), the current findings show that print exposure also makes a difference to conventional readers’ technical reading and spelling skills. Examining the influence of age in the set of studies on school-aged children, we found that the correlations between print exposure and skills such as basic reading skills, word recognition, and spelling are higher as in middle school than in primary school samples, which is in line with reciprocal causality. Readers with higher technical reading and spelling skills are more inclined to read, and more print exposure promotes technical reading and spelling skills. Even in the studies on college and university students, we found that effect sizes for technical reading and spelling skills in relation to print exposure were on the same level. One reason may be that these print exposure studies were conducted in countries with opaque languages such as English, French, and Chinese, where children have to familiarize with numerous letter clusters in order to become a skilled reader and where they reach a ceiling in their technical reading and spelling development later than children who learn to read in transparent languages (Furnes & Samuelsson, 2010; Patel et al., 2004; Ziegler & Goswami, 2005). To test this interpretation, it will be important to examine technical reading and spelling skills of schoolchildren and students who learn to read in more transparent languages (see also Share, 2008). We expect that the technical reading and spelling skills of beginning readers of a language with less extreme ambiguity of spelling–sound correspondences than English will benefit from independent print exposure for a shorter developmental period.

Another reason for the unexpected finding that such associations appear to persist into adulthood may be that outcome measures are constructed in a way that test scores will continue to explain variance in each age group and remain sensitive to differences in students’ ability levels even at higher reading proficiency levels. Test adjustments may be made across development to avoid ceiling effects, resulting in unconstrained measures for constrained skills (Paris & Luo, 2010). For instance, the difficulty of words that students must write correctly in a spelling task can be increased for each age group, so that there is enough variance left in the performance of participants to be predicted by print exposure checklists.

In general, a shift occurs in the focus and content of technical reading and spelling measures that are used at different educational levels. For example, alphabet knowledge is measured only in preschoolers, kindergartners, and first graders, which seems methodologically and theoretically sound, as no group variance will be left once children received some formal reading instruction and know all letters of the alphabet (Paris, 2005). Phonological and orthographic processing and word recognition appear to be predominantly assessed in children attending primary school, when the most rapid growth in these skills can be expected. By way of contrast, of all the technical reading and spelling skills assessed in college and university students, spelling skills were taken into account more often. It can be argued that at this educational level, variance in reading proficiency may not be effectively captured by a receptive test such as orthographic processing in which correct spellings have to be selected from words that sound similar or by word recognition tasks in which an upper limit may be reached for the speed at which single words can be pronounced. Instead, spelling may be a preferable measure of word form knowledge because exact knowledge of word forms, especially in English, has to be available in order to write words correctly (Bourassa & Treiman, 2001). As a result of such discrepancies in assessments, direct comparisons of effect sizes for technical reading and spelling skills across age groups may be complicated.

Low-Ability Readers

Leisure time reading is especially important for low-ability readers. We found that the basic reading skills of children in primary and middle school with a lower ability level were more strongly related to print exposure as compared with higher ability readers. When low-ability readers have experience with books at home, they practice basic reading skills more, and as a result they become more accurate and fluent in reading text than their lower ability peers who are less exposed to print. The findings suggest that stimulating leisure time reading should be an effective intervention for low-ability readers as is predicted by the self-teaching hypothesis (Share, 1995). However, for children with reading difficulties, it may not be easy to get access to age- and interest-appropriate materials that match their reading ability level, and these children may therefore be more dependent on assistance from their parents and/or teachers in selecting stimulating books (Allington & McGill-Franzen, 2008; Kim & White, 2008; Martin et al., 2009).

As for spelling, we found that low-ability readers in studies on college and university students benefited less from print exposure than students whose reading skills fell into the normal range. Older skilled readers may be more capable of deriving word spellings during independent print exposure than less skilled older readers (Ehri & Saltmarsh, 1995; Reitsma, 1983). We suggest that low-ability readers’ uptake of word-specific orthographic details may be limited because they pay attention to words in a text in a way that is qualitatively different from that of more proficient readers. Low-ability readers’ use of context information as a compensatory reading strategy may, for instance, interfere with learning word spellings from exposure to print (Ehri & Wilce, 1980; Stanovich, 1986). In all, the current results indicate that encouraging skilled readers to read more may turn them into better spellers, an effect that should not be expected to the same extent for low-ability readers (Nunes & Bryant, 2009; Perfetti & Hart, 2002).

Measurement of Print Exposure

One strength of our meta-analysis is that we were able to compare methods for assessing print exposure by matching studies that administered self-report questionnaires with those using print exposure checklists in the youngest group of preconventional readers. A single question about frequency of book reading revealed weaker correlations with oral language and basic reading skills than print exposure checklists. Such a simple measure is more likely to be positively skewed because it suffers more from (social desirability) biases and therefore shows lower predictive power than the checklist. However, we found no discrepancy between print exposure checklists and self-report questionnaires when a home literacy composite was used that included a more extensive—and thus more time-consuming—set of questions about the home literacy environment (e.g., the age at which parents started reading, visits to the library and bookstores, number of persons who read to children, parents' ability to mention children's favorite books). The number of books at home—another rather objective indicator of reading volume—reveals effect sizes comparable with print exposure checklists, further stressing the validity of the checklists as indicators of print exposure.

A relatively small percentage of school-aged children and college and university students completed both a print exposure checklist and a self-report questionnaire about their reading activities or home literacy environment. The moderate to strong correlations between both measurement methods implies that there is overlap in the constructs that are measured by the checklists and questionnaires in these age groups. Interestingly, students who indicated preferring reading as a leisure time activity to other activities such as listening to music scored higher on print exposure checklists, whereas students who preferred watching television to reading scored significantly lower on print exposure checklists. Apparently, print exposure checklists distinguish frequent readers from students who are less likely to choose to read during leisure time. Print exposure checklists and simply counting books are also less intrusive measures to administer and easier to score than self-report questionnaires. We conclude that checklists and counting books should be preferred as methods to assess print exposure across ages.

Limitations and Future Directions

There are four main limitations of the current meta-analysis. The first is that the findings overrely on studies conducted in English, whereas different developmental patterns might be found for transparent languages with shallow orthographies.

Second, children from low socioeconomic backgrounds were rarely studied in the youngest age group, probably because researchers expect floor effects on print exposure checklists in families with limited means and/or few literacy activities. We expect effect sizes in the same range as were detected in our meta-analysis if researchers would succeed to create print exposure checklists that are sensitive to children with varying home literacy experiences. In selecting titles or authors, researchers should take into account that preferences for leisure time reading materials may vary across socioeconomic status groups and related factors such as ethnicity.

Third, unlike in the set of studies on schoolchildren and students in which the same respondent completed the checklist as well as outcome measures, the effect sizes in the youngest group of children were not based on a single respondent. Parents completed the checklists, and preconventional readers completed the outcome measures, which precludes the hypothesis that a third factor such as memory skills or intelligence explains the relation between print exposure and cognitive outcomes (Davidse et al., 2010). Interestingly, the effect sizes that are found for primary school children who were administered both a print exposure checklist and an oral language measure ($r = .36$) were almost identical to the effect sizes found when parents of somewhat younger children filled in the print exposure checklists and children completed the language test ($r = .34$). Therefore, there is not much evidence that the associations merely reflect children's general cognitive capacity.

A fourth limitation is that different measures may have different levels of reliability, which may place constraints on correlations with criterion measures. Larger measurement errors may result in lower correlations (Hunter & Schmidt, 1990). However, in the present set of studies, the reliabilities of the measures for print exposure and reading skills were homogeneous and comparably high. For example, the range of reported Cronbach's alpha reliabilities for the print exposure checklists was between .75 and .89, which indicates that 75%–89% of the variance is due to the true score and 11%–25% is due to error of measurement. The reliabilities of reading measures were even higher, with alpha reliabilities centering around .90. Thus, we do not believe that differential reliabilities were problematic.

Future studies should test the possibility of spiral causality in the reading development of children who are followed longitudinally from infancy through to school age or even adulthood. It would be particularly interesting to identify processes that turn sharing books in infancy into choosing to read as a leisure activity in adolescence and adulthood. For instance, we expect that children's attitudes, beliefs, or motivation toward reading are likely to influence and depend on current reading skills as well as previous reading experiences, but this has been examined only in a handful of studies so far (e.g., Baker et al., 1997; DeBaryshe, 1995; Guthrie & Wigfield, 1999; Katzir, Lesaux, & Kim, 2009; Kush et al., 2005; Schutte & Malouff, 2007; Shapiro & Whitney, 1997). Knowing why some children choose to read whereas others do not feel attracted to books might prove useful for the development of successful intervention programs that stimulate skilled as well as less skilled readers of all ages to spend (more of) their leisure time on reading narrative texts.

Conclusions

There is a general belief in society that frequent exposure to print has a long-lasting impact on academic success, as if practicing reading is the miracle drug for the prevention and treatment of reading problems (for reviews, see Dickinson & McCabe, 2001; Phillips, Norris, & Anderson, 2008). This comprehensive meta-analysis of print exposure provides some scientific support for this belief. Our findings are consistent with the theory that reading development starts before formal instruction, with book sharing as one of the facets of a stimulating home literacy environment. Books provide a meaningful context for learning to read, not only as a way of stimulating reading comprehension but also as a means of developing technical reading skills even in early childhood. In preconventional readers we found that print exposure was associated moderately with oral language and basic knowledge about reading. Reading books remained important for children in school who were conventional readers. The meta-analyses suggest that reading routines, which are part of the child's leisure time activities, offer substantial advantages for oral language growth. Interestingly, independent reading of books also enables readers to store specific word form knowledge and become better spellers. Finally, college and university students who read for pleasure may also be more successful academically.

We do not claim that reading more in leisure time is sufficient to turn children into better readers and brighter students in a direct way. Our findings suggest that the relation between print exposure and reading components is reciprocal, as the intensity of print exposure also depends on students' reading proficiency. Print exposure becomes more important for reading components with growing age, in particular for oral language and word recognition. Apparently, children who have developed a reading routine will acquire increasingly more word meanings and word forms from books, which further facilitates their reading development and their willingness to read for pleasure. Such a spiral also implies that readers who lag behind in comprehension or technical reading and spelling skills are especially at risk of developing serious reading problems because they are less inclined to read during leisure time (Stanovich, 1986). With less print exposure, low-ability readers are unlikely to improve their reading and spelling skills to the same extent as their peers who do choose to read. Thus, the reading gap widens, and the Matthew effect becomes ever more forceful. Preventing such a downward spiral for poor readers may be among the major challenges of contemporary reading research. We must find ways to motivate these students and their parents to read more as a leisure time activity. In this respect one of our most promising findings is that poor readers' basic reading skills profit most from reading books in their leisure time.

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