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Reading abilities in school-aged preterm children: a review and meta-analysis

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Abstract

AIM—Children born preterm (at ≤32wk) are at risk of developing deficits in reading ability. This meta-analysis aims to determine whether or not school-aged preterm children perform worse than those born at term in single-word reading (decoding) and reading comprehension.

METHOD—Electronic databases were searched for studies published between 2000 and 2013, which assessed decoding or reading comprehension performance in English-speaking preterm and term-born children aged between 6 years and 13 years, and born after 1990. Standardized mean differences in decoding and reading comprehension scores were calculated.

RESULTS—Nine studies were suitable for analysis of decoding, and five for analysis of reading comprehension. Random-effects meta-analyses showed that children born preterm had significantly lower scores (reported as Cohen's *d* values [*d*] with 95% confidence intervals [CIs]) than those born at term for decoding ($d=-0.42$, 95% CI −0.57 to −0.27, $p<0.001$) and reading comprehension ($d=-0.57$, 95% CI −0.68 to −0.46, $p<0.001$). Meta-regressions showed that lower gestational age was associated with larger differences in decoding (Q[1]=5.92, $p=0.02$) and reading comprehension (Q[1]=4.69, $p=0.03$) between preterm and term groups. Differences between groups increased with age for reading comprehension (Q[1]=5.10, $p=0.02$) and, although not significant, there was also a trend for increased group differences for decoding (Q[1]=3.44, $p=0.06$).

INTERPRETATION—Preterm children perform worse than peers born at term on decoding and reading comprehension. These findings suggest that preterm children should receive more ongoing monitoring for reading difficulties throughout their education.

Significant advances in neonatal care in the 1990s, including the standardization of surfactant therapy use, improved ventilation, and routine administration of antenatal corticosteroids, have led to an increase in the survival rates of neonates born at or before 32-weeks gestation.[1–4] Despite these improved mortality rates, the prevalence of subtle neural injury, and subsequent adverse neurodevelopmental outcomes, in children born preterm has remained largely unchanged.[5–7] Long-term neuropsychological impairments have been well

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documented in preterm children, and these impairments range from major disabilities to subtle deficits in numerous domains of cognitive and intellectual development, including reading.[8–15]

Reading is an essential skill for academic and occupational success.[16,17] Proficient readers tend to read more than less able readers, further improving their reading ability, increasing their knowledge and vocabulary, and reinforcing related language skills. The avoidance of reading by less able readers may impair growth in reading skills and stunt academic potential.[18–20]

Reading has classically been divided into two fundamental component skills: single-word reading, also known as decoding, and reading comprehension.[21,22] Decoding refers to the ability to accurately identify written words and retrieve word-level information from the mental lexicon. Reading comprehension refers to the ability to derive meanings from and form interpretations of written words and sentences. Decoding and reading comprehension skills depend on many of the same underlying cognitive and linguistic abilities;[22–24] however, they are dissociable, partially independent components.[25,26] Decoding stems from primary linguistic skills, such as phonological awareness and alphabet knowledge,[22,27,28] while reading comprehension requires the integration of these linguistic skills with higher-order cognitive processes, such as working memory.[26,29–34] While other domains, such as fluency or morphological awareness, have been related to reading ability, these domains are considered nested within decoding or reading comprehension, or are considered domains of language ability.[26,34] Proficiency in both decoding and reading comprehension is necessary to be a skilled reader,[25] and problems with reading can occur as a result of deficits in either or both domains.[34–37]

Studies investigating reading performance in preterm children have produced inconsistent results. Many studies have found that preterm children perform less well on decoding and/or reading comprehension tasks than their term-born peers.[10,38–42] However, in some studies, the difference between preterm and term groups is not statistically significant.[43–47] Furthermore, contradictory findings have also been reported, with preterm children having greater reading ability than their term-born peers.[48] These contrasting study findings may be partly explained by differences in external environmental factors, such as socio-economic status (SES), which can affect reading and academic ability.[38,49] Additionally, many studies do not differentiate between decoding and reading comprehension when assessing reading ability; findings on whether or not preterm children exhibit deficits in only one or both domains of reading are inconclusive.

Few studies have investigated the development of reading ability in preterm children longitudinally. Results on whether or not impairments exist at a young age, and persist into later childhood and adolescence, are inconsistent.[40,50–52] It is unclear whether or not there is a ‘catch-up’ effect, and whether or not deficits which persist into later childhood and adolescence occur in specific domains. A previous meta-analysis conducted by Aarnoudse-Moens et al., investigating the impact of preterm birth on a wide variety of long-term neurodevelopmental outcomes, reported significantly lower reading ability in individuals born preterm than in those born at term.[53] Their method combined studies investigating neurodevelopmental outcomes in children and adults born preterm and aged between 5 years and 20 years, thus limiting the inferences that can be drawn about reading ability to school-aged preterm children. Moreover, this previous meta-analysis did not investigate each component of reading individually.

The primary objective of this meta-analysis was to determine if there are significant differences in decoding and reading comprehension abilities between school-aged children born preterm or at term in the modern era of neonatal care. The meta-analysis focused on the reading ability of children born in or after 1990, when it is widely accepted that neonatal care practices significantly improved and stabilized.[54] Given the wide range of deficits in the underlying skills associated with reading documented in preterm children,[12,13,55] we hypothesized that children born preterm would perform significantly worse than those born at term on both decoding and reading comprehension tasks. Decoding and reading comprehension were analyzed in separate meta-analyses because different underlying cognitive and neural factors might have affected the developmental trajectory and proficiency of each component throughout early education.[56,57] A meta-analysis on both components of reading is critical, as results may inform about the specificity of reading difficulties in preterm children, and therefore guide future developmental monitoring and intervention.

The secondary objective of this meta-analysis was to investigate whether or not the gestational age of preterm children and the age at which reading abilities were assessed is associated with differences in reading performance between preterm and term groups. Gestational age was examined because previous studies have found that outcomes are more adverse with decreasing gestational age.[58–60] We hypothesized that differences between preterm and term-born children, on both decoding and reading comprehension tasks, would increase with decreasing gestational age of the preterm sample. Age at assessment was also examined because reading ability varies with age. Decoding is a less complex skill than reading comprehension, and early reading instruction tends to emphasize single-word decoding rather than reading comprehension;[22,56] therefore, it was important to clarify whether or not age at assessment influences the group differences found for each of the components of reading. We hypothesized that group differences between preterm and term-born children, in both decoding and reading comprehension, would increase as the age of the sample increased.

METHOD

Study selection

The guidelines recommended by Stroup et al.[61] for reporting meta-analyses of observational studies were followed. Electronic database searches of PubMed, PsycINFO, ERIC, EBSCO Academic Search Premier, SCOPUS, and Google Scholar were conducted by two authors (VNK and JNA). Additional searches of the references of retrieved articles were also conducted. The following keywords were combined using Boolean logic: ‘prematur*’, ‘preterm*’, ‘gestational age’, ‘VLGA’, ‘ELGA’, ‘birth weight’, ‘VLBW’, ‘ELBW’, ‘decoding’, ‘single word reading’, ‘word reading’, ‘reading’, ‘reading comprehension’, ‘passage comprehension’, ‘academic’, ‘child*’, and ‘school*’. Database searches were filtered to include articles published only in English-language peer-reviewed journals between January 2000 and December 2013. Poster presentations, abstracts, and unpublished manuscripts were excluded.

Studies were reviewed and were included in the analyses if they met the following criteria: (1) the mean age of participants was 6 years or older, but less than 13 years (as this is the age range when children are learning fundamental reading skills and problems with reading are likely to emerge);[62] (2) the mean gestational age of preterm children was 32 weeks or less; (3) a case–control design with children born at term was employed; (4) the sample size was 15 or more participants per group; (5) participants were born in 1990 or later, as this is generally accepted to coincide with the beginning of modern neonatal care;[54] (6) assessments were conducted in English, as the opaque orthography of the English language may make comparisons with reading in other languages difficult;[37,63] (7) the study reported mean scores and standard deviations, or a comparable statistic that could be transformed into a mean difference, per group, for either or both decoding and reading comprehension using reliable and validated standardized assessments; (8) decoding was assessed by tasks where children read single words aloud in isolation; (9) reading comprehension was assessed with tasks where children answer questions after reading a passage, or provide missing information in a Cloze (i.e. ‘fill in the blank’) test; and (10) reading assessments were untimed, and stimuli were present for the duration of the task. Studies were excluded from analyses if they did not meet all inclusion criteria.

If multiple studies fitting the inclusion criteria were found to analyze data from the same cohort, the study with the largest sample size was included in the analyses. Larger sample sizes enhance statistical robustness because they are more representative of the whole population.[64] If multiple studies fitting the inclusion criteria analyzed data from the same cohort and had the same sample size, the most recently published study was included. It was decided a priori that corresponding authors would not be contacted to obtain additional data or statistics; however, if available, missing demographic information was extracted from other publications reporting on the identical cohort of the study in question.

Statistical analysis

Comprehensive Meta-Analysis (version 3)[65] was used to conduct all statistical analyses. Individual meta-analyses were conducted for decoding and reading comprehension using a random-effects model. A random-effects model provides a more conservative estimate of effect size than a fixed-effects model when sample characteristics differ among studies.[65,66] For each individual meta-analysis, only one task per study was included to meet the assumption of independence of effect size. Standardized mean differences, weighted by the inverse variance and sample size, were calculated for each study to ensure comparability among the included assessments. When data were provided for subgroups within preterm sample groups, a group mean and standard deviation, weighted by the sample size of the subgroup, was calculated.[67,68]

Effect sizes for each meta-analysis were reported as Cohen’s *d* values with 95% CIs. Cohen’s guidelines specify that *d* values of 0.2, 0.5, and 0.8 represent a small, medium, and large effect, respectively.[69] A negative *d* value indicates that the preterm group performed worse, on average, than the term-born group. A forest plot was constructed to visually represent the weight and direction that each study contributed to the overall effect size. Two statistics were used to quantify heterogeneity: Cochran's *Q* and the I^2 index. Cochrane's *Q* statistic (*Q*), a measure of weighted squared deviations, achieves significance and indicates the presence of heterogeneity at *p* values of less than 0.05. The I^2 index is the ratio of true heterogeneity to all observed variation among included studies. I^2 values of 25, 50, and 75 indicate a mild, moderate, and high level of variation, respectively, as a result of real variation, as opposed to random error.[66,70]

Given our strict search and inclusion criteria, a rigorous investigation into publication bias was performed. A funnel plot and Egger's test were conducted to test for evidence of publication bias. A fail-safe N statistic (FSN) was calculated to estimate the number of negative studies that would be needed to overturn a significant effect size calculated in a meta-analysis.[66] The estimated number of unpublished studies must be greater than five times the number of published studies in order for the FSN to be considered robust.[66]

Subgroup analyses and meta-regressions were undertaken to investigate possible sources of heterogeneity. Subgroup analyses were used to assess the impact of study-level variables on effect size. Exclusion criteria within the studies, based on intellectual disability, major disability, and significant differences in SES between preterm and term groups, were used as subgroup variables. Subgroup analyses were used, as opposed to meta-regressions, for these variables as individual studies used different criteria to index intellectual disability, major disability, and SES. Meta-regressions using a random-effects (unrestricted maximum likelihood) model were then conducted to investigate the effect of gestational age and age at assessment on preterm and term group differences in decoding and reading comprehension. The mean gestational age of the preterm group, and the mean age at assessment of the total sample group (weighted by sample size), were analyzed as possible explanatory variables, and the effect sizes of decoding and reading comprehension were analyzed as outcome variables.

RESULTS

Search results

The electronic database searches identified 712 studies. After reviewing their titles and abstracts, 639 of these studies were excluded. Six additional studies were identified from searching the references of the retrieved articles. Researchers then conducted full-text reviews of the 79 retrieved studies. Eighteen of these studies fitted the inclusion criteria for the decoding meta-analysis, reading comprehension meta-analysis, or both. However, to avoid duplication bias, we excluded seven of these studies as they reported data on the same study cohorts. Nine studies were included in the decoding meta-analysis (Table I),[44,45,67,68,71–75] and five were included in the reading comprehension meta-analysis (Table II).[41,42,67,68,73] A summary of the database search and selection process is shown in Figure 1.

Study characteristics

The following assessments were used in the included studies to measure decoding and/or reading comprehension: Gray Silent Reading Tests;[76] Peabody Individual Achievement Test, revised;[77] Wechsler Individual Achievement Test, second edition (WIAT-II-UK);[78] Woodcock-Johnson III Tests of Achievement;[79] Woodcock-Johnson Tests of Achievement, revised;[80] Woodcock-Johnson Tests of Cognitive Ability, revised;[81] and Wide Range Achievement Test, third edition.[82] These assessments have similar normative scales, with a mean score of 100 and standard deviation of 15. All included studies reported standardized mean scores per group for reading assessments. Additionally, information on exclusion criteria, based on intellectual disability, major disability, and SES for both preterm and term groups, was available for each study. Demographic information, and mean scores and standard deviations for the decoding and reading comprehension analyses, can be found in Tables I and II, respectively.

Decoding

Random effects meta-analysis indicated that preterm children scored significantly lower on decoding assessments than their term peers, with a combined effect size of $d=-0.42$ (95% CI −0.57 to −0.27, $p<0.001$) for the combined effect size. A forest plot and detailed statistics for the individual studies and total effect size for the meta-analysis are shown in Figure 2. A moderate to high level of heterogeneity was found ($Q(8)=24.74$, $p=0.002$; $I^2=67.67$). Funnel plot inspection and Egger's regression intercept ($p=0.27$) did not indicate any publication bias. The FSN confirmed that the result of the meta-analysis was robust (N=230). Subgroup analyses showed that the effect size remained significant upon removal of studies that excluded preterm children with intellectual disability[68] ($d=-0.41$, 95% CI −0.56 to −0.24, $p<0.001$) or with major disabilities[68,71,73,74] ($d=-0.43$, 95% CI −0.54 to −0.32, $p<0.001$). One study reported a significant group difference in SES between preterm and term participants;[72] however, upon removal of this study the combined effect size of decoding remained significant ($d=-0.41$, 95% CI −0.58 to −0.24, $p<0.001$).

Meta-regressions showed that there was a significant association between the mean gestational age of the preterm group and decoding ability ($Q(1)=5.92$, $p=0.02$): the lower the gestational age, the greater the difference in decoding ability between preterm and term children (intercept −2.40, slope 0.08, 95% CI 0.02–0.14, $p=0.02$; Fig. 3a). There was no significant association between the age at assessment and decoding ability ($Q(1)=3.44$, $p=0.06$; Fig. 3b).

Reading comprehension

A random effects meta-analysis indicated that preterm children scored significantly lower on reading comprehension assessments than their term peers, with a combined effect size of $d=-0.57$ (95% CI −0.68 to −0.46, $p<0.001$). A forest plot and detailed statistics for the individual studies and total effect size for the meta-analysis are shown in Figure 2. As expected, significant heterogeneity existed among the studies ($Q(4)=24.48$, $p<0.001$; $I^2=83.66$). Funnel plot inspection and Egger's regression intercept ($p=0.07$) did not indicate any publication bias. FSN confirmed that the result of the meta-analysis was robust ($N=121$). Subgroup analyses showed that the effect size remained significant upon removal of studies that excluded preterm children with major disabilities[41,67] (d=−0.59, 95% CI −1.01 to −0.17, p=0.006), or studies that reported significant group differences in SES[41,42] (d=−0.58, 95% CI −1.01 to −0.14, p=0.01). None of the studies used for reading comprehension meta-analysis excluded preterm children with intellectual disability.

Meta-regressions showed that there is a significant association of the mean gestational age of the preterm group and reading comprehension (Q(1)=4.69, p=0.03): the lower the gestational age of the preterm sample, the greater the difference in reading comprehension between preterm and term-born children (intercept −3.43, slope 0.10, 95% CI 0.01–0.20, p=0.03; Fig. 4a). There was also a significant association of age at assessment and reading comprehension (Q(1)=5.10, p=0.02): the difference in reading comprehension between preterm and term groups increased as the mean age at assessment increased (intercept 0.27, slope −0.09, 95% CI −0.16 to −0.01, p=0.02; Fig. 4b).

DISCUSSION

This meta-analysis confirmed that school-aged children born preterm perform significantly worse than those born at term on both decoding and reading comprehension, the two fundamental components of reading.[21,26] Group differences between preterm and term-born children on reading tasks were not dependent on study-level exclusion of individuals with intellectual impairments, major disabilities, or significant group differences in SES. One novel feature of this study was the investigation of decoding and reading comprehension as separate components. Previous findings by Aarnoudse-Moens et al.[53] found that prematurity affects general reading ability. The present meta-analysis expands this finding by documenting that both fundamental components of reading are affected by preterm birth.

Meta-regressions found that the gestational age of preterm sample was significantly associated with both decoding and reading comprehension abilities: lower gestational ages were associated with greater group differences in the performance of preterm and term groups on each component of reading. Although modern neonatal clinical care has increased the likelihood of survival of children born as early as 23 weeks gestation, it has not eliminated the adverse, long-term sequelae on reading. This finding bolsters previous research describing the negative impact of lower gestational ages on reading and other long-term academic outcomes.[8,39,83–85] One likely explanation for these adverse outcomes is the high rate of neural injury in the very low gestational age preterm population. Preterm infants born at the lowest gestational ages are at greater risk of severe intraventricular hemorrhage, periventricular leukomalacia, and ventriculomegaly than infants born at low gestational ages.[86–88] Furthermore, preterm children born at the lowest gestational ages have high rates of subtle brain injury, such as white matter abnormalities,[89–91] that may elude detection by conventional imaging methods, and may not lead to major disability. In the subgroup analyses, we found no change in the effect size when studies that excluded children with major disabilities were eliminated from the meta-analyses. In future studies, it will be important to consider both major and subtle neurobiological injuries as potentially important factors leading to reading difficulties in preterm children.

Meta-regression analyses on age at assessment found that school-age children born preterm did not 'catch up' with their term-born peers in either decoding or reading comprehension. Although a trend was apparent, age at assessment was not significantly associated with decoding: the overall degree of disparity in performance between preterm and term-born children did not significantly increase or decrease with age. However, age at assessment was significantly associated with reading comprehension: group differences in reading comprehension increased as at assessment increased. The differential developmental trajectories of decoding and reading comprehension in children with typical development may explain the age at assessment meta-regression findings. Decoding stems from fundamental speech, language, and phonological processing, and these skills develop and stabilize at an early stage of education.[22,27,92] By contrast, reading comprehension integrates these same fundamental skills with more advanced cognitive skills, such as inferential deduction, syntactic and semantic analysis, and working memory.[30,93,94] Preterm children have been found to have deficits not only in basic pre-reading skills,[85,95] but also in higher-order cognitive skills.[14,96–100] Additionally, as children age, the level of difficulty and cognitive demands of reading comprehension tasks increases.[101,102] It is likely that, as reading comprehension tasks increase in difficulty, the increasing challenge of integrating higher-order cognitive abilities with reading may explain the widening gap between preterm and term-born children.

One limitation to these meta-analyses was the relatively small number of included studies, particularly in the meta-analysis of reading comprehension. However, there was no significant evidence of publication bias. This small number reflects the paucity of current research investigating reading, particularly the important skill of reading comprehension, in preterm children born in the modern era of neonatal care. A second limitation was that the included studies were limited to those that investigated reading in the English language. Thus, conclusions drawn from the meta-analyses presented here may not extend to reading performance in preterm children who read in other languages, which have varying levels of sound–symbol pairing regularity or transparent orthographies. A trend for an association between age at assessment and decoding was observed, but this trend did not reach statistical significance. This could be, in part, because of the shared variance of decoding with reading comprehension; however, it was not possible to conduct this analysis with the included studies. The meta-regression with decoding and age at assessment was based on a larger number of studies than the regression with reading comprehension, and thus had higher statistical power. Therefore, we would have expected any true difference in this domain to achieve statistical significance. This finding should be reassessed in longitudinal studies, or in larger meta-analyses, in the future. As with all reviews using meta-analytic techniques, the results found in the current meta-analysis are dependent on the preterm and term sample groups in the individual studies.

Future studies should aim to describe the full developmental trajectory of reading in preterm children, from the pre-reading stage up to adolescence, to investigate how various deficits across different academic domains affect, and, in turn, are affected by, decoding and reading comprehension. Additionally, functional and structural neuroimaging studies linking neural substrates to academic impairment could be critical in understanding the relationship between preterm neural injury, and later academic deficit. Studies using neuroimaging data acquired concurrently with reading assessments in young children at the onset of reading acquisition, and during the mastery of reading skills, are needed; such studies may elucidate the neural underpinnings of reading deficits, and compensatory mechanisms in children born preterm.

In summary, children who are born preterm are more likely than children born at term to have deficits in both decoding and reading comprehension. The results of this meta-analysis add to the growing body of literature providing evidence that preterm children continue to exhibit deficits at school age across a wide range of academic and cognitive domains, even with substantial advancements in neonatal care.[8,12,53] There are several important implications of these findings. Early identification of children with poor reading attainment, and early intervention implementation, has been shown to greatly improve reading outcomes in school-aged children.[103,104] High-risk infant follow-up programs often discontinue developmental monitoring at the toddler or preschool stage, prior to formal instruction in reading. Thus, identification of preterm children with impaired reading skills may be delayed, reducing the possible effectiveness of academic interventions. Additionally, educational interventions typically target phonological awareness in order to increase decoding ability, and there are few effective interventions that target reading comprehension.[94,105] Findings that deficits in reading comprehension increase with age in preterm children highlight the need for ongoing monitoring not only in decoding, but also in reading comprehension.[106] Specific interventions designed to improve reading comprehension must be developed, and tested for efficacy in preterm children. Continued investigation into the extent, causes, and consequences of cognitive deficits in the preterm population is vital.

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ABBREVIATIONS

FSN	Fail-safe N statistic
SES	Socio-economic status

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What this paper adds

- This meta-analysis confirms that children born preterm perform worse than children born at term on decoding and reading comprehension.
- It demonstrates that lower gestational age is associated with greater differences in decoding and reading comprehension abilities between preterm and term-born children.
- It shows that, although there is a trend for increased differences in decoding with assessment age, this difference is not significant.
- It demonstrates that group differences in reading comprehension increase with assessment age.

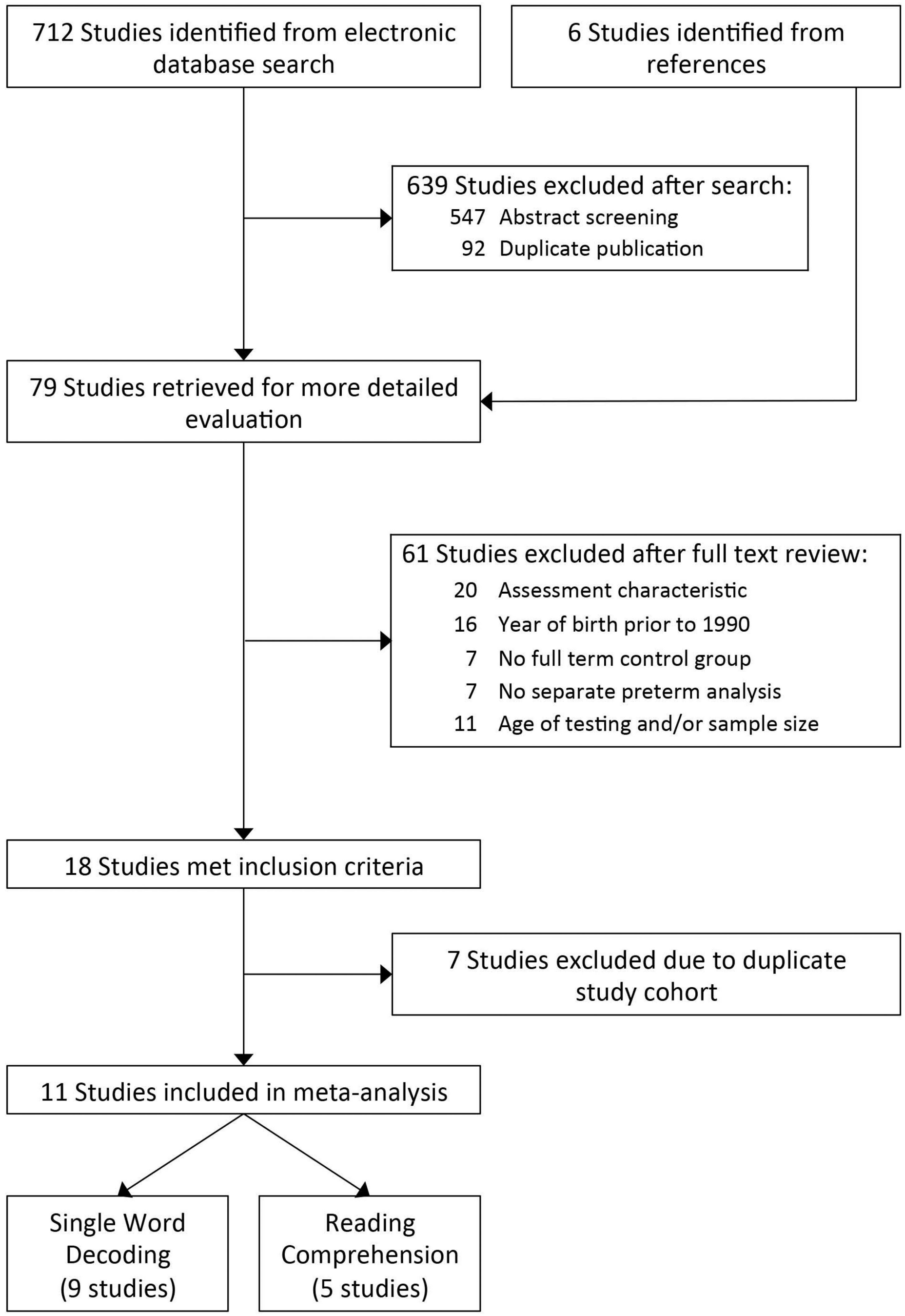
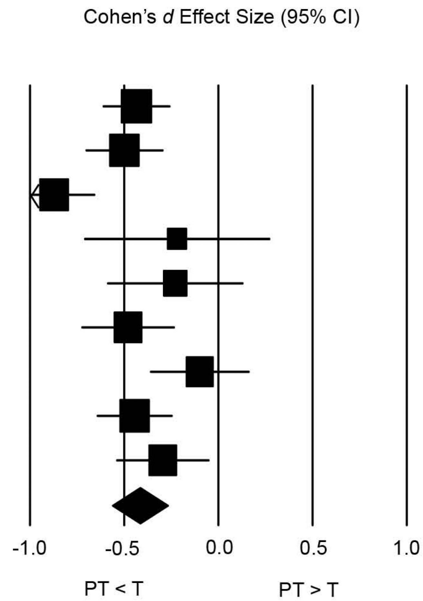


Figure 1.

Flow diagram for all stages of article selection.

Decoding

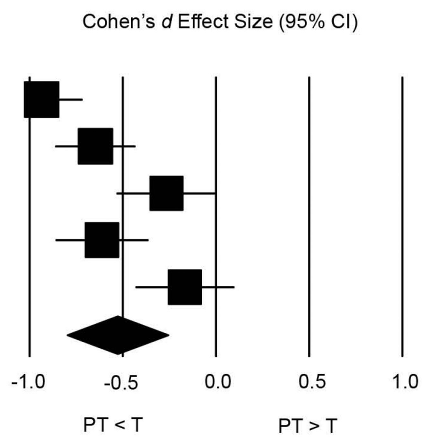
Study Name	Effect Size (95% CI)	*p*	Weight, %
Anderson & Doyle, 2003	-0.435 (-0.62, -0.25)		13.65
Hutchinson et al., 2013	-0.499 (-0.71, -0.29)		12.78
Johnson et al., 2011	-0.872 (-1.09, -0.65)		12.43
Kesler et al., 2004	-0.219 (-0.72, 0.28)		5.81
Rose et al., 2011	-0.229 (-0.59, 0.14)		8.36
Short et al., 2003	-0.479 (-0.73, -0.23)		11.50
Taylor et al., 2008	-0.099 (-0.37, 0.17)		11.00
Taylor et al., 2006	-0.445 (-0.65, -0.24)		12.95
Taylor et al., 2011	-0.295 (-0.54, -0.05)		11.52
Combined Effect Size	**-0.421 (-0.57, -0.27)**	**<0.0001**	



Heterogeneity: Q(8) = 24.74; $p = 0.002$; $I^2 = 67.7$

Reading Comprehension

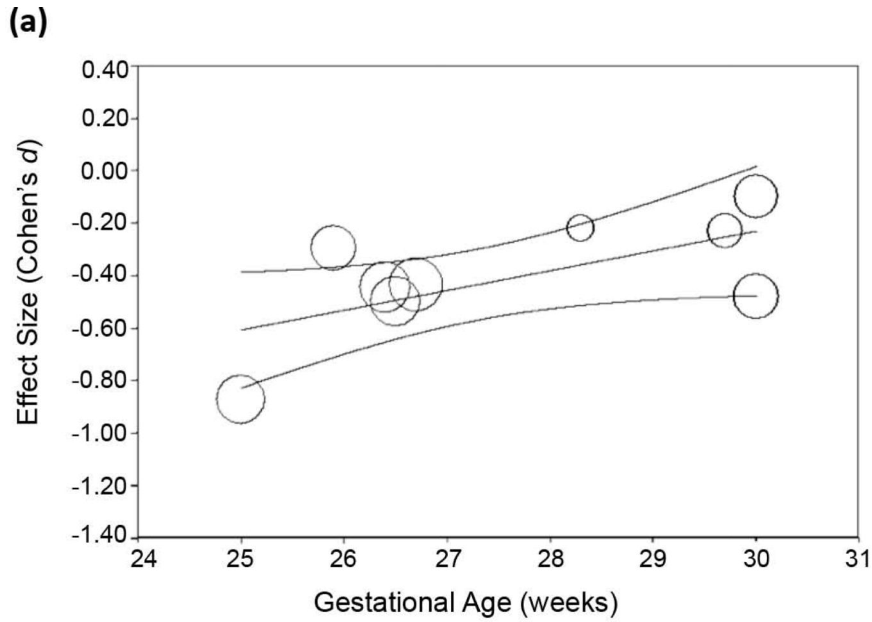
Study Name	Effect Size (95% CI)	*p*	Weight, %
Johnson et al., 2011	-0.936 (-1.16, -0.71)		20.64
Luu et al., 2009	-0.647 (-0.87, -0.43)		20.76
Pritchard et al., 2009	-0.265 (-0.54, 0.01)		19.32
Short et al., 2003	-0.611 (-0.86, -0.36)		19.86
Taylor et al., 2008	-0.166 (-0.43, 0.10)		19.43
Combined Effect Size	**-0.532 (-0.80, -0.26)**	**<0.0001**	



Heterogeneity: Q(4) = 24.48; $p < 0.0001$; $I^2 = 83.7$

Figure 2.

Forest plots of the effect sizes and heterogeneity statistics for decoding and reading comprehension meta-analyses. Negative effect sizes indicate poorer performance on reading tasks for the preterm sample in comparison with the term-born sample. CI, confidence interval; T, term-born; PT, preterm.



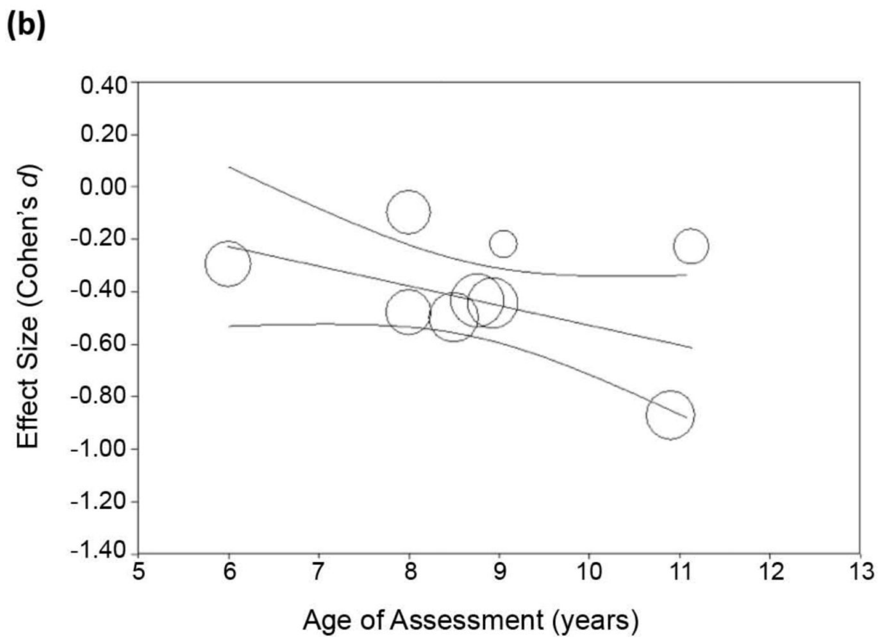


Figure 3.
Meta-regression (slope with corresponding 95% CIs) of decoding effect sizes with (a) gestational age of the preterm sample and (b) age at assessment. Mean gestational age of the preterm sample was significantly associated with decoding. Age at assessment was not significantly associated with decoding.

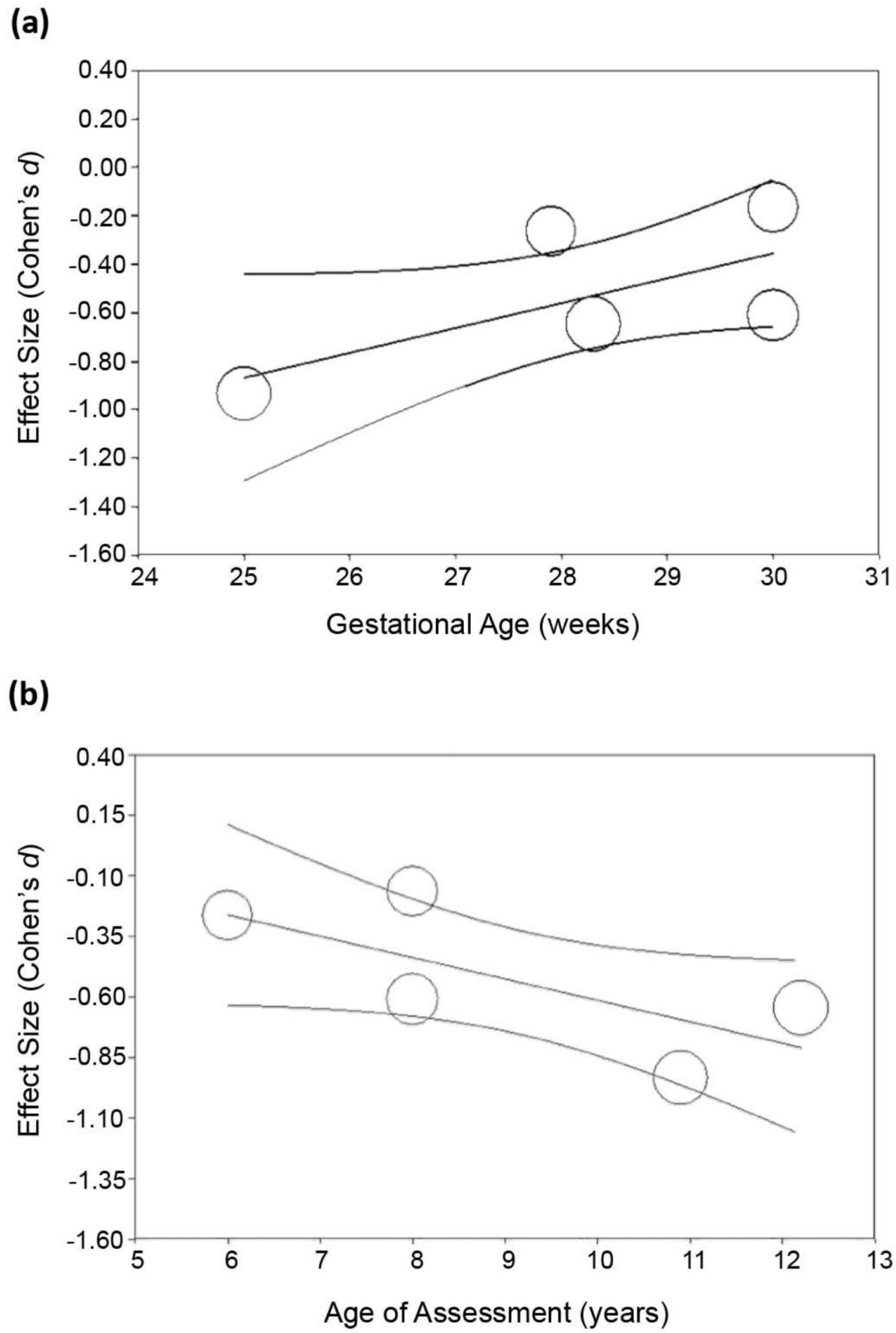


Figure 4.

Meta-regression (slope with corresponding 95% CIs) of reading comprehension effect sizes with (a) gestational age of the preterm sample and (b) age at assessment. Mean gestational age of the preterm sample was significantly associated with reading comprehension. Age at assessment was significantly associated with reading comprehension.

Table I

Characteristics of included studies – decoding

Study	*n*	Mean gestational age, wk (SD)	Mean birth weight, g (SD)	Mean age, y:mo (SD, mo)	Assessment (task)	Mean score (SD)
Anderson and Doyle[71]	259 PT	26.7 (1.9)	884 (162)	8:8 (4)	WRAT-3 (Reading)	96.6 (16.0)
	219 T	39.3 (1.4)	3407 (443)	8:11 (5)		103.3 (14.7)*
Hutchinson et al.[72]	189 PT	26.5 (2.0)	833 (164)	8:6 (5)	WRAT-3 (Reading)	98 (16.1)
	173 T	39.3 (1.1)	3506 (1455)	8:6 (5)		105.5 (13.8)*
Johnson et al.[73]	199 PT	≤25	740 (660,840)[a]	10:11 (5)	WIAT-II-UK (Word Reading)	86.3 (17.3)
	153 T	N/A	N/A	10:11 (7)		99.6 (12.1)*
Kesler et al.[45]	73 PT	28.3 (1.9)	966 (168)	9:2 (8)	PIAT-R (Reading Recognition)	97 (19)
	20 T	N/A	N/A	8:6 (8)		101 (15)
Rose et al.[74]	44 PT	29.7 (2.8)	1165.2 (268.4)	11:2 (5)	WJ-III (Letter-Word ID)	98.0 (14.5)
	86 T	38–42	>2500	11:1 (5)		100.6 (9.8)
Short et al.[67]	173 PT	30 (2)	1256 (176)	8	WJ-R (Letter-Word ID)	94.7 (15.4)[b]
	99 T	40 (1)	3451 (547)	8		102.6 (18.0)*
Taylor et al.[68]	155 PT	30 (2.2)[b]	1127 (148)[b]	8	WJ-R COG (Word ID)	99.3 (20.8)
	83 T	40 (0.4)	3229 (677)	8		101.2 (16.0)
Taylor et al.[75]	204 PT	26.4 (2)	810 (124)	8:8 (7)	WJ-III (Letter-Word ID)	88.6 (17.7)
	176 T	>36	3300 (513)	9:2 (10)		95.7 (13.7)*
Taylor et al.[44]	142 PT	25.9 (1.6)	818 (174)	6:0 (5)	WJ-III (Letter-Word ID)	106.1 (13.5)
	111 T	>36	3382 (446)	6:0 (4)		110.1 (13.5)*

N/A indicates information not available.

*Significant difference between PT and T groups ($p<0.05$).

[a]Median (interquartile range).

[b]Mean and SD are weighted.

PT, preterm children; T, term-born children; WRAT-3, Wide Range Achievement Test (third edition); WIAT-II-UK, Wechsler Individual Achievement Test (second edition); PIAT-R, Peabody Individual Achievement Test (revised); WJ-III, Woodcock–Johnson III Tests of Achievement; WJ-R, Woodcock–Johnson Tests of Achievement (revised); WJ-R COG, Woodcock–Johnson Tests of Cognitive Ability (revised).

Table II

Characteristics of included studies – reading comprehension

Study	*n*	Mean gestational age, wk (SD)	Mean birth weight, g (SD)	Mean age, y:mo (SD, mo)	Assessment (task)	Mean score (SD)
Johnson et al.[73]	195 PT	≤25	740 (660,840)[a]	10:11 (5)	WIAT-II-UK (Reading Comprehension)	85.9 (18.3)
	153 T	N/A	N/A	10:11 (7)		100.6 (11.6)*
Luu et al.[42]	375 PT	28.3 (1.9)	966 (168)	12:2 (5)	GSRT (Silent Reading Quotient)	88.6 (24.8)
	109 T	N/A	N/A	12:8 (10)		104.3 (22.4)*
Pritchard et al.[41]	102 PT	27.9 (2.3)	1071 (315)	6:0	WJ-III (Passage Comprehension)	108.9 (15.6)
	108 T	39.5 (1.2)	3575 (410)	6:0		113.0 (15.5)*
Short et al.[67]	173 PT	30 (2)	1256 (176)	8:0	WJ-R (Passage Comprehension)	97.5 (15.5)[b]
	99 T	40 (1)	3451 (547)	8:0		107.6 (18.0)*
Taylor et al.[68]	155 PT	30 (2.2)[b]	1127 (148)[b]	8:0	WJ-R COG (Passage Comprehension)	98.8 (21.0)
	82 T	40 (0.4)	3229 (677)	8:0		102.0 (15.4)

N/A indicates information not available.

*Significant difference between PT and T groups (p<0.05).

[a]Median (interquartile range).

[b]Mean and SD are weighted.

PT, preterm children; T, term-born children; WIAT-II-UK, Wechsler Individual Achievement Test (second edition); GSRT, Gray Silent Reading Tests; WJ-III, Woodcock-Johnson III Tests of Achievement; WJ-R, Woodcock–Johnson Tests of Achievement (revised); WJ-R COG, Woodcock–Johnson Tests of Cognitive Ability (revised).