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Socioeconomic status and reading outcomes: Neurobiological and behavioral correlates

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Abstract

In this chapter, we examine reading outcomes and socioeconomic status (SES) using a developmental cognitive and educational neuroscience perspective. Our focus is on reading achievement and intervention outcomes for students from lower SES backgrounds who struggle with reading. Socioeconomic disadvantage is a specific type of vulnerability students experience, which is often narrowly defined based on parental income, education level, and/or occupational prestige. However, implications of socioeconomic status extend broadly to a suite of areas relevant for reading outcomes including a student's access to resources, experiences, language exposure, academic outcomes, and psychological correlates. Underlying this constellation of factors are brain systems supporting the processing of oral and written language as well as stress-related factors. We review the implications of SES and reading achievement, and their intersectionality, for the science and practice of reading instruction.

Keywords

cognitive neuroscience; reading; reading instruction; reading intervention; socioeconomic status

INTRODUCTION

Socioeconomic status (SES) is one lens through which to study vulnerability students may experience during reading development. SES is a complex index of a child's access to financial and social resources, two intertwined aspects that are often reflected in a child's home, school, and/or neighborhood (Entwisle & Astone, 1994; Mueller & Parcel, 1981). While reading acquisition is dependent on many student-based characteristics, environmental factors are highly impactful and indeed predictive of reading achievement throughout schooling. SES may indirectly influence many factors relevant for reading outcomes, including a student's access to educational resources, early literacy experiences,

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CONFLICT OF INTEREST

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language exposure, academic skills and resources, and psychological correlates. Underlying this constellation of factors are brain systems supporting the processing of oral and written language, as well as the other contextual factors that often coincide with socioeconomic disadvantage (e.g., stress). In this chapter, we address how SES intersects with reading development by describing their historical relationship in the US educational context, characterizing factors that link SES to reading achievement, reviewing findings on the neurobiological systems that support reading and how they are influenced by SES and early environmental variation, and finally by emphasizing principles, programs, and actions that educators and related stakeholders could take for improving reading outcomes among vulnerable students.

SOCIOECONOMIC STATUS AND READING ACHIEVEMENT

Reading acquisition is based on an accumulation of experiences dependent on language development, opportunities to access print, and social scaffolding and instruction (among others), each embedded within the context of SES. Both school and home settings make the relevance of SES apparent, in topics ranging from ‘the achievement gap’ and special education enrollment to language exposure and books in the home. We explore these and related factors in turn.

The phrase ‘achievement gap’ is commonly used to refer to average differences in reading achievement by subgroups of students, such as by gender, race/ethnicity or family income. These performance disparities often signify inequity in educational opportunities and experiences, which in turn reflect undue restrictions on fulfillment of student potential. The US-based National Assessment of Education Progress (NAEP) tracks achievement gaps based on whether a child qualifies for free or reduced-price lunch, which indexes family income below 185% of the poverty line. Data reveal persistent achievement gaps in 4th, 8th, and 12th grade reading scores that have been relatively consistent in magnitude since data began to be aggregated in 1998 (National Center for Education Statistics, U.S. Department of Education, 2019). These enduring disparities in reading performance across the US emphasize the pervasive and persistent issue in attaining sufficient achievement levels for students. In this way, literacy is an issue highly relevant for equity considerations.

The relevance of children’s early environment is apparent at school entry, when student performance on language-based precursors to reading acquisition differs by SES (Lee & Burkam, 2002; Noble et al., 2007). Children from lower-SES backgrounds (as indexed by parental education, income, and/or occupation) exhibit slower trajectories of literacy growth in the early school years (Hecht et al., 2000), with oral language skills in preschool and Kindergarten strongly predicting reading outcomes in 3rd and 4th grades (Durham et al., 2007; NICHD Early Child Care Research Network, 2005). SES continues to be a robust predictor of reading achievement throughout the school years, and meta-analyses suggest that SES accounts for approximately 10% of the variance in children’s reading skills (Sirin, 2005; White, 1982). Interestingly, children from lower-SES backgrounds are disproportionately identified with learning disabilities, including reading disabilities (Kincaid & Sullivan, 2016; Shifrer et al., 2011; Sullivan & Bal, 2013). It is unclear what drives these disproportionalities, and whether children from disadvantaged backgrounds

may simply be meeting diagnostic criteria more often due to lower scores on standardized assessments. Regardless of the cause(s), it is essential to understand what factors give rise to SES differences in children's early literacy development.

ENVIRONMENTAL FACTORS LINKING SES TO READING ACHIEVEMENT

Because SES is a multifaceted index of an individual's financial, educational, and social resources, there are presumably many ways in which a child's SES background may influence their cognitive and academic development. The bioecological model of development (Bronfenbrenner & Ceci, 1994; Bronfenbrenner & Morris, 1998) proposes that SES is a distal environmental factor that does not directly influence development, but rather does so through children's proximal environments, or their day-to-day environments (e.g., school, home), opportunities and experiences. Several proximal experiences have been found to partially contribute to SES differences in reading achievement.

Children's early literacy experiences are perhaps one of the best-studied set of proximal factors. The home literacy environment (HLE) refers to children's exposure to literacy-related resources, interactions, and attitudes. HLE encompasses measures such as the number of books available in a child's home, the frequency/quality of book reading with the child, caregivers' efforts to teach print-related concepts (e.g., the alphabet), and adults' own modeling of reading practices and attitudes toward literacy (Payne et al., 1994; Sénéchal & LeFevre, 2002). HLE also includes parents' own experience with reading difficulties, which negatively predicts children's later reading fluency, while shared reading in kindergarten is positively associated with reading in later elementary school (Khanolainen et al., 2020).

Several studies have found, on average, SES-related differences in home literacy environment. In terms of material resources, children from lower-SES environments often have reduced access to reading materials in the home and in their communities as compared to their peers from higher-SES homes (Feitelson & Goldstein, 1986; Neuman & Celano, 2001). Even after children enter school, disparate access to reading resources and opportunities has been attributed to the fact that children from lower-SES backgrounds tend to lag in reading development and progress during suspended or interrupted formal learning such as during the summer vacation months (Alexander et al., 2007) and during the COVID-19 pandemic (Tulsa S.E.E.D. Study Team, 2021). Additionally, children from lower-SES backgrounds may not, on average, be read to as frequently or taught early print concepts (Burgess et al., 2002; Karrass et al., 2003; Phillips & Lonigan, 2009). Several studies have revealed that individual differences in HLE partially or fully explain associations between SES and literacy development (Chazan-Cohen et al., 2009; Foster et al., 2005; Hamilton et al., 2016; Kiernan & Huerta, 2008; Krishnakumar & Black, 2002). However, there is also great variability in HLE across families with similar SES backgrounds, such that some children from lower-SES backgrounds experience ample HLE resources and experiences, while some children from higher-SES backgrounds experience reduced HLE resources and experiences. These studies have revealed that HLE predicts children's reading achievement over and above SES indices alone (Bracken & Fischel, 2008; Christian et al., 1998; Gottfried et al., 2015; Payne et al., 1994; Rodriguez & Tamis-LeMonda, 2011; Smith & Dixon, 1995). This finding is supported by a number of

intervention studies that demonstrate that increasing children's early exposure to literacy activities can significantly improve children's reading development, regardless of SES (for review, see Sénéchal & Young, 2008).

A related proximal influence is children's oral language exposure, and specifically child-directed speech. In a landmark study, Hart and Risley (1995) found that children from lower-SES homes heard fewer than a third of the words per hour heard by higher-SES children. This study has received valid methodological criticisms (e.g., Sperry et al., 2018), and more recent studies with less obtrusive technology suggest that the differences are much smaller (see Piot et al., 2021, for a recent meta-analysis) and emphasize that variation is larger within SES groups than between them (Gilkerson et al., 2017). Other studies have shifted focus from the quantity of child-directed speech to the quality, encompassing measures such as syntactic complexity and lexical diversity (Hoff, 2003; Hoff et al., 2002; Hoff-Ginsberg, 1991; Huttenlocher et al., 2002; Naigles & Hoff-Ginsberg, 1998; Rowe, 2008), the contingency of responses and contiguity of conversation (Conway et al., 2018; Goldstein et al., 2003; Hirsh-Pasek et al., 2015; Hoff-Ginsberg, 1991; Reed et al., 2016; Smith et al., 2018; Tamis-LeMonda et al., 2014), and the use of decontextualized language (Rowe, 2012). Rowe and Snow (2020) categorize these qualitative measures of early language experience into three dimensions—interactive, linguistic, and conceptual—which interact with each other across early development. These qualitative measures of oral language exposure predict greater variance in children's language development than quantitative measures (Pace et al., 2017), which in turn predicts SES-related differences in literacy skills later in elementary school (Durham et al., 2007; Marchman & Fernald, 2008; Morgan et al., 2015; Walker et al., 1994). These findings suggest that quantitative and especially qualitative measures of children's early language experience may contribute to SES-related disparities in reading development.

It is critical to note that many structural inequities contribute to disparities in children's early language and literacy environments. Socioeconomic disadvantage, and particularly financial scarcity, can cause immense psychological stress on caregivers (c.f. the Family Stress Model; Conger et al., 2010), which systematically reduces their child-directed speech (Ellwood-Lowe et al., 2022). Families facing economic hardship tend to experience greater environmental stress (Evans & English, 2002). In the context of elevated household chaos, children's language outcomes were negatively associated with lack of routine (linked to fewer learning materials) and having the television generally on (Martin et al., 2012). Furthermore, constraints on lower-income caregivers' time, such as that due to the need for supplemental employment or lack of paid parental leave, physically limits the time they can invest in educational activities such as book reading or teaching early print concepts, which is further exacerbated by reduced capacity to provide material goods that support educational enrichment (c.f., the Family Investment Model; Conger & Donnellan, 2007). A more obvious correlate of lower-SES is access to resources such as books; the number of books that children have in the home and their frequency of independent reading have been linked to growth in expressive vocabulary, reading achievement, and phonological awareness (Johnson et al., 2008). Additionally, caregivers with lower educational attainment may have reduced knowledge of child development and factors that promote cognitive development (Bornstein et al., 2010), which may limit their motivation to provide cognitively stimulating

early environments (Rowe, 2018). These structural barriers and others may intertwine to create learning inequities “at the starting gate” before children even enter school (Lee & Burkam, 2002; Roubinov & Boyce, 2017).

Unfortunately, inequities do not stop at school entry. Horace Mann, a 19th century champion of public education, famously referred to education as the “great equalizer,” but research suggests that vast disparities exist in the quality of public education students receive, especially in the United States. These “opportunity gaps,” or unequal distributions of educational resources, span inequitable access to material educational resources such as libraries and educational technology, as well as intellectual resources such as instructional quality. Children growing up in lower-income families also tend to live in less-resourced neighborhoods with under-resourced schools and educational opportunities such as libraries and after-school programs (US Commission on Civil Rights, 2018). Even when disadvantaged children are provided with equal access to modern, high-quality libraries, children from higher-SES neighborhoods (i.e., communities with less poverty) tend to use these resources more for literacy-enhancing activities (Neuman & Celano, 2006). Furthermore, children attending schools in lower-SES neighborhoods on average are exposed to less complex literacy-supporting language in the classroom (Neuman, Kaefer, & Pinkham, 2018), and teachers in low-resource schools tend to have less explicit knowledge of the linguistic constructs that contribute to literacy, and may thus rely on non-evidence-based instructional practices (Pittman et al., 2020). Combined, these opportunity gaps in school-aged literacy instruction may exacerbate existing disparities from before school entry to create lasting socioeconomic inequities in reading achievement.

Finally, it is important to acknowledge that most of the research on SES disparities in reading involves correlational studies finding associations between demographic and/or experiential factors and language/reading outcomes. However, even well-controlled, longitudinal correlational studies still limit causal interpretations. There are many other factors that may influence children’s reading development, including genetic contributions. Additionally, the reverse relationship may also be true—because literacy is critical to success in much of modern society, low reading skills may limit parents’ job opportunities and thus lead to lower SES. Such inter-generational cycles of disparities are not uncommon. Further research is needed to characterize potential bidirectional pathways between SES and reading development, and to identify the mechanisms of greatest influence, at both the individual and societal level, for targeted interventions.

NEUROSCIENCE OF READING DEVELOPMENT AND READING INEQUITIES

Although the basic architecture of the brain’s reading network is consistent across individuals on average, there is variation across individuals. Many studies have found that individual differences in brain structure and/or function are associated with differences in reading skill and/or reading development. Differences in the brain’s reading network are especially salient in children and adults with reading disorders, who tend to exhibit hypoactivation in temporoparietal and occipitotemporal regions during language and reading tasks, and a possible over-reliance on right hemisphere homologues (see D’Mello & Gabrieli, 2018 for review). People with reading disorders may also exhibit reduced gray

matter in key regions of the left hemisphere reading network (Richlan et al., 2013) as well as reduced connectivity and integrity in the white matter pathways between them (Vandermosten et al., 2012). Importantly, many of these brain differences appear before children learn to read (Clark et al., 2014; Phan et al., 2021; Saygin et al., 2013), suggesting they predate reading experiences.

Several studies suggest that both the structure and function of the reading brain may also vary according to children's early environments. During a phonological processing task, children from lower-SES backgrounds exhibit less left lateralization in the inferior frontal cortex (Raizada et al., 2008). The same region is implicated in children with reading disorders, where lower SES is more strongly associated with reduced cortical thickness than clinically-relevant reading scores (Romeo, Christodoulou et al., 2018). Children from lower-SES backgrounds also exhibit reduced structural and functional connectivity amongst left hemisphere reading regions (Ozernov-Palchik et al., 2019; Su et al., 2021) and reduced cortical surface area throughout the reading network (Noble et al., 2015). However, recent evidence also suggests that SES moderates brain-behavior relationships in reading, such that equivalent reading proficiency may be associated with different neural patterns in children from varying SES backgrounds. Specifically, lower SES is associated with more bilateral activation during phonological processing (Younger et al., 2019) and stronger relationships between phonological skill and phonological activation in the fusiform gyrus (Noble et al., 2006), and between phonological skill and right hemisphere white matter tracts that support visuospatial and orthographic processing (Gullick et al., 2016).

Independent of SES, variations in the home literacy environment are associated with greater activation of left hemisphere reading networks during language tasks (Hutton et al., 2015; Powers et al., 2016) as well as the microstructural integrity of left frontotemporal white matter pathways (Hutton et al., 2020). Furthermore, children's early experience with oral language has been found to correlate with the structure and function of reading networks in children from infancy through elementary school (Brito et al., 2020; King et al., 2021; Merz et al., 2020; Pierce et al., 2020; Romeo, Choi et al., 2021; Romeo, Leonard et al., 2021; Romeo, Segaran et al., 2018), and these neural mechanisms partially explain SES differences in language and reading skills (Merz et al., 2020; Romeo, Leonard et al., 2018; Romeo, Leonard et al., 2021; Romeo, Segaran et al., 2018). While research on SES effects on reading-specific neural networks has primarily focused on the cognitive environment, other factors associated with socioeconomic disadvantage have also been linked to SES differences in brain development, including chronic stress, increased exposure to violence, inadequate nutrition, and exposure to environmental toxins and noise (for review, see Farah, 2017; Olson et al., 2021). Together, these studies suggest that specific aspects of children's early experiences in their environments may have subtle influences on the brain's reading network and inequities in the development of reading skills. Although the majority of this work has focused on early childhood during "sensitive periods" for brain development, there is less work on whether SES-related differences in experience continue to shape the brain's reading networks in later childhood and adolescence, or if differences that develop in early childhood are simply maintained. Further research, and especially longitudinal work, should investigate how SES relates to reading-related brain development across the lifespan.

SOCIOECONOMIC STATUS AND READING INTERVENTION OUTCOMES

While reading and socioeconomic status each exist along a continuum, research studies on reading development and/or difficulties have often captured an asynchronous representation of these factors. Specifically, research on reading outcomes has been most focused on either lower SES and higher reading achievement or mid/high SES and lower reading achievement (see Romeo, Christodoulou et al., 2018). For reading intervention studies, SES has not often been used as a core lens through which to understand individual differences in reading outcomes (see Lam & McMaster, 2014). As a consequence, a gap emerges for understanding low reading achievement and lower SES, that is, readers with two notable vulnerabilities. Similarly, research on the cognitive neuroscience of reading development and difficulties has infrequently addressed the role of SES in reading outcomes (see Barquero et al., 2014). Of the limited work explicitly examining reading difficulty across the full continuum of SES, findings indicated that readers from lower-SES backgrounds and those with more severe reading difficulties showed greater reading improvement and structural brain changes in regions supporting language processing than their peers from higher-SES backgrounds and with less severe reading difficulties (Romeo, Christodoulou et al., 2018). Brain structure changes for children from lower-SES backgrounds presented as greater thickening across left hemisphere occipitotemporal regions, which are core regions of the reading network, and parallel regions in the right hemisphere, which are often considered to be compensatory network regions. Greater benefit found in this summer study for children from lower-SES backgrounds counters other studies, conducted during the school year, showing intervention outcome advantage for children from higher SES backgrounds (Hatcher et al., 2006; Morris et al., 2012; Torgesen et al., 1999). As more research addresses the full range of SES and reading skill, behavioral and neurocognitive evidence will improve our understanding of individual differences as well as opportunities for instructional impact.

Converging efforts and data have identified core components of reading instruction important for all children. The National Reading Panel Report (NICHD, 2000) described five critical components for instruction to address: phonemic awareness, phonics, fluency, vocabulary, and comprehension. For readers who struggle due to reading disabilities, the International Dyslexia Association put forth structured literacy as an approach to delivering effective reading instruction that addresses features of instruction, such as explicit, systematic, intensive, student data-driven, and using targeted assessments (International Dyslexia Association, 2020). Specific considerations are important for struggling readers from lower-SES backgrounds. One distinction to draw is between “skills-based competencies” (e.g., decoding, encoding) and “knowledge-based competencies” (e.g., conceptual and semantic knowledge); the former often an area of dedicated instructional time and the latter less often addressed during literacy instruction (Lesaux, 2012). This distinction is especially helpful in recognizing reading difficulties that can be addressed with a heavier emphasis on one set of competencies over the other. Consistent throughout reading instruction recommendations for vulnerable readers is the directive to clearly identify areas of challenge underlying the difficulty to avoid a faulty one-size-fits-all approach.

Efforts along several fronts have yielded improved reading and related outcomes for students from lower-SES backgrounds. Among the interventions that have been implemented most

widely are structured storybook reading, increasing access to tangible educational resources, providing free formalized instruction to children outside of school, offering children motivational support, and modifying parent beliefs. Interventions focused on enhancing the storybook reading experience for children focus not only on teaching children how to read but also on training parents or teachers to apply interactive storybook reading techniques (e.g., discussing the story narrative, asking open-ended and contextelic questions to encourage children to think about the relationships between story elements, etc.) (Colmar, 2014; Hockenberger et al., 1999; Karweit, 1989; Morgan & Goldstein, 2004; Peterson et al., 1999; Whitehurst et al., 1994). Similarly, programming during the summer, when formal schooling is suspended in the US, has yielded positive gains for students attending high-poverty schools enrolled in programs like READS, which uses a structured program matching books to student interest and level, teaches routines for reading comprehension, engages families, and fosters participation purposefully (Gill, 2018; Kim & Quinn, 2014). Efforts to address reading difficulty in adolescent readers have shown promising outcomes when combining reading and motivational remediation in largely low-to-moderate SES groups (Lovett et al., 2021).

Similar to storybook intervention strategies, other intervention programs that incorporate parent participation have promoted children's achievement. The Even Start Program, which aims to increase lower-SES parents' access to knowledge on child development through federally-funded programs in the community and at home, has been linked to improvements on expressive, receptive, and written language skills (St. Pierre et al., 2005). Other programs have improved child achievement levels by shifting parental mindsets about the impact of early child investments, parental investments and child outcomes, showing positive effects on augmented beliefs associated with enriched parent-child interactions and higher vocabulary, math, and social-emotional skills for the children using an intensive program that included home visitation intervention to low-SES homes (List et al., 2021). In addition to home and school settings, physicians offer important access points for screening and information about literacy for families, with programs such as Reach Out and Read providing books and guidance for book sharing, reaching about 25% of low-income children in the US (Zuckerman & Needlman, 2020).

Continued efforts to support reading progress in vulnerable learners can expand on multiple fronts in the future. Considering student affect is one direction that selected studies have evaluated with students who have reading disabilities, where reading curricula have been supplemented with instruction intended to foster reading motivation and/or address anxiety (e.g., Lazowski & Hulleman, 2016; Vaughn et al., 2021). Another lens has been dedicated to considering sociocultural parameters of a student's background, such as language variability (Washington & Seidenberg, 2021). New research will also have to address research findings of fade-out effects and counterevidence of program efficacy. For example, Durkin et al. (2022) report results from a randomized statewide pre-K program with students who were eligible for free or reduced-price lunch, showing that initial literacy benefit was followed by a fading out of that benefit by the end of Kindergarten and lower achievement through sixth grade compared to students who did not attend pre-K.

CONCLUSION AND FUTURE DIRECTIONS

Learning to read is a singular achievement launched in early childhood, and built on the foundations of language development, formal schooling, home experiences, and associated neurobiological systems. Given the essential nature of reading as a portal to learning in academic and non-academic settings, the difficulty of acquiring reading skills renders children vulnerable in direct and indirect ways. Opportunities to improve both proximal and distal correlates of lower socioeconomic status contexts can start well before formal schooling, for example by fostering children's early literacy experiences. More broadly, countering risk and leveraging resilience warrants contributions from stakeholders in and out of school settings. Insights from education and developmental cognitive neuroscience offer valuable contextualization of experiences associated with SES, particularly regarding plasticity of brain function and structure.

Future research, especially through researcher-practitioner partnerships, will be central to purposefully studying the full range of SES and reading ability, addressing the current gap that has disproportionately constrained new knowledge on the double vulnerabilities of lower-SES and reading disability. Both reading disability and lower-SES are associated with reading challenges, but the distinct mechanisms driving disparities in experiences, resources, and opportunities remain under-examined. Continued research using brain imaging and behavioral tools can help differentiate the impact of these vulnerabilities on reading development, and therefore support the allocation of resources for instruction, identification, and intervention related to reading. Continued efforts to address the systemic factors contributing to reading difficulty among vulnerable learners will build the repertoire of knowledge needed to precisely address the specific mechanisms impacting students.

As a complement to research advances, practitioner stakeholders will be central to future progress. Practitioners can serve as partners in developing and informing research questions, participating in studies, and interpreting and contextualizing research findings. Practice-partners (including educators, clinicians, students and parents/guardians) can integrate evidence-based practices in home and school-based settings to address reading vulnerabilities. This combination of applying and generating new knowledge can support future efforts working toward advancing reading progress for vulnerable readers.

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