Published in final edited form as:

J Appl Dev Psychol. 2019 ; 62: 173–184. doi:10.1016/j.appdev.2019.02.009.

Exploring neighborhood environmental influences on reading comprehension

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Failure to attain adequate literacy skills inhibits school performance and future academic success (Hernandez, 2011), as well as the development of “21st Century skills” needed to function in society (Pelligrino & Hilton, 2013). Yet, results of the 2015 National Assessment for Educational Progress (NAEP), indicated 33% of 4th graders and 42% of 8th graders performed at or below basic reading levels (NAEP, 2015). Reading proficiency is impacted by both genetic and environmental influences (Knopik et al., 2016); however, the full spectrum of these influences has yet to be identified. Analogous to molecular genetic work, where single genetic variants produce trivial effect sizes, but combinations of these genetic variants can be used to create polygenic risk scores with larger effects (Grigorenko, 2013; Keers et al., 2016), identifying environmental components with independently small effects can lead to environmental indices with larger predictive capability (Taylor et al., 2017). With the large percentage of 4th and 8th graders performing at or below basic reading levels (NAEP, 2015), it is crucial to develop indices that better predict environmental variance in reading outcomes. The present study aimed to identify additional environmental influences on reading comprehension using geocoding and behavioral genetic methods, and estimated the contribution of these influences to the shared environment of reading.

To understand the environmental variance on reading, considerable attention has been focused on variables such as family-level characteristics (including pre- and peri-natal risk factors such as maternal smoking), classroom influences, and individual interactions with these characteristics (e.g. Becker et al., 2017; Mascheretti et al., 2018; Nye et al., 2004). The accumulated research on these environmental influences has revealed that they account for a statistically significant portion of the variance in reading outcomes. However, this variance is generally small to moderate in size (<1–40%; e.g. Molfese et al., 2003; Sénéchal & LaFevre, 2002; Griffin & Morrison, 1997; Taylor et al., 2010; Guo et al., 2012; Nye et al., 2004; Cameron et al., 2008; Ponitz et al., 2009) which suggests an incomplete account of the factors that influence reading and indicates other environmental processes may be operating. To increase the total percentage of reading variance that can be explained, novel environmental predictors should be identified and examined.

Though the majority of studies examining specific environmental predictors have focused on aspects of the home or school; substantially less research has focused on broader factors such as aspects of the neighborhood environment. Evidence from the small number of studies in these areas indicate that such factors could be important influences of reading achievement (Milam, et al., 2010; LaPointe et al., 2007). Additionally, Taylor and Schatschneider (2010) examined the influence of neighborhood income on reading, finding higher genetic influences on reading for twins with middle to high neighborhood income and higher shared environmental influences on reading for twins with low neighborhood income. Socio-economic status (SES) represents the potential to access important resources via wealth, power or social status (Sirin, 2005); therefore, lower SES indicates reduced access to resources and higher SES indicates greater access to resources, which potentially influence reading achievement.

Under the well-established ecological systems theory, development occurs through a series of interactions between individuals and environmental contexts. These interactions, termed proximal processes, are defined as aspects of the environment interacting directly with the individual, such as home, family, school, and community influences (Bronfenbrenner, 1994). Furthermore, under the equally well-accepted diathesis-stress model, the risk for developing a condition (diathesis) is hypothesized to intensify with the presence of environmental stressors (stress), suggesting that negative environmental influences may serve to hinder children at-risk for reading disorder, depending on the level of exposure to negative environments (Rende & Plomin, 1992). Both of these theories allow for the potential that community-level aspects such as neighborhood factors could influence reading performance. As a whole, however, there are relatively few scientifically rigorous investigations of neighborhood factors as proximal processes or sources of environmental stress. Beyond SES, neighborhood factors include resources that may serve a support function such as parks, libraries, learning centers (i.e. museums, art galleries, zoos, & theaters) and medical facilities (e.g. Jencks & Mayer 1990, Sampson et al., 2002). Alternatively, potential risk factors that have been indicated include low average SES, crime and violence, pollution, and disorder (e.g. Rosenthal et al., 2015; Calderón-Garcidueñas et al., 2014; Bowen & Bowen, 2002). Identifying neighborhood aspects that pose either as potential protective factors or potential risk factors within the shared environment can help to provide a more complete picture of the possible mechanisms that operate on reading achievement. Although these potential risk and protective features and facilities have been proposed in the literature, to date, no studies have examined neighborhood characteristics beyond SES as measured environmental predictors of reading outcomes while also accounting for genetic influences. This is important because genetic and environmental influences are often confounded when both are shared among family members (Petrill et al., 2004); therefore a design which accounts for genetic influences can more precisely estimate the influence of specific environmental elements.

It is important to note, however, that genetic and environmental influences can be correlated to the extent that genetics apply a degree of control over environmental exposure (Kendler & Eaves, 1986). Genes influence outcomes both directly and through gene-environment correlation where genetics influence exposure to environments and lead to potential genetic influences on the “environment.” With gene-environment correlation, individuals act on the

environment in addition to the environment acting on the individual (Plomin, DeFries, Knopik, & Neiderhiser, 2013). For example, parents with a genetic predisposition towards reading may select neighborhood environments with more access to libraries and other learning centers because they prefer those environments for themselves and for their children. Children of these parents are both genetically and environmentally influenced towards reading achievement, whereas parents with increased genetic risk for poor reading performance may select environments with lower potential for exposure to books and learning centers for themselves and for their children. Despite this limitation, including a measured environmental predictor is a useful technique for estimating the influence of a particular environmental component on the proportion of shared environmental influences present, which was the last step in the current analyses (Miller et al., 2001).

Environmental protective factors

Neighborhood affluence has been repeatedly shown to have a moderate impact on educational outcomes (Shumow et al., 1999; Leventhal & Brooks-Gunn, 2000; LaPointe et al., 2007; Froiland, Powell, Diamond, & Son, 2013) with higher levels of neighborhood SES positively associated with better educational outcomes (Sirin, 2005), suggesting influences of neighborhood affluence such as community stability and concentrated institutional resources contribute to higher achievement (Bowen et al., 2002; Sampson et al., 2002).

Sampson et al. (2002) defined institutional resources as access to recreational centers, libraries and learning centers, medical facilities, and family support centers (Sampson, et al., 2002). In addition to general affluence or community-level SES, neighborhood resources such as parks, libraries, learning centers and other institutional resources may serve as beneficial or protective factors towards school readiness and achievement. Further, when these resources were available to members of the community in abundance so that competition for resources was reduced, neighborhood quality was considered higher (Jencks & Mayer, 1990).

Parks.

Public parks supported by government funding share several common features which promote leisure, emotional well-being, and physical activity (e.g. Kaczynski & Henderson, 2007; Godbey, 2009). Having closer proximity to a park may increase the likelihood of engaging in physical activity for children (Roemmich, et al., 2006), and reviews of the influences of physical activity and exercise on cognition and educational achievement have found trends of increased cognitive outcomes in association with higher activity levels (Chang, et al., 2012; Singh et al., 2012). Further, research has indicated that students with higher levels of emotional wellbeing and social competence display greater academic competence relative to their peers (Welsh, et al., 2001; Zins, 2004; Arnold et al., 2012). Given the initial evidence suggesting public parks improve psychological and physical characteristics associated with educational outcomes as well as overall neighborhood quality, access to public parks is hypothesized as an environmental protective factor associated with academic outcomes.

Libraries.

Recent research has found positive associations between increased public library use and behaviors related to academic achievement (Bhatt, 2010; Clark & Hawkins, 2010). For instance, individuals who visit public libraries more frequently are more likely to read to themselves and to spend more time engaging in shared reading with their children (Bhatt, 2010; Clark & Hawkins, 2010). Moreover, children who spend more time using library facilities exhibit higher rates of homework completion and higher reading comprehension levels than their counterparts (Celano & Neuman, 2001; Bhatt, 2010). In addition, libraries provide technology assistance and internet access which supply critical support to learning and educational outcomes (Becker et al., 2010). However, the amount of time spent utilizing library features may be dependent upon accessibility (Park, 2012). Physical distance between residence and library location among registered library users was a significant determinant of time spent using library facilities (Park, 2012), suggesting proximity to public libraries as an additional protective factor related to academic outcomes.

Art & Science Resources (Learning Centers).

Museums, zoos, art galleries, and theaters have been hypothesized as institutional learning centers which act to improve neighborhood quality and function as protective factors for community residents (Jencks & Mayer, 1990; Sampson et al., 2002). Frequency of learning center visits has been associated with higher literacy scores among elementary, middle and high school students (Borman & Dowling, 2006; Powell, et al., 2012; Weinstein, et al., 2014; Suter, 2014). Interestingly, these relations held when visits to learning centers were between parents and their children and when they were between educational institutions and children, pointing to benefits for educational outcomes across a range of implementation (Powell et al., 2012; Weinstein et al., 2014; Suter, 2014). As suggested by prior evidence, distance to community facilities may have a significant influence on frequency of their use (Park, 2011); therefore, proximity to learning centers highlighted within this section will be examined to investigate their role as protective factors within communities.

Medical Facilities.

Access to adequate medical care has been suggested to substantially influence developmental outcomes that both directly and indirectly influence educational progress such as frequency of school attendance, general cognitive ability, stress, and attention (e.g. Geier et al., 2007; Scheffler et al., 2009; Jackson et al., 2011; Cohen, et al., 2013). Quick and effective diagnosis and treatment are the most reliable predictors of recovery (World Health Organization, 2010). However, in neighborhoods where geographic accessibility to health facilities is limited, health outcomes are generally lower (Yamashita & Kunkel, 2010; Pfeiffer et al., 2011), suggesting proximity to health and support centers as an important environmental protective factor.

Environmental risk factors

Research suggests neighborhood poverty is associated with reduced access to environmental protective factors such as those outlined in the previous section as well as greater exposure to environmental risk factors such as crime or violence, pollution, and disorder (Sampson, et

al., 2002). These potential facets of environmental risk may influence achievement through a multitude of methods such as direct exposure to stressful life events, higher instances of mental and physical illness, and constructing material or psychological barriers between individuals and access to protective institutional, school or other resources (e.g. Shumow et al., 1999; Aikens & Barbarin, 2008; Leventhal & Brooks-Gunn, 2000). Importantly, high rates of community violence have been associated with psychological trauma after controlling for violence in the home, indicating that neighborhood crime influences health and well-being above and beyond family-level conditions (Garrido et al., 2010). Though investigation of neighborhood risk factors in association with academic outcomes is limited, these studies have converged on several features: perceptions of crime, violence, pollution, and disorder (Shumow et al., 1999; Aikens & Barbarin, 2008; Leventhal & Brooks-Gunn, 2000; Sampson, 2002; LaPointe et al., 2007; Rosenthal et al., 2015).

Crime & Violence.

Exposure and perceived exposure to violence and crime has been significantly linked with acute and long term health problems and poor academic outcomes, though the mechanisms through which these influences operate may vary across situations and contexts (e.g. Rosenthal et al., 2015; Sampson, 2002). Neighborhoods and communities with high crime statistics have higher rates of mental and physical health problems, delinquency among youth, school truancy and drop-out rates (Schwartz & Proctor, 2000; Busby et al., 2013; Smith, 2013; Boynton-Jarrett et al., 2013). Experiencing victimization or directly witnessing crimes can lead to psychosocial difficulties such as depression or post-traumatic stress disorder (Garrido et al., 2010) which may interfere with school and learning-related behaviors to the point that grades and grade point averages are significantly decreased (Overstreet & Mathews, 2011). Even without direct exposure to violence, fear of victimization may lead to academic problems through increased stress levels and avoidance of community spaces or routes to protective institutional resources (Milam et al., 2010). Community violence levels can be measured by obtaining municipal crime statistics (Sampson et al., 2002); however measurements have also been developed which attempt to account for community features that are indirectly related to crime and violence (Furr- Holden et al., 2008). Furr- Holden et al., (2008) examined exposure to violence, drugs, and alcohol, through a comprehensive questionnaire and observational assessment of neighborhood characteristics such as presence of drug vials, alcohol bottles and shell casings. Considering the emerging evidence of an association between signs of violence, drug and alcohol use, and academic outcomes (Milam et al., 2010) it is important to extend measures of neighborhood violence to include physical structures related to these factors (i.e. liquor stores, drug rehabilitation clinics, and firearms dealers).

Pollution.

Environmental pollutants in air and water have consistently and substantially been linked with reduced health statuses among adults and children (Peters et al., 1999; World Health Organization, 2005; Schwarzenbach et al., 2010). Even more recently, studies have focused on cognition and achievement outcomes, with the majority of the evidence indicating negative influences for cognitive development and achievement outcomes attributable to exposure to pollution (Calderón-Garcidueñas et al., 2014; Harris et al., 2015), but some

indicating null results for the association (Freire et al., 2010). The accumulating evidence indicates influences may be present; however, further investigation into the association between pollution and cognitive and achievement outcomes is warranted. Sources of pollution most commonly recognized in the literature include landfills, sewage plants, toxic dumps and industrial facilities such as factories and power plants (Rogers, 1996; Kampa & Canstanoğlu, 2008; Calderón-Garcidueñas et al., 2014), indicating a potential for diminished academic outcomes among children living in closer proximity to these types of facilities.

Disorder.

Under the social disorganization theory, disorder at the neighborhood level inhibits access to resources within the community (Bowen & Bowen, 2002). Neighborhood disorder has been characterized by excessive noise pollution, abandoned buildings and ineffective land-use patterns, vandalism, and the presence of homeless persons (e.g. Cohen et al., 1973; Milam et al., 2016). Moreover, noise pollution has been shown to have a negative relation with verbal skills and reading scores (Cohen et al., 1973; Shield & Dockerrell, 2008). Excessive environmental noise may exert negative influences on cognition and achievement through increased stress levels, increased distraction during study or homework sessions, and loss of sleep (Shield & Dockerrell, 2008); however, a systematic investigation of chronic noise exposure and achievement has not been conducted within the United States. Airports, industrial plants and factories, freeways, and public transportation lines are all potential sources of chronic noise that are hypothesized to influence academic outcomes.

Additionally, proximity to shelters and commercial land usage are predicted to negatively influence achievement as suggested by social disorganization theory (Bowen & Bowen, 2002; Sampson et al., 2002).

To better understand how specific neighborhood features influence reading achievement it is important to examine the relation between broad environmental features and achievement by combining existing evidence with novel techniques such as geocoding. Geocoding involves using specialized software (geographic information software or GIS) to map selected locations based on addresses or other attributes (Goldberg et al., 2007). Furthermore, geocoding enables the calculation of spatial analyses such as distance between two or more selected locations (Apparicio et al., 2008). Distance attributes, such as proximity, are commonly used to represent accessibility to a particular location or a potential for interaction between individuals and locations (Park, 2011). Combining distance attributes from neighborhood protective and risk factors can be used to develop an index of neighborhood quality which can then be examined in relation to reading outcomes.

As suggested by the literature, influences from the more proximal home environment account for a larger portion of the variance in reading outcomes than the more distal influences of both teacher characteristics and school environments (e.g., Lindo, 2014; Taylor et al., 2010; D'Agostino, 2000). Defined as proximal influences under the ecological systems theory of development (Bronfenbrenner, 1994), neighborhood features are expected to demonstrate similar patterns of influence to home and school environments. However, because neighborhood resources are more distal than home and school-based environmental influences they are hypothesized to exert lower levels of influence on reading. The present

study extends previous work by combining geocoding and quantitative genetic modeling to develop a more in-depth understanding of the genetic and environmental influences on reading achievement. By evaluating of a number of potential neighborhood characteristics we have the opportunity to examine individual neighborhood influences on reading, which could potentially be combinable downstream in the same way genetic risk scores are developed from individual SNP predictors. It is hypothesized that neighborhood quality will account for a significant, but small portion of the shared environmental influence on reading comprehension. Although a small influence is hypothesized, combining neighborhood influences with other sources of influence from home and school environments can lead to better overall predictions of reading outcomes. Identifying additional sources of environmental influence and combining these with existing sources can achieve greater predictive capability for reading comprehension.

Methods

Participants

Participants were obtained from The Florida Twin Project on Reading (FTP-R), a cohort-sequential twin study (Taylor & Schatschneider, 2010; Taylor et al., 2013). Available achievement data for the FTP-R were collected through Florida's Progress Monitoring and Reporting Network (PMRN), a statewide educational database. For this study, developmental scale scores from the Florida Comprehensive Assessment Test Reading (FCAT) were available for 2215 twin pairs (751 MZ, 1464 DZ) in 3rd through 10th grades (mean age = 13.7 years). Forty-eight percent of participants were female and the racial composition was 49% White, 25 % Hispanic, 18% Black, 1.7% Asian, 4.4% multi-racial and 1.5% other. Sixty percent of participants were eligible for free or reduced-price lunch (FRL).

Procedure and measures

This study was approved by the university's Institutional Review Board prior to data analysis. Zygosity was determined via a parental five-item questionnaire on physical similarity (Lykken et al., 1990). Reading comprehension (FCAT) data and family-level SES, determined by students' eligibility for free or reduced price lunch, were obtained from the PMRN for the 2013–2014 school year. Addresses for 2141 twin families were obtained from the FTP-R (Taylor & Schatschneider, 2010; Taylor et al., 2013) and geocoded using ArcGIS 10.4 software. All online searches for neighborhood variables were conducted between the months of February and May of 2016. Additional variables such as community-level SES and crime statistics were obtained at the census block group level and city level, respectively.

Measures

FCAT reading.—The Florida Comprehensive Assessment Test (FCAT) consists of criterion-referenced assessments in mathematics, reading, science, and writing that measures student progress toward meeting the Sunshine State Standards benchmarks (Florida Department of Education, 2001). Administered by trained school staff, the FCAT was completed by Florida students in Grades 3–10 within the spring of each school year. The reading comprehension subtest contains six to eight narrative or expository passages, with comprehension of each passage assessed through multiple choice, short-response or

extended-answer questions. This assessment has established reliability, with a reported Cronbach's alpha of .90 (FLDOE, 2005). Construct validity has been determined through correlations with several other established reading comprehension measures such as the Stanford Achievement Test – 9, with correlations of .86 in 4th grade and .95 in 8th grade, indicating that FCAT is a representative measure of reading comprehension skill (Schatschneider et al., 2004; Stanley & Stanley, 2011; Greene, 2001).

SES.—Family-level SES was determined by eligibility status for free or reduced price lunch (FRL) as reported in the PMRN. Family-level SES is a tri-level variable (0=not eligible, 1=eligible for reduced price lunch, 2=eligible for free lunch) which is coded so that higher scores indicates lower SES. Community-level SES was determined by average household income reported within census block group level from the U.S. Census Bureau's American Community Survey (ACS; U.S. Census Bureau 2014). Income statistics from the ACS used 5-year estimates ending in 2013, which overlapped with the 2013–2014 school year in which FCAT scores were attained.

Participant addresses.—Addresses for 2141 twin families were obtained from the FTP-R (Taylor & Schatschneider, 2010; Taylor et al., 2013). Addresses were then geocoded using ArcGIS software and used to calculate Euclidean distance between participant's homes and neighborhood facilities.

Environmental protective factors:

Parks.—A list of physical addresses for 575 parks, nature preserves and trails listed as properties under the management jurisdiction of the State of Florida, Department of Environmental Protection Division of Parks and Recreation (Florida Department of Environmental Protection) was obtained from the website <http://www.dep.state.fl.us>. Where street addresses were not available, latitude and longitude coordinates were used to pinpoint a location within ArcGIS.

Libraries.—All branches of Florida public libraries were located using the National Center for Education Statistics (NCES) database which included physical addresses for libraries among all of Florida's counties (<https://nces.ed.gov/surveys/libraries/>) for use in pinpointing library locations. Five hundred and forty one libraries and physical addresses were located within the State of Florida.

Learning centers.—Public and private facilities established to share art and knowledge with the public were included in the search for learning centers. These included museums of history, art, science and culture, theaters and performing arts centers, zoos and art galleries. One hundred and twelve theaters were located using online blog sources such as <http://florahomeusa.blogspot.com/>, 394 museums and 46 zoos were located from the Florida Association of Museums website (<http://www.flamuseums.org/>). Physical addresses were provided via the online sources, or through separate browser searches when necessary.

Medical facilities.—The search for medical facilities included both public and private hospitals, health clinics and public health departments located within the State of Florida.

Physical addresses for 344 medical facilities were located through the <http://floridahealth.gov> website.

Environmental risk factors:

Crime statistics.—The total number of reported violent crime incidents (i.e. murder, forcible rape and aggravated assault) and property crime incidents (i.e. burglary, larceny-theft) for 2013 by city for the State of Florida were obtained from the Federal Bureau of Investigation (FBI) website: <https://www.fbi.gov>. On an annual basis, the FBI collects data from local city and state police jurisdictions; however, there are several limitations for using crime statistics at the census block group level as reported by Applied Geographic Solutions (AGS) methodology for determining crime risk (http://downloads.esri.com/esri_content_doc/dbl/us/AGS_CrimeRisk_2014A_Methodology.pdf). The report states that the FBI does not use census bureau codes in their agency documentation, which potentially leads to errors in assigning crime occurrences to smaller geographic areas such as census block groups. Further, reporting may be inconsistent between police jurisdictions which may lead to some suppression of statistics where boundaries are uncertain. Therefore, crime statistics were obtained at the city level in order to increase reliability.

Liquor sellers.—Liquor licenses were restricted to wine and spirits sales and did not include bottle clubs, breweries, importers and exporters of alcoholic beverages, makers and manufacturers of alcoholic beverages or beer sales only. A complete list of active wine and spirits licensed brokers within the State of Florida was obtained from <http://www.myfloridalicense.com/> public records database. The total number of active and delinquent licenses included 9,826 salespersons with physical addresses.

Firearm dealers.—Gun dealers were identified as any individual, partnership or corporation with an active Federal Firearm license (FFL) associated with a Florida physical address. An FFL license allows license holders to buy, sell and make firearms (Florida Bureau of Alcohol, Tobacco, Firearms and Explosives). The list of FFL holders includes pawnbrokers or other firearms dealers and firearms and destructive device manufacturers, dealers and importers. The list of 3,125 active licenses and addresses in the State of Florida was obtained from <http://fflgundealers.net/transfer/florida/>.

Superfund sites.—Sources of pollution identified through the U.S. Environmental Protection Agency National Priorities List or “Superfund” sites (CERCA, 1980) were located using the U.S. EPA website (<https://www.epa.gov/superfund/superfund-national-priorities-list-npl>). The U.S. EPA identifies 53 Superfund sites within the State of Florida and addresses or latitude and longitude coordinates were matched to all locations.

Landfills.—Landfills are divided into three classes with Class I landfills representing those that receive 20 or more tons of solid waste per day, Class II landfills representing facilities that receive less than 20 tons of solid waste per day and Class III landfills representing facilities that receive “yard trash, construction and demolition debris, waste tires, asbestos, carpet, cardboard, paper, glass, plastic, furniture other than appliances, or other materials approved by the Department which are not expected to produce leachate which poses a

threat to public health or the environment.” (Florida Administrative Code Rule 62–701.340(3)). One hundred and eighty-six Class I, 171 Class II, and 127 Class III landfill sites were located through the Florida Department of Environmental Protection Solid Waste Management, website (http://www.dep.state.fl.us/waste/categories/solid_waste).

Wastewater facilities.—Both domestic and industrial wastewater facilities along with their physical addresses were located through FDEP website <http://www.dep.state.fl.us/water/wastewater/facinfo.htm>. Wastewater facilities treat and handle industrial run-off, biosolids management, reuse of reclaimed water, and surface water run-off from sources like percolation ponds or spray fields for over 2.5 billion gallons of water per day. The FDEP database provided information and physical addresses for 1,492 wastewater facilities.

Industrial facilities and commercial buildings.—Physical addresses for 2,611 factories, warehouses, industrial facilities, distribution centers, hangars and commercial office buildings both active and for lease or sale were collected from <http://www.enterpriseflorida.com/>, a website maintained by economic development company Enterprise Florida, Inc.

Shelters.—A list of 155 homeless resources including homeless shelters, transitional resources and low cost and free alcohol and drug treatment rehab centers within the State of Florida were obtained from the online resource: <http://www.homelessshelterdirectory.org/>. Addresses for all resource facilities were located by browsing the shelter or social service website or through a separate browser search.

Neighborhood distance.—Physical addresses for parks, libraries, learning centers, medical facilities, potential sources of pollution, industrial facilities, homeless shelters, airports and commercial buildings were used to calculate Euclidean (straight-line) distance in meters from each participant’s home address using geocoding analyses.

All online searches for protective and risk factors were conducted between the months of February and May of 2016. Due to the timing of the searches some identified facilities may have opened or begun operation sometime after the 2013–2014 school year in which the FCAT scores were obtained, though it is unlikely that many new facilities were established within a two-year duration. For example, 10 new grants were issued by the Florida Department of State Division of Library and Information Services during the 2014–2015 and 2015–2016 fiscal years, resulting in several renovations and expansions, but only 5 new library facilities, 2 of which remain under construction as of 2016 (Florida Statutes (Rural Economic Development Initiative)). Moreover, some facilities that were open and operating during the 2013–2014 school year may have since closed and were not identified within the current search, though the rate of hospital closures and other potentially publicly funded sites such as libraries is low (Capps, Dranove & Lindrooth, 2010). Additionally, while some landfill or wastewater facilities were listed as closed in 2016, they may have been active in 2014 and the potential for pollution from closed sources may also be significant (Westlake, 2014). In general, the locations included in the present study are likely to represent the neighborhood composition during the time in which the participant’s reading scores were gathered.

Analyses

Descriptive analyses, including means, standard deviations, ranges, and skewness were conducted for all variables. In cases where assumptions of normality were violated, variables were transformed using appropriate techniques. Because influences of age and gender were not the focus of this study, FCAT reading scores were regressed on age, age-squared and gender as outlined by McGue and Bouchard (1984), and those corrected scores were used in subsequent analyses. Correlations between neighborhood variables and FCAT were examined to determine candidates for neighborhood quality. Next, hierarchical regression was conducted to determine which of the neighborhood variables were significantly correlated with FCAT and should be retained for biometric analyses.

Using a classical twin design to compare known genetic and environmental relations between MZ and DZ twins a univariate Cholesky decomposition model was conducted to decompose FCAT reading scores into relative proportions of additive genetic influences, shared environmental influences (those that increase similarities between twins); and non-shared environmental influences (those that decrease similarities between twins; plus error. Twin studies compare monozygotic (MZ) twins, who share 100% of their segregating genetic material, to dizygotic (DZ) twins, who share approximately 50% of their segregating genetic material (i.e., additive genetic influences; Plomin et al., 2013). Both MZ and DZ twins who are raised together are assumed to share 100% of their shared environmental influences. Using these known genetic and environmental relations between MZ and DZ twins the variance in a trait of interest can be decomposed into additive genetic influences, shared environmental influences and non-shared environmental influences. To the extent that MZ twins are more similar than DZ twins on a particular outcome, additive genetic influences, labeled heritability (A), are assumed and when MZ twins are less than two times as similar as DZ twins are on a particular trait, shared environmental (C) influences are inferred. When correlations between MZ pairs do not equal one, non-shared environmental influences (E) are indicated. Next, to explore whether neighborhood quality accounted for a portion of the shared environmental influences on reading, we conducted a model which estimates the proportion of variance in reading predicted by neighborhood, while simultaneously estimating A, C, and E (Petrill et al., 2004). These analyses were conducted both with and without controlling for the influence of community-level SES on FCAT reading. In control model, community-level SES was regressed on FCAT reading before entering FCAT into the final model. The difference in the shared environmental estimates between the two models indicates the influence of community level-SES on FCAT reading. Additionally, by controlling for community-level SES, the influence of neighborhood quality can be separated from its correlation with SES to obtain a more accurate estimation of the association between neighborhood quality and reading achievement.

Results

All data were examined for outliers, skewness, restriction of range, and missing values using SAS 9.4 (SAS Institute Inc., 2014). Across the neighborhood distance variables extreme univariate outliers were identified and removed for class I, II and III landfills, vacant commercial properties, theaters, wastewater facilities, libraries, industrial sites, superfund

sites and parks. Examination of the outliers revealed they were extreme cases in which facilities were greater than 75 miles from any participant addresses and in which the environmental feature could not be considered part of a neighborhood for any participants. Where skewness was above 2, values greater than 3 standard deviations from the mean were removed in order to normalize the distribution of these variables. These corrections were performed for firearms dealers, liquor stores and bars, and museums, resulting in skewness values less than 2. Table 1 displays the descriptive statistics for all neighborhood distance variables and crime statistics. Standard deviations revealed that variation from the mean ranged from less than a mile from participants' homes to approximately 37 miles from participants' homes. Further, inspection of standard deviations represented approximate tertiles, quartiles or greater of the range of values, indicating little to no restriction of range across neighborhood variables. Distance values were generated for all addresses in ArcGIS; therefore, missing values were only present in cases where outliers were removed, composing less than 10% of the sample. For crime statistics, all skewness values fell within an acceptable range. Additionally, for crime variables, standard deviation values suggested no restriction of range was present.

Correlations among neighborhood distance variables are listed in Table 2. With the exception of class I and III landfills, superfund sites and wastewater facilities the correlations indicated distances between participants' homes and neighborhood features were significantly positively correlated with each other, suggesting the hypothesized features clustered together and were representative of neighborhood characteristics. For class I and III landfills, superfund sites and wastewater facilities correlations were lower, suggesting that these features were farther away from twin's homes and possibly from central locations. Correlations between FCAT reading and neighborhood variables revealed significant positive associations between distance to firearms dealers and distance to shelters and FCAT reading scores (see Table 3). These significant positive correlations indicated greater distances between participants' homes and these neighborhood features were associated with higher FCAT reading scores. Distance from Class II landfills and FCAT reading were significantly negatively correlated when one random twin was selected for analyses, but not the other (although both correlations were similar in magnitude). Table 3 displays correlations between family and community-level SES with neighborhood features. Proximity to parks, zoos, class III landfills, superfund sites, wastewater facilities and industry were associated with higher community-level SES and proximity to shelters, firearms dealers and bars or liquor stores was associated with lower community-level SES. Having higher family- and community-level SES was associated with higher FCAT scores (Table 4).

Assessing the relation between neighborhood quality and reading.

In order to examine whether neighborhood protective and risk factors are significantly associated with FCAT reading¹, hierarchical regression was conducted, using one randomly selected member of the twin pair. Family-level SES and community-level SES were added

¹Results were repeated with the co-twin to control for dependence of data. The pattern of results was consistent across both sets of analyses suggesting the findings were robust.

as covariates into the first block and parks, firearms dealers, Class II landfills, and shelters were entered into the second block. Results of the hierarchical regression are presented in Table 5. Results indicated that the variance accounted for by the first set of variables (SES) equaled $R^2 = .053$, accounting for 5% of the variance in FCAT reading. The addition of parks, firearms dealers, Class II landfills and shelters accounted for an additional 2.9% of the variance in FCAT reading. Community-level SES was a significant predictor of FCAT reading, and outside of the covariates, proximity to shelters was significantly associated with lower FCAT reading scores. Unique R^2 estimates indicated shelters contributed to less than 1% of the variance in FCAT reading. The difference between unique R^2 estimate and the total R^2 for Block 2 could potentially be explained by suppression influences from the SES variables in the model. Suppressor variables are often correlated with other, third-party variables associated with the outcome and can increase the predictive ability of other variables when included in regression analyses (Thompson & Levine, 1997). Of the proposed neighborhood variables, distance to shelters was the sole predictor of FCAT reading and the only neighborhood variable included in the biometric analyses.

Following the initial selection of neighborhood variables, a univariate biometric model was fit using Mx (Neale et al., 2006) to obtain estimates of A, C, and E on FCAT reading. Results from this model indicated significantly large genetic ($A = .47$), and moderate shared environmental ($C = .34$), and non-shared environmental ($E = .19$) influences were present. Next, the biometric model was re-fit with distance to shelters included as a predictor of FCAT reading. This model allowed for the estimation of genetic and overall environmental influences on FCAT, as well as the estimation of the specific environmental effects of shelter proximity. In this model, shared environment was composed of the variance accounted for by the known environmental variable, distance to shelters, as well as the remaining shared environmental variance from additional unidentified sources of variance. Results of both models are displayed in Table 6. Shelter distance accounted for a significant, but small proportion of the total influence (.6%) on FCAT reading and (2%) shared environmental influences on FCAT reading. Distance to shelters was predictive of FCAT reading over and above SES within the phenotypic analyses; therefore, SES was not included in the first set of biometric analyses. When community-level SES was included in the analyses shelter distance accounted for a smaller, yet still significant portion of total variance (.4%) and shared environmental variance (1%). These values were calculated from the estimates in Table 6 by dividing the estimate of influence for shelter distance (.006 or .004) by the sum of the shared environmental estimate and the estimate of shelter distance (.33 + .006) or (.004 + .27).

Shared environmental influences dropped from .334 to .277 when controlling for SES, indicating the influence of SES on achievement accounted for approximately 6% of the shared environmental influence. A post-hoc examination revealed that within a subsample of twins ($n = 756$) who completed a 7-item questionnaire about neighborhood safety, shelter proximity significantly predicted lower neighborhood safety ratings over and above community-level SES $b = -.07$, $t(754) = -2.08$, $p = .038$; [$b = -.08$, $t(755) = -2.25$, $p = .025$ without controlling for community-level SES]. Additionally, in a post-hoc examination of 2012–2013 school-level attendance rates, shelter proximity predicted a higher percentage of absenteeism above and beyond community-level SES $b = -.06$, $t(1343) = -2.33$, $p = .02$; [$b =$

-.07, $t(1344)=-2.49$, $p=.01$ without controlling for community-level SES] and neighborhood safety ratings were not significantly predictive of school attendance, $b = -.04$, $t(262)=-0.66$, $p=.51$; [$b = -.06$, $t(263)=-1.03$, $p=.302$ without controlling for community-level SES].

Discussion

This study supplied evidence that shelter proximity is negatively associated with reading scores, supporting the hypothesis that shelters may represent aspects of neighborhood risk for achievement. Under social disorganization theory, indications of neighborhood disorder such as the presence of homeless persons, broken bottles, drug paraphernalia, litter and signs of vandalism exert a negative influence on educational behavior (Bowen & Bowen, 2002; Sampson et al., 2002). Shelters may serve as attractors or collection points for these and other negative influences. The negative association between shelters and reading may occur through indirect (i.e., increased stress, reduced physical and mental health) or direct (i.e., exposure to violence) processes which are discussed within the next sections in greater detail.

Shelters in this study included homeless shelters, free and low-cost alcohol and drug rehabilitation centers, domestic abuse shelters, and services such as food banks or soup kitchens. The population served by these facilities is often homeless, transient or experiencing severe crises which lead them to seek assistance (Robertson & Greenblatt, 2013). These individuals, estimated at 2–3 million in the U.S. and between 35,000 and 45,000 in Florida (2015 Report, Council on Homelessness; Shelton et al., 2015), are commonly characterized by high levels of poverty, joblessness, mental disorder, drug addiction or alcoholism, and social-adjustment issues (Shelton et al., 2015). The shelters established to provide temporary aid to these individuals are frequently overcrowded, in poor physical condition, and associated with crime and health concerns (Gilderbloom et al., 2013). Furthermore, emergency shelters, the most common type of shelter facility, may limit visits to overnight hours, leaving individuals unsheltered, but nearby during the day (Gilderbloom et al., 2013). The combination of risk factors associated with individuals utilizing shelter facilities and the shelter conditions may result in greater perceptions of disorder and lowered perceptions of safety for residents living nearby (Milam et al., 2016). Specifically, greater instances of poverty, drug and alcohol abuse, and mental disorder among those seeking shelter services may lead to behaviors which increase disorder and chaos in the surrounding neighborhood.

Lower perceptions of neighborhood safety have been shown to negatively influence sleep quality, increase stress, and reduce overall health quality (Singh & Kenney, 2013; Ross, 2000; Weir et al., 2006; Rosenthal et al., 2015). Heightened levels of fear and stress may disrupt sleep patterns for children, leading to difficulty concentrating in school or on homework (Sadeh, 1996; Taras & Potts-Datemah, 2005). Moreover, long-term sleep deprivation increases risk of illness, disease, social and behavioral disorders, as well as deficits in cognitive functioning, which have been associated with reading comprehension difficulties (Roberts et al., 2009). Disorder may be a mechanism through which shelters influence surrounding residents' mental and physical health, sleep patterns, and reading achievement (e.g. Milam et al., 2016). The current results provided additional supporting

evidence for the negative association between disorder and reading comprehension as well as enhanced knowledge of which neighborhood features may be associated with disorder, although future research should further assess indirect influences on reading.

Apart from indirect influences, safety concerns may directly prevent children from attending school, resulting in decreased instructional time and subsequently lower reading scores (e.g. Milam et al., 2010; Gottfried, 2009). The post-hoc examination of 2012–2013 school-level attendance rates, indicated shelter proximity predicted a higher percentage of absenteeism above and beyond community-level SES. Neighborhood safety ratings were not significantly predictive of school attendance, however, suggesting other factors influenced attendance. Lower attendance rates may result from a higher likelihood of risk behaviors in children living near shelter populations, from other, as of yet, unidentified influences associated with proximity to shelters or from other family or school-level influences. Attendance rates were available at the school-level, but not the individual level for the present study. Future research may benefit from including student-level attendance data to examine individual differences in attendance in relation to shelter proximity and reading outcomes.

Within the current study, shelter proximity explained a small, yet significant proportion of shared environmental influences on FCAT reading, suggesting shelters may be associated with chaotic conditions in the neighborhood, which may have important consequences for children's reading comprehension. Few genetically sensitive studies have examined specific sources of shared environmental influence on reading, although it is important to note that the current findings, while unique, lend support to these studies. Previous studies have suggested that chaotic home environments influence children's reading skills through noise, disruption and distraction as well as potentially indicating increased parental disorganization or stress (Petrill et al., 2004, Hart et al., 2007, Taylor & Hart, 2014). Chaos in the nearby, external environment may influence children's reading in similar ways. For instance, noise or other distractions may influence children's ability to concentrate while reading books, limiting the time in which children engage in reading at home (Griffin & Morrison, 1997). Additionally, external disorder and chaos may distract children in the same ways in which chaos in the home could, preventing them from completing reading-related homework assignments (Hart et al., 2007). A study identified overlapping shared environmental influences between reading and homework behavior, although the sources of overlap are presently unknown (Little et al., 2014). External chaos levels could explain a portion of this overlapping variance. Moreover, external chaos and disorder may lead to increased chaos within the home, or may act additively with home chaos to influence children's reading outcomes.

It is additionally possible that proximity to shelters is associated with FCAT reading in ways unrelated to disorder or chaotic environments. The results of the hierarchical regressions revealed that distance to shelters accounted for a portion of the variance in FCAT reading after controlling for community-level SES, suggesting the association was did not merely represent a lack of resources due to lower socio-economic conditions. Although, the association between shelters and reading could still be driven by some other factor such as "urbanity" which is also related to SES, as suggested by the potential suppression effects. Shelters are often located in low-income, industrial areas (Gilderbloom et al., 2013);

however, it is important to note that in the present study, neither distance to industrial facilities nor to commercial buildings was predictive of FCAT reading scores. Further, shelters served as significant predictors of FCAT reading after accounting for the influences of family and community-level SES, suggesting that shelter conditions, not their locations in cities are associated with children's reading outcomes, though the exact mechanisms are not yet clear. Future studies will benefit from examining the association of shelters with reading while testing additional covariates such as urbanity or a relevant proxy, drug crime, substance abuse, stress, mental and physical health, and sleep patterns. Furthermore, future studies could conduct dose-response analyses of the association between reading and proximity to shelters to identify if a differential association exists above or below a certain threshold of proximity.

Distance to shelters, though significant, accounted for less than 1% of the total variance over and above community-level SES which accounted for approximately 5% of the total variance, supporting the hypothesis that neighborhood features would account for a smaller portion of the variance than more proximal features such as home and school environment. Despite their small association, shelters mark an additional component of environmental predictors of reading and contribute to a larger sum of variance accounted for by known environmental sources. Shelter proximity and SES can be combined with other established environmental predictors of reading comprehension to create larger indices which have greater predictive ability than individual influences, alone (e.g., Taylor et al., 2017).

It is important to note that hypothesized protective neighborhood features were not significantly associated with FCAT reading. As suggested by Scarr & Weinberg (1978), these protective features may contribute to maintaining "functional equivalency" or an environment that is good enough to allow individual differences in genes to predominantly influence reading comprehension. Conditions associated with shelters may pose enough of a risk to reading comprehension to drop below the functional equivalency threshold. Additionally, protective facilities such as museums, libraries and parks may have been underutilized, reducing their potential to facilitate reading outcomes. An important extension of this study would be to include survey data on resource utilization and other measures of accessibility in addition to distance.

These results, although informative, should be considered with four limitations in mind. First, classic twin studies cannot fully disentangle environmental influences from genetic influences (Purcell & Koenen, 2005). Due to the presence of gene-environment correlation, shared environmental influences may partially capture some genetic influences from either parents or children and results of this study should be interpreted bearing this in mind. Second, distance to neighborhood facilities and features might not accurately reflect neighborhood conditions for all participants. In rural areas, the nearest shelter may be over 20 miles away; therefore, less likely to exert influence. However, in urban areas multiple shelters may exist within a mile of participant's homes. Thus, distance as an indicator of accessibility may be inaccurate under certain conditions. Third, the association between shelter proximity and reading outcomes may have been due to a suppression effect from SES which, in reality, represents other third-party conditions such as urbanity or population density that influence both shelter proximity and reading outcomes. Finally, this study is

correlational in nature therefore is not possible to determine causal directions in the observed relations. Replication studies are needed to determine whether the current results are supported.

Despite its limitations, this study has important implications for the fields of sociology and education. This study used a novel approach to account for individual variability in genes and environment for school-aged children and stands to provide clinicians and educational stakeholders with the tools to better understand complex mechanisms underlying reading achievement. These findings provide evidence for an association between SES, shelter proximity and reading achievement, adding more information about neighborhood influences than has previously been understood. This study intended to combine several statistically significant sources of neighborhood influence into a larger index of neighborhood quality or risk that could be used to improve the prediction of reading outcomes. However, only one of the proposed neighborhood features was significantly associated with reading, limiting the ability to create a larger index. Despite this low level of prediction from the current results, these findings can be extended by including additional measures of neighborhood conditions such as urbanity, population density, or per capita crime rates, and as larger patterns of associations are uncovered, can be used to inform how educational expenses are devoted to addressing newly identified environmental correlates of achievement. Expanding the scope of environmental influences on important school outcomes can also inform policy, such that intervention efforts could be targeted to these identified environmental factors in disadvantaged students sooner, rather than waiting for gaps in achievement to advance to critical levels. Hence, developing a comprehensive index of environmental influences that are negatively and positively associated with learning outcomes can improve the scope of treatment and intervention for those at risk.

Acknowledgements

The first author was supported by Predoctoral Interdisciplinary Fellowship (funded by the Institute of Education Sciences, US Department of Education (R305B090021)). The research project was supported, in part, by a grant from the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (P50 HD052120). Views expressed herein are those of the authors and have neither been reviewed nor approved by the granting agencies.

The authors wish to thank the twins and their families for their participation in making this research possible.

References

- Aikens NL, & Barbarin O (2008). Socioeconomic differences in reading trajectories: The contribution of family, neighborhood, and school contexts. *Journal of Educational Psychology*, 100(2), 235.
- Apparicio P, Abdelmajid M, Riva M, & Shearmur R (2008). Comparing alternative approaches to measuring the geographical accessibility of urban health services: Distance types and aggregation-error issues. *International journal of health geographics*, 7(1), 1. [PubMed: 18190678]
- Arnold DH, Kupersmidt JB, Voegler-Lee ME, & Marshall NA (2012). The association between preschool children's social functioning and their emergent academic skills. *Early Childhood Research Quarterly*, 27(3), 376–386. [PubMed: 23002324]
- Becker S, Crandall MD, Fisher KE, Kinney B, Landry C, & Rocha A (2010). Opportunity for All: How the American Public Benefits from Internet Access at US Libraries. Institute of Museum and Library Services.

- Becker N, Vasconcelos M, Oliveira V, Dos Santos FC, Bizarro L, De Almeida RM, ... & Carvalho MRS (2017). Genetic and environmental risk factors for developmental dyslexia in children: systematic review of the last decade. *Developmental neuropsychology*, 1–23.
- Bhatt R (2010). The impact of public library use on reading, television, and academic outcomes. *Journal of Urban Economics*, 68(2), 148–166.
- Borman GD, & Dowling NM (2006). Longitudinal achievement effects of multiyear summer school: Evidence from the Teach Baltimore randomized field trial. *Educational Evaluation and Policy Analysis*, 28(1), 25–48.
- Bowen NK, Bowen GL, & Ware WB (2002). Neighborhood social disorganization, families, and the educational behavior of adolescents. *Journal of Adolescent Research*, 17(5), 468–490.
- Boynton-Jarrett R, Hair E, & Zuckerman B (2013). Turbulent times: Effects of turbulence and violence exposure in adolescence on high school completion, health risk behavior, and mental health in young adulthood. *Social Science & Medicine*, 95, 77–86. [PubMed: 23063217]
- Bronfenbrenner U (1994). Ecological models of human development. *International encyclopedia of education*, 3(2), 37–43.
- Busby DR, Lambert SF, & Ialongo NS (2013). Psychological symptoms linking exposure to community violence and academic functioning in African American adolescents. *Journal of youth and adolescence*, 42(2), 250–262. [PubMed: 23277294]
- Calderón-Garcidueñas L, Torres-Jardón R, Kulesza RJ, Park SB, & D'Angiulli A (2014). Air pollution and detrimental effects on children's brain. The need for a multidisciplinary approach to the issue complexity and challenges. *Frontiers in human neuroscience*, 8.
- Cameron CE, Connor CM, Morrison FJ, & Jewkes AM (2008). Effects of classroom organization on letter–word reading in first grade. *Journal of School Psychology*, 46(2), 173–192. [PubMed: 19083356]
- Celano D, & Neumann SB (2001). The role of public libraries in children's literacy development. Pennsylvania, PA: Pennsylvania Library Association.
- Chang YK, Labban JD, Gapin JJ, & Etnier JL (2012). The effects of acute exercise on cognitive performance: a meta-analysis. *Brain research*, 1453, 87–101. [PubMed: 22480735]
- Clark C and Hawkins L (2010). *Public Libraries and Literacy*. London: National Literacy Trust.
- Cohen S, Glass DC, & Singer JE (1973). Apartment noise, auditory discrimination, and reading ability in children. *Journal of experimental social psychology*, 9(5), 407–422.
- Cohen S, Evans GW, Stokols D, & Krantz DS (2013). *Behavior, health, and environmental stress*. Springer Science & Business Media.
- D'Agostino JV (2000). Instructional and school effects on students' longitudinal reading and mathematics achievements. *School Effectiveness and School Improvement*, 11(2), 197–235.
- Florida Department of Education (2005). *FCAT briefing book*. Tallahassee, FL: Author
- Freire C, Ramos R, Puertas R, Lopez-Espinosa MJ, Julvez J, Aguilera I, ... & Olea N (2010). Association of traffic-related air pollution with cognitive development in children. *Journal of epidemiology and community health*, 64(3), 223–228. [PubMed: 19679705]
- Froiland JM, Powell DR, Diamond KE, & Son SHC (2013). Neighborhood Socioeconomic Well-being, Home Literacy, and Early Literacy Skills of At-risk Preschoolers. *Psychology in the Schools*, 50(8), 755–769.
- Furr-Holden CDM, Smart MJ, Pokorni JL, Ialongo NS, Leaf PJ, Holder HD, & Anthony JC (2008). The NIfETy method for environmental assessment of neighborhood-level indicators of violence, alcohol, and other drug exposure. *Prevention Science*, 9(4), 245–255. [PubMed: 18931911]
- Garrido EF, Culhane SE, Raviv T, & Taussig HN (2010). Does community violence exposure predict trauma symptoms in a sample of maltreated youth in foster care?. *Violence and victims*, 25(6), 755. [PubMed: 21287965]
- Geier AB, Foster GD, Womble LG, McLaughlin J, Borradaile KE, Nachmani J, ... & Shults J (2007). The relationship between relative weight and school attendance among elementary schoolchildren. *Obesity*, 15(8), 2157–2161. [PubMed: 17712135]
- Gilderbloom JL, Squires GD, & Wuerstle M (2013). Emergency homeless shelters in North America: An inventory and guide for future practice. *Housing and Society*, 40(1), 1–37.

- Godbey G (2009). Outdoor recreation, health, and wellness: Understanding and enhancing the relation. Washington, DC: Resources for the Future.
- Goldberg DW, Wilson JP, & Knoblock CA (2007). From text to geographic coordinates: The current state of geocoding. *URISA journal*, 19(1), 33–46.
- Gottfried MA (2009). Excused versus unexcused: How student absences in elementary school affect academic achievement. *Educational Evaluation and Policy Analysis*, 31(4), 392–415.
- Greene JP (2001). An evaluation of the Florida A-Plus accountability and school choice program. Center for Civic Innovation at the Manhattan Institute.
- Griffin EA, & Morrison FJ (1997). The unique contribution of home literacy environment to differences in early literacy skills 1. *Early Child Development and Care*, 127(1), 233–243.
- Grigorenko EL (2013). What we know (or do not know) about the genetics of reading comprehension and other reading-related processes. In Miller B, Cutting L, McCardle P (eds.) *Unraveling Reading Comprehension*, Baltimore, Maryland, pp. 293–213.
- Guo Y, Connor CM, Yang Y, Roehrig AD, & Morrison FJ (2012). The effects of teacher qualification, teacher self-efficacy, and classroom practices on fifth graders' literacy outcomes. *The Elementary School Journal*, 113(1), 3–24.
- Harris MH, Gold DR, Rifas-Shiman SL, Melly SJ, Zanoibetti A, Coull BA, ... & Bellinger DC (2015). Prenatal and childhood traffic-related pollution exposure and childhood cognition in the project viva cohort (Massachusetts, USA). *Environmental health perspectives*, 123(10), 1072. [PubMed: 25839914]
- Hart SA, Petrill SA, Deckard KD, & Thompson LA (2007). SES and CHAOS as environmental mediators of cognitive ability: A longitudinal genetic analysis. *Intelligence*, 35(3), 233–242. [PubMed: 19319205]
- Hernandez DJ (2011). Double Jeopardy: How Third-Grade Reading Skills and Poverty Influence High School Graduation. Annie E. Casey Foundation.
- Jackson SL, Vann WF Jr, Kotch JB, Pahel BT, & Lee JY (2011). Impact of poor oral health on children's school attendance and performance. *American Journal of Public Health*, 101(10), 1900–1906. [PubMed: 21330579]
- Jencks C, & Mayer SE (1990). The social consequences of growing up in a poor neighborhood. *Inner-city poverty in the United States*, 111, 186.
- Kaczynski AT, & Henderson KA (2007). Environmental correlates of physical activity: a review of evidence about parks and recreation. *Leisure Sciences*, 29(4), 315–354.
- Kampa M, & Castanas E (2008). Human health effects of air pollution. *Environmental pollution*, 151(2), 362–367. [PubMed: 17646040]
- Keers R, Coleman JR, Lester KJ, Roberts S, Breen G, Thastum M, ... & Nauta M (2016). A Genome-Wide Test of the Differential Susceptibility Hypothesis Reveals a Genetic Predictor of Differential Response to Psychological Treatments for Child Anxiety Disorders. *Psychotherapy and psychosomatics*, 85(3), 146–158. [PubMed: 27043157]
- Kendler KS, & Eaves LJ (1986). Models for the joint effect of genotype and environment on liability to psychiatric illness. *The American journal of psychiatry*.
- Knopik VS, Neiderhiser JM, DeFries JC, & Plomin R (2016). *Behavioral genetics*. Macmillan Higher Education.
- Lapointe VR, Ford L, & Zumbo BD (2007). Examining the relationship between neighborhood environment and school readiness for kindergarten children. *Early Education and Development*, 18(3), 473–495.
- Leventhal T, & Brooks-Gunn J (2000). The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes. *Psychological bulletin*, 126(2), 309. [PubMed: 10748645]
- Lindo EJ (2014). Family background as a predictor of reading comprehension performance: An examination of the contributions of human, financial, and social capital. *Learning and Individual Differences*, 32, 287–293.
- Little CW, & Hart SA (2014). Examining associations among ADHD, homework behavior, and reading comprehension: A twin study. *Journal of Learning Disabilities*, 49 (4), 410–423. [PubMed: 25349092]

- Mascheretti S, Andreola C, Scaini S, & Sulpizio S (2018). Beyond genes: A systematic review of environmental risk factors in specific reading disorder. *Research in developmental disabilities*.
- McGue M, & Bouchard TJ Jr (1984). Adjustment of twin data for the effects of age and sex. *Behavior genetics*, 14(4), 325–343. [PubMed: 6542356]
- Milam AJ, Furr-Holden CDM, & Leaf PJ (2010). Perceived school and neighborhood safety, neighborhood violence and academic achievement in urban school children. *The Urban Review*, 42(5), 458–467. [PubMed: 21197388]
- Milam AJ, Johnson RM, Nesoff ED, Reboussin BA, & Furr-Holden CD (2016). Evaluating nighttime observational measures of neighborhood disorder: Validity of the nighttime NIFeTY assessment. *Journal of Environmental Psychology*, 45, 97–102. [PubMed: 28979058]
- Miller P, Mulvey C, & Martin N (2001). Genetic and environmental contributions to educational attainment in Australia. *Economics of Education Review*, 20(3), 211–224.
- Molfese VJ, Modglin A, & Molfese DL (2003). The Role of Environment in the Development of Reading Skills A Longitudinal Study of Preschool and School-Age Measures. *Journal of learning disabilities*, 36(1), 59–67. [PubMed: 15490892]
- National Center for Education Statistics (2015). *The Nation's Report Card: 2015 Mathematics and Reading* (NCES 2015). Institute of Education Sciences, U.S. Department of Education, Washington, D.C.
- Nye B, Konstantopoulos S, & Hedges LV (2004). How large are teacher effects?. *Educational evaluation and policy analysis*, 26(3), 237–257.
- Okbay A, Beauchamp JP, Fontana MA, Lee JJ, Pers TH, Rietveld CA, ... & Oskarsson S (2016). Genome-wide association study identifies 74 loci associated with educational attainment. *Nature*, 533(7604), 539–542. [PubMed: 27225129]
- Overstreet S, & Mathews T (2011). Challenges associated with exposure to chronic trauma: Using a public health framework to foster resilient outcomes among youth. *Psychology in the Schools*, 48(7), 738–754.
- Park SJ (2012). Measuring public library accessibility: A case study using GIS. *Library & Information Science Research*, 34(1), 13–21.
- Pellegrino JW, & Hilton ML (Eds.). (2013). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. National Academies Press.
- Peters JM, Avol E, Gauderman WJ, Linn WS, Navidi W, London SJ, ... & Thomas DC (1999). A study of twelve Southern California communities with differing levels and types of air pollution: II. Effects on pulmonary function. *American Journal of Respiratory and Critical Care Medicine*, 159(3), 768–775. [PubMed: 10051249]
- Petrill SA, Pike A, Price T, & Plomin R (2004). Chaos in the home and socioeconomic status are associated with cognitive development in early childhood: Environmental mediators identified in a genetic design. *Intelligence*, 32(5), 445–460.
- Pfeiffer PN, Glass J, Austin K, Valenstein M, McCarthy JF, & Zivin K (2011). Impact of distance and facility of initial diagnosis on depression treatment. *Health services research*, 46(3), 768–786. [PubMed: 21210800]
- Plomin R, DeFries J, Knopik V, & Neiderhiser J (2013). *Behavioral Genetics*. Vol. 6.
- Ponitz CC, Rimm-Kaufman SE, Grimm KJ, & Curby TW (2009). Kindergarten classroom quality, behavioral engagement, and reading achievement. *School Psychology Review*, 38(1), 102.
- Powell DR, Son SH, File N, & Froiland JM (2012). Changes in parent involvement across the transition from public school prekindergarten to first grade and children's academic outcomes. *The Elementary School Journal*, 113(2), 276–300.
- Rende R, & Plomin R (1992). Diathesis-stress models of psychopathology: A quantitative genetic perspective. *Applied and Preventive Psychology*, 1(4), 177–182.
- Roberts RE, Roberts CR, & Duong HT (2009). Sleepless in adolescence: prospective data on sleep deprivation, health and functioning. *Journal of adolescence*, 32(5), 1045–1057. [PubMed: 19361854]
- Robertson MJ, & Greenblatt M (Eds.). (2013). *Homelessness: A national perspective*. Springer Science & Business Media.

- Roemmich JN, Epstein LH, Raja S, Yin L, Robinson J, & Winiewicz D (2006). Association of access to parks and recreational facilities with the physical activity of young children. *Preventive medicine*, 43(6), 437–441. [PubMed: 16928396]
- Rogers HR (1996). Sources, behaviour and fate of organic contaminants during sewage treatment and in sewage sludges. *Science of the total environment*, 185(1), 3–26. [PubMed: 8643958]
- Rosenthal SR, Vivier PM, Rogers ML, Saadeh FM, & Clark MA (2015). Measures of Neighborhood Quality: Self-reports of Mothers of Infant Children. *Journal of Child and Family Studies*, 24(5), 1256–1261.
- Ross CE (2000). Neighborhood disadvantage and adult depression. *Journal of Health and Social Behavior*, 177–187.
- Sadeh A (1996). Stress, trauma, and sleep in children. *Child and Adolescent Psychiatric Clinics of North America*, 5, 685–700.
- Sampson RJ, Morenoff JD, & Gannon-Rowley T (2002). Assessing” neighborhood effects”: Social processes and new directions in research. *Annual review of sociology*, 443–478.
- Scarr S, & Weinberg RA (1978). The influence of” family background” on intellectual attainment. *American Sociological Review*, 674–692.
- Schatschneider C, Buck J, Torgesen J, Wagner R, Hassler L, Hecht S, & Powell-Smith K (2004). A Multivariate Study of Individual Differences in Performance on the Reading Portion of the Florida Comprehensive Assessment Test: A Brief Report. Florida Center for Reading Research.
- Scheffler RM, Brown TT, Fulton BD, Hinshaw SP, Levine P, & Stone S (2009). Positive association between attention-deficit/hyperactivity disorder medication use and academic achievement during elementary school. *Pediatrics*, 123(5), 1273–1279. [PubMed: 19403491]
- Schwartz D, & Proctor LJ (2000). Community violence exposure and children’s social adjustment in the school peer group: the mediating roles of emotion regulation and social cognition. *Journal of consulting and clinical psychology*, 68(4), 670. [PubMed: 10965642]
- Schwarzenbach RP, Egli T, Hofstetter TB, Von Gunten U, & Wehrli B (2010). Global water pollution and human health. *Annual Review of Environment and Resources*, 35, 109–136.
- Sénéchal M, & LeFevre JA (2002). Parental involvement in the development of children’s reading skill: A five-year longitudinal study. *Child development*, 73(2), 445–460. [PubMed: 11949902]
- Shield BM, & Dockrell JE (2008). The effects of environmental and classroom noise on the academic attainments of primary school children. *The Journal of the Acoustical Society of America*, 123(1), 133–144. [PubMed: 18177145]
- Shelton KH, Taylor PJ, Bonner A, & van den Bree M (2015). Risk factors for homelessness: evidence from a population-based study. *Psychiatric Services*.
- Shumow L, Vandell DL, & Posner J (1999). Risk and resilience in the urban neighborhood: Predictors of academic performance among low-income elementary school children. *Merrill-Palmer Quarterly* (1982-), 309–331.
- Singh GK, & Kenney MK (2013). Rising prevalence and neighborhood, social, and behavioral determinants of sleep problems in US children and adolescents, 2003–2012. *Sleep disorders*, 2013.
- Singh A, Uijtendewilligen L, Twisk JW, Van Mechelen W, & Chinapaw MJ (2012). Physical activity and performance at school: a systematic review of the literature including a methodological quality assessment. *Archives of pediatrics & adolescent medicine*, 166(1), 49–55. [PubMed: 22213750]
- Sirin SR (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of educational research*, 75(3), 417–453.
- Smith D (2013). *The Impact of Neighborhood Violent Crime on School Attendance* (Doctoral dissertation, University of Cincinnati).
- Stanley N, & Stanley L (2011). Predicting FCAT reading scores using the reading-level indicator. *Reading Psychology*, 32(2), 99–112.
- Suter LE (2014). *Visiting Science Museums During Middle and High School: A Longitudinal Analysis of Student Performance in Science*. *Science Education*, 98(5), 815–839.
- Taras H, & Potts-Datema W (2005). Sleep and student performance at school. *Journal of school health*, 75(7), 248–254. [PubMed: 16102087]

- Taylor J, Ennis CR, Hart SA, Mikolajewski A, & Schatschneider C (2017). Home environmental and behavioral risk indices for reading achievement. *Learning and Individual Differences*, 57, 9–21. [PubMed: 29151723]
- Taylor J, Mikolajewski A, Hart S, & Schatschneider C (2013, 11). Behavior problems and academic support at home as contexts for reading achievement. In *Behavior Genetics* (Vol. 43, No. 6, pp. 542–543). 233 Spring St, New York, NY 10013 USA: Springer.
- Taylor J, Roehrig AD, Hensler BS, Connor CM, & Schatschneider C (2010). Teacher quality moderates the genetic effects on early reading. *Science*, 328(5977), 512–514. [PubMed: 20413504]
- Taylor J, & Hart SA (2014). A chaotic home environment accounts for the association between respect for rules disposition and reading comprehension: A twin study. *Learning and individual differences*, 35, 70–77. [PubMed: 25328362]
- Thompson FT, & Levine DU (1997). Examples of easily explainable suppressor variables in multiple regression research. *Multiple Linear Regression Viewpoints*, 24(1), 11–13.
- U.S. Census Bureau. American Community Survey. U.S. Government Printing Office; Washington, DC: 2016 Design and Methodology
- Weinstein M, Whitesell ER, & Schwartz AE (2014). Museums, Zoos, and Gardens How Formal-Informal Partnerships Can Impact Urban Students' Performance in Science. *Evaluation review*, 38(6), 514–545. [PubMed: 25304519]
- Weir LA, Etelson D, & Brand DA (2006). Parents' perceptions of neighborhood safety and children's physical activity. *Preventive medicine*, 43(3), 212–217. [PubMed: 16712912]
- Welsh M, Parke RD, Widaman K, & O'Neil R (2001). Linkages between children's social and academic competence: A longitudinal analysis. *Journal of School Psychology*, 39(6), 463–482.
- World Health Organization. (2010). World health statistics 2010. World Health Organization.
- World Health Organization. (2005). Effects of air pollution on children's health and development: a review of the evidence.
- Yamashita T, & Kunkel SR (2010). The association between heart disease mortality and geographic access to hospitals: county level comparisons in Ohio, USA. *Social Science & Medicine*, 70(8), 1211–1218. [PubMed: 20138417]
- Zins JE (2004). Building academic success on social and emotional learning: What does the research say? New York: Teachers College Press.

Table 1

Means, standard deviations (SD), minimums, maximums and skewness for neighborhood distance variables.

<i>Protective Factors</i>							
Variable	Mean	SD	Min	Max	Skew¹	Skew²	<i>n</i>
Parks	5222.40	4192.44	0.03	26522.82	1.72	1.62	2140
Libraries	3673.26	2794.56	0.66	19401.15	1.87	1.61	2139
Museums/Art Galleries	6397.57	4537.23	89.51	22492.46	2.10	1.13	2114
Theaters	10859.68	7791.89	119.96	44585.89	1.39	1.35	2140
Zoos	17153.22	12042.97	305.84	78671.65	1.55	1.55	2141
Medical Facilities	5926.00	4365.36	232.72	32057.96	1.62	1.62	2141
<i>Risk Factors</i>							
Variable	Mean	SD	Min	Max	Skew¹	Skew²	<i>n</i>
Bars/Liquor Stores	1305.57	1036.06	0.04	6756.24	5.76	1.96	2099
Firearm Dealers	2050.12	1362.31	3.12	7305.61	2.30	1.06	2103
Class I Landfill	22864.67	14794.95	485.36	82396.93	2.67	1.36	2138
Class II Landfill	76938.74	60863.90	644.23	181468.60	0.60	0.24	2119
Class III Landfill	30222.92	25674.19	519.85	121017.97	1.51	1.34	2138
Superfund/Pollution Sites	18175.54	16787.99	387.94	91750.03	2.34	1.73	1994
Wastewater Facilities	18900.89	16430.36	25.68	75176.13	2.37	1.45	2138
Industry	13406.02	10826.05	267.79	72573.58	4.36	1.99	2137
Vacant Properties/Airports	4845.79	4475.06	50.61	33617.38	13.28	1.99	2138
Shelters	11956.90	8898.58	165.45	52269.27	1.36	1.36	2141

Note: Distance represented in meters. Skew¹ = skewness before corrections. Skew² = skewness after outliers removed. *n* = reported sample size after outliers were removed. Sample size before corrections was 2141 for all neighborhood variables.

Table 2

Pearson correlations between neighborhood distance variables.

Variable	Parks	Libraries	Museums/ Art Galleries	Theaters	Zoos	Medical Facilities	Total Crime	Violent Crime	Property Crime	Bars/ Liquor Stores	Firearm Dealers	Class I Landfill	Class II Landfill	Class III Landfill	Superfund/ Pollution Sites	Wastewater Facilities	Industry	Vacant Properties	Shelters
Parks	1.00																		
Libraries	.21 [†]	1.00																	
Museums/ Art Galleries	.14 [†]	.48 [†]	1.00																
Theaters	.23 [†]	.37 [†]	.50 [†]	1.00															
Zoos	.12 [†]	.25 [†]	.29 [†]	.38 [†]	1.00														
Medical Facilities	.27 [†]	.47 [†]	.51 [†]	.60 [†]	.22 [†]	1.00													
Total Crime	.08 ^{**}	-.23 [†]	-.28 [†]	-.26 [†]	.29 [†]	-.22 [†]	1.00												
Violent Crime	-.01	-.26 [†]	-.30 [†]	-.28 [†]	.30 [†]	-.23 [†]	---	1.00											
Property Crime	.09 [†]	-.22 [†]	-.27 [†]	-.26 [†]	.28 [†]	-.21 [†]	---	---	1.00										
Bars/ Liquor Stores	.19 [†]	.50 [†]	.39 [†]	.36 [†]	.21 [†]	.45 [†]	-.19 [†]	-.20 [†]	-.19 [†]	1.00									
Firearm Dealers	.12 [†]	.34 [†]	.34 [†]	.24 [†]	.10 [†]	.33 [†]	-.06 [*]	-.07 [*]	-.06 [*]	.34 [†]	1.00								
Class I Landfill	-.08 [†]	.08 [†]	.10 [†]	-.01	.14 [†]	.11 [†]	.21 [†]	-.21 [†]	-.21 [†]	.08 [†]	.26	1.00							
Class II Landfill	.06 ^{**}	.26 [†]	.31 [†]	.11 [†]	.13 [†]	.23 [†]	-.35 [†]	-.39 [†]	-.35 [†]	.20 [†]	.13 [†]	.32 [†]	1.00						
Class III Landfill	.09 [†]	.21 [†]	.14 [†]	.02	-.01	.16 [†]	-.24 [†]	-.26 [†]	-.24 [†]	.12 [†]	.03	.46 [†]	.07 ^{**}	1.00					
Superfund Sites	.04	.37 [†]	.32 [†]	.26 [†]	.36 [†]	.37 [†]	-.21 [†]	-.30 [†]	-.31 [†]	.28 [†]	.14 [†]	.04	.26 [†]	.28 [†]	1.00				
Wastewater Facilities	-.04 [*]	.15 [†]	.08 ^{**}	.01	.12 [†]	.18 [†]	-.35 [†]	-.33 [†]	-.35 [†]	.12 [†]	.05 [*]	.64 [†]	.18 [†]	.51 [†]	.39 [†]	1.00			
Industry	.10 [†]	.34 [†]	.46 [†]	.40 [†]	.59 [†]	.27 [†]	-.40 [†]	-.38 [†]	-.40 [†]	.26 [†]	.15 [†]	-.11 [†]	.20 [†]	.11 [†]	.41 [†]	.04	1.00		
Vacant Properties	-.01	.24 [†]	.24 [†]	.28 [†]	.16 [†]	.39 [†]	-.11 [†]	-.09 [†]	-.11 [†]	.25 [†]	.17 [†]	-.08 [†]	-.18 [†]	.28 [†]	.38 [†]	-.03	.26 [†]	1.00	
Shelters	.19 [†]	.27 [†]	.37 [†]	.41 [†]	.34 [†]	.40 [†]	-.25 [†]	-.24 [†]	-.25 [†]	.23 [†]	.26 [†]	.22 [†]	.28 [†]	.32 [†]	.22 [†]	.28 [†]	.32 [†]	.19 [†]	1.00

Note:

1000>d
,
'100'>d
**
'50'>d
*

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Table 3

Pearson correlations between FCAT reading and neighborhood distance variables.

Variable	FCAT
Parks	−0.05*
Libraries	0.03
Museums/Art Galleries	0.03
Theaters	−0.03
Zoos	0.00
Medical Facilities	−0.02
Violent Crime	0.02
Property Crime	0.01
Bars/Liquor Stores	0.01
Firearm Dealers	0.06*
Class I Landfill	0.01
Class II Landfill	−0.06*
Class III Landfill	0.00
Superfund/Pollution Sites	0.01
Wastewater Facilities	−0.02
Industry	−0.03
Vacant Properties/Airports	0.05
Shelters	0.07*

Note: Bolded estimates indicate significance.

Table 4

Pearson correlations between SES and neighborhood distance variables.

Variable	Family-level SES	Community-level SES
Parks	-0.08	-0.10
Libraries	-0.08	0.03
Museums/Art Galleries	-0.03	0.01
Theaters	-0.09	-0.02
Zoos	0.05	-0.07
Medical Facilities	-0.06	-0.03
Violent Crime	0.03	-0.01
Property Crime	0.02	-0.02
Bars/Liquor Stores	-0.02	0.06
Firearm Dealers	-0.05	0.19
Class I Landfill	-0.09	0.02
Class II Landfill	-0.07	-0.03
Class III Landfill	-0.03	-0.08
Superfund/Pollution Sites	-0.04	-0.05
Wastewater Facilities	-0.05	-0.10
Industry	-0.01	-0.11
Vacant Properties/Airports	0.01	0.03
Shelters	-0.04	0.09
FCAT Reading	-0.11	0.28

Note: Bolded estimates indicate significance at $p < .05$. Family-level SES is coded with higher scores indicating lower SES.

Table 5

Beta weights, standard errors and p values for demographic and neighborhood distance variables predicting FCAT reading.

Variable	FCAT		
	β	SE	<i>p</i>
Step 1	$R^2=0.053$		
Family-level SES	-0.04	6.10	0.448
Community-level SES	0.21	<0.001	<.0001
Step 2	$R^2=0.082$	$R^2=0.029$	
Parks	-0.05	<0.001	0.354
Firearms Dealers	-0.06	<0.001	0.330
Class II Landfills	0.11	<0.001	0.07
Shelters	0.180	<0.001	.004

Note: Bolded estimates indicate significance.

Table 6.

Univariate Models for FCAT with and without shelter proximity as a predictor.

	FCAT	FCAT ^{SES}
No predictor		
A	.47 [†] [.39-.55]	.51 [†] [.42-.61]
C	.34 [†] [.26-.43]	.28 [†] [.20-.37]
E	.19 [†] [.17-.22]	.21 [†] [.19-.24]
Shelter proximity as predictor		
A	.47 [†] [.39-.55]	.51 [†] [.42-.60]
C	.33 [†] [.26-.41]	.27 [†] [.19-.35]
E	.19 [†] [.17-.22]	.21 [†] [.18-.24]
Shelter distance	.006 [†] [.001-.014]	.004 [†] [.0003-.010]

[†] significance based on 95% confidence intervals not bounding zero.

FCAT^{SES} = community-level SES regressed onto FCAT reading.