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# Thresholds of Resilience and Within- and Cross-Domain Academic Achievement among Children in Poverty

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## Abstract

Growing up in poverty increases the likelihood of maladaptive development. Yet, some children are able to overcome the adversity of poverty and demonstrate resilience. Currently, there is limited agreement among researchers about how to operationalize resilience, both in terms of who should be the comparison group against whom at-risk children are compared and in terms of what developmental domains of resilience are most predictive of later positive development. The present study investigated how different thresholds and domains of resilience at school entry were associated with within-domain and cross-domain academic achievement across elementary school. Using a nationally representative and longitudinal sample, the results demonstrated that children who reached a high threshold of resilience at entry to kindergarten had similar mathematics and literacy achievement throughout elementary school as academically competent children not in poverty. Additionally, cross-domain associations were found for both mathematics and literacy resilience predicting later achievement. These findings have important research and intervention implications for promoting positive academic development among children in poverty.

**Keywords:** resilience, poverty, cross-domain, academic achievement

## Introduction

Poverty affects many children in the United States, with about 14.5 million children living in poverty in 2015, or just under 20% of children under 18 years (Proctor, Semega, & Kollar, 2016). Growing up in poverty places children at risk for worse behavioral, cognitive, and health outcomes (Berger, Paxson, &Waldfogel, 2009; Brooks-Gunn & Duncan, 1997; McLoyd, 1998; Yoshikawa, Aber, & Beardslee, 2012). Children's cognitive abilities and academic achievement seem to be particularly negatively impacted by growing up in poverty (Duncan, Yeung, Brooks-Gunn, & Smith, 1998) and these negative impacts are evident as early as 9 months of age (Halle et al., 2009). Childhood poverty is also associated with structural differences in brain regions associated with school readiness among children and adolescents, as well as, lower achievement (Hair, Hanson, Wolfe, & Pollack, 2015).

One potential explanation for why early environments are important for later development is the notion of "skills beget skills," which argues that early social-emotional and cognitive skills are predictive of later human capital, and that early skills determine whether later investments will be beneficial (Cunha, Heckman, Lochner, & Masterov, 2006). It follows that children without early skills will lag behind their competent peers in tests of later skills, and thus identifying whether certain groups of children have consistently lower skills is an important first step for reducing early gaps.

Family income generally, and poverty status in particular, has been implicated as a key determinant of early skill gaps. By the time children enter kindergarten, there is an evident "income achievement gap," such that children from low-income families have much lower math and literacy skills than children from high-income families (Reardon, 2011). This income achievement gap grows very little from kindergarten to 8$^{th}$ grade, changing from 1.15 to 1.25 standard deviations, which suggests that the gap emerges before children reach formal schooling (Reardon, 2011). Therefore, early experiences of poverty in a child's life can be particularly detrimental for later development because children's school readiness creates the foundation of later capabilities.

Despite all of the risks associated with growing up in poverty, some children are able to overcome the odds to display positive development; these children are considered resilient (Masten, 2014). Resilience is an accepted and widely used concept in developmental science, yet there is a lack of consensus about how to operationalize it. Resilience has been defined as merely avoiding psychopathology (Tiet et al., 1998), as doing better than others facing similar risks (Rutter, 2006), or as doing as well as those not experiencing risk (Luthar, Cicchetti, & Becker, 2000). Each of these definitions has different assumptions about the comparison group used to classify resilience. The first definition is typically used with populations studying psychopathology, and given our interest in achievement, we will focus on the other two definitions. Classifying resilience as doing better than others experiencing the same risk inherently results in a lower standard when compared to classifying resilience as doing as well as others not experiencing risk. If such a standard is used to determine whether social programs are promoting the development of children in poverty, the use of a lower threshold can leave the mistaken impression that the income achievement gap has closed, when in fact it has not.

It is also unclear what developmental domains should be used in considering resilience (Luthar et al., 2000). There is some evidence that certain academic domains might be more influential for continued positive development, such as mathematics being a stronger predictor of academic achievement than literacy (Duncan et al., 2007). The aim of this study is to investigate how different thresholds of resilience, or different comparison groups for defining resilience, are related to children's later development. Additionally, we explore within-domain and cross-domain associations between resilience and academic achievement to determine whether certain developmental domains are more predictive of continued positive development. In doing so, we inform future research by identifying the implication of considering different operationalizations and domains of resilience and inform future evaluations of social programs for children in poverty that might be focused on boosting resilience in particular domains.

## Conceptualizing Resilience

Although the concept of resilience has been studied for decades, there is still a lack of agreement about how to define resilience (Masten 2014; Vanderbilt-Adriance & Shaw, 2008; Zolkoski & Bullock, 2012). One thread of research defines resilience based on the adaptive "capacity of a dynamic system" to overcome adverse experiences (Masten, 2014). In other words, this line of resilience research focuses on the processes between risk and protective factors in promoting or hindering positive adjustment. Adaptive systems and protective factors can exist across ecological levels, from family relations to cultural norms (Masten & Obradović , 2006). Among children in poverty, individual-level

protective factors can include social competence and problem solving, whereas positive relationships with parents and teachers or availability of social services are family-, school-, and community-level protective factors (Abelev, 2009).

A second definition of resilience focuses specifically on the criteria used for judging competence following adversity. In other words, resilience is defined based on whether or not children display specific positive outcomes after experiencing risk (Masten, 2001; Luthar et al., 2000). The current study examines the different criteria used for measuring resilience by comparing two operationalizations: (1) doing better than peers experiencing similar risks (Rutter, 2006), and (2) doing as well as peers not experiencing risk (Luthar et al., 2000). Classifying resilience as doing better than peers in similar risky environments (Rutter, 2006) assumes that the comparison group for resilience is others experiencing the same risk (e.g. Cicchetti, Rogosch, Lynch, & Holt, 1993; D'Imperio, Dubow, & Ippolito, 2010). For the current study, we refer to this definition as "low-threshold resilience" because children are doing better than other children in poverty but not as well as the average child who has not experienced poverty. In contrast, defining resilience as thriving, or fulfilling "major expectations of a given society or culture in historical context for the behavior of the children of that age and situation" despite exposure to serious risks (Masten, 2001, p. 229), assumes the comparison group for this operationalization of resilience is others who are not at risk (e.g. Buckner, Mezzacappa, & Beardslee, 2003; Jaffee, Caspi, Moffitt, Polo-Tomas, & Taylor, 2007; Obradović et al., 2009). This is a higher standard for functioning despite living in poverty and thus we refer to it as "high-threshold resilience".

The key difference between these two definitions of resilience is that they use different comparison groups, the implication of which is that children of varying competence can be classified as resilient depending on the threshold used. For example, if resilience is defined as merely doing better than others in similar risky environments, i.e. low-threshold resilience, these children are not on track to reach high or even average levels of competence experienced by the general population of children. To illustrate, Figure 1 displays how we calculated low-threshold resilience for the current study using the Early Childhood Longitudinal Study, Kindergarten Cohort of 1998. The distributions of fall kindergarten math scores for children in poverty and children not in poverty are plotted together. The mid-point of the non-poor sample constitutes the "high threshold" line, meaning that poor children who score above this mean for children in poverty are succeeding despite adversity to be in the upper half of scores of children not in poverty. In contrast, the "low threshold" line is the midpoint of the math scores for children in poverty, which is over 6 points below the mean for the non-poor group. The difference between these two thresholds is a group of children (bracketed as C in the figure) who would be considered resilient under the low threshold definition but not resilient under the high-threshold definition. Considering such children to be functionally "resilient" does a disservice to these children, as they may be passed over for targeted interventions or resources because they met only a very low threshold for resilience. For example, a child from a poor family who attends school with nearly all-poor students and is reading at a higher level than her similarly poor peers may be passed over for remedial tutoring even though she is behind grade level when compared with non-poor students in other schools. Thus, holding children to a lower threshold of resilience creates a discrepancy between being considered competent by doing better than other children in poverty, but not necessarily performing on par with children who are not at risk. As a society, we should not be satisfied with only making sure that children in poverty reach a low threshold of resilience; our goal should be that poor children reach the standard of achievement met by non-poor children.

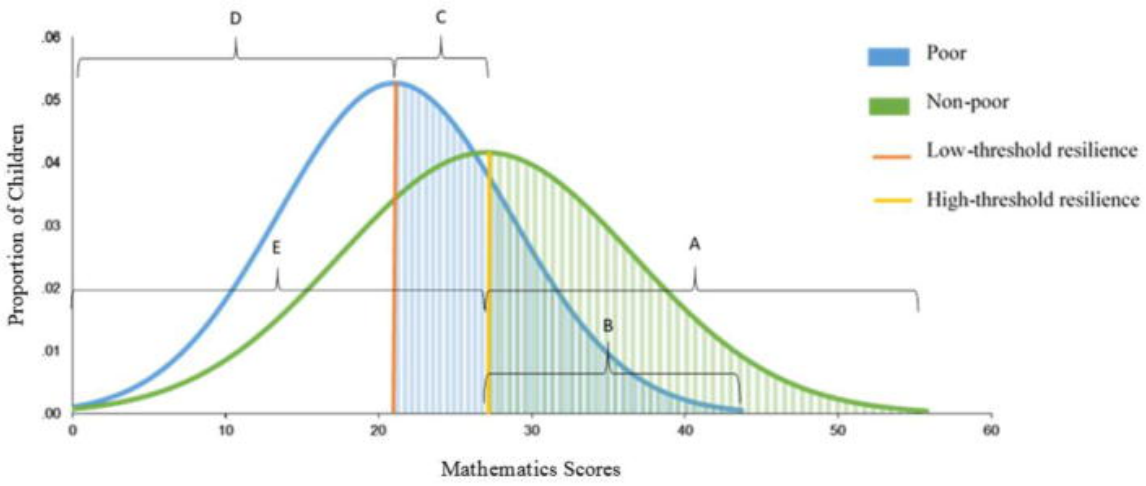


Figure 1

Distributions of mathematics scores for poor and non-poor children at fall of kindergarten for imputed ECLS-K data. Groups: A = Not in poverty and at or above average of other children not in poverty (i.e., key comparison group or "competent children not in poverty"); B = High-threshold resilience for children in poverty; C = Low-threshold resilient for children in poverty; D = Not resilient; E = Not in poverty and below average of other children not in poverty.

Most literature on resilience has examined resilience as an outcome (Masten 2014; Vanderbilt-Adriance & Shaw, 2008) and very little attention has been paid to resilience as a predictor of later outcomes. This is particularly worrisome because in the context of different risk environments, the likelihood of displaying positive development is likely to change over time (Luthar et al., 2000). Therefore, it is important to understand how resilience at a given time point might influence adjustment later on. Examining cognitive resilience at school entry is particularly important for later outcomes because school readiness is predictive of later academic achievement (Duncan et al., 2007). The cognitive skills children enter school with will also be the foundation of later academic success and determine whether or not they are able to gain more advanced skills (Cunha et al., 2006).

## Resilience and Within- and Cross-Domains of Development

There is also disagreement about what developmental domains should be used to classify resilience. Specifically, there is a lack of consistent data on how specific domains of resilience (e.g. mathematics or literacy) might relate to within-domain and cross-domain achievement at later time points. The "skill begets skills" argument (Cunha et al., 2006) argues that early skills in one domain will make it more likely the child will exhibit skills in this domain later in childhood; for example, mathematics should be a strong predictor of later mathematic ability and literacy should be a strong predictor of later literacy. There is certainly evidence to support this claim. Early mathematics abilities are the strongest predictor of later mathematics achievement (Duncan et al., 2007; Claessens, Duncan, & Engel, 2009) and level of emergent literacy skills in early childhood is a strong predictor of later literacy (Lonigan, Schatschneider, & Westberg, 2008; Lonigan, Purpura, Wilson, Walker, & Clancy-Menchetti, 2013). The strength of the within-domain association between early skills and later skills reflects the fact that both mathematics and literacy are taught in ways that build upon previously learned concepts (Sarama, Lange, Clements, & Wolfe, 2012).

Yet there is also research demonstrating that early skills can have cross-domain benefits; this makes particular sense when thinking of language skills preceding math skills, given that children must be able to read well in order to solve math word problems on standardized tests. They must also be able to appreciate that different words can have similar meaning, such as "subtract" or "take away" (Purpura & Ganley, 2014). Cross-domain links between early literacy and later math skills have been demonstrated in several studies. One study found that vocabulary and print knowledge, but not phonological awareness, was predictive of early numeracy skills among preschoolers (Purpura, Hume, Sims, and Lonigan, 2011). A study of preschoolers and kindergarteners found that language skills were related to a wide range of mathematics skills, from counting to number comparisons (Purpura & Ganley, 2014). Another study demonstrated that children's vocabulary size at age 2 was significantly related to later mathematics and reading achievement (Morgan, Farkas, Hillemeier, Hammer, & Maczuga, 2015).

Additional research has found evidence of cross-domain effects in the other direction, such that early math skills promote later language and literacy skills. It may be that children can apply the critical and logical thinking skills fostered by early math education to literacy tasks in ways that improve their comprehension. In analyses using six longitudinal data sets the level of early mathematics skills was the strongest predictor of both later mathematics and reading achievement (Duncan et al., 2007). Other studies have demonstrated that early math curricula interventions are related to improvements in mathematics but also to gains in language and literacy skills (Clements, Sarama, Spitler, Lange, & Wolfe, 2011; Sarama et al., 2012; Clements & Sarama, 2011). Resilience might vary across different domains of development, however, we would expect that children who do well on one domain will also do well on theoretically similar domains of development (Luthar et al., 2000). Although mathematics and literacy are both cognitive domains of development, given the inconsistent evidence on how competence in one domain relates to competence in another domain, we will investigate how resilience at school entry in each of these key academic domains predicts competence within- and across-domains during elementary school.

### The Current Study

Understanding how early resilience among children in poverty predicts their later development is an important step for identifying the type and timing of interventions that will be most helpful in overcoming the risks that accompany a life lived in poverty. Yet because the field has failed to reach a consensus about how to define and operationalize resilience, such efforts have been hindered. This study aims to move the field forward by contrasting two ways of operationalizing resilience among poor children and by examining the implications of each operationalization for predicting children's later development. It does so by answering a key question: Is reaching a resilience threshold at school entry that is based on a comparison with other poor children, what we term "low-threshold resilience", sufficient for promoting later math and reading achievement? Or must children in poverty reach a resilience threshold at kindergarten entry that is defined by a comparison with non-poor children, or "high-threshold resilience"? Furthermore, there is limited research on how resilience in one domain of development predicts later competence within and across domains of development. Thus, this study also investigates the question does resilience (defined as "low" or "high) in one domain promote achievement only within that same domain or does it also promote cross-domain achievement?

## Method

### Data Source

The current study utilized data from the Early Childhood Longitudinal Study- Kindergarten Cohort 1998–1999 (ECLS-K; for sampling information see Tourangeau, Nord, Le, Sorongon, & Najarian, 2009). The ECLS-K is a nationally representative and longitudinal study of over 21,000 children who entered kindergarten in the fall of 1998 and who were followed through eighth grade. We limited the

sample to children with a valid longitudinal sample weight, to ensure our models were nationally representative ($N$ = 9,796). This study focused on children's elementary school academic achievement and used data from assessments at fall of kindergarten, spring of kindergarten, spring of 1st grade, spring of 3rd grade, and spring of 5th grade. During each wave, data were collected through parent and teacher interviews and through direct assessments of children.

## Participants

Descriptive characteristics of the sample for our analyses, all of which were covariates in the analyses below, are shown in Table 1. Overall, the sample was about 5 years old at kindergarten entry, about half female, and racially diverse. English was the primary language spoken at home, about four members lived in the household, and most mothers were married and averaged about 33 years old. A family's poverty status was determined by comparing their income-to-needs ratio, which takes into account family size, with Census poverty thresholds for 1998. Children were classified as living in poverty if their families' income-to-needs ratio fell below the Census poverty threshold. In the ECLS-K full sample, 19.1% of families fell below the poverty thresholds for 1998 (e.g., $16,655 for a family of two adults and two children), almost identical to the national poverty rate for children in 1998 of 18.9% (Dalaker, 1999). In the sample used in the present analyses, the poverty rate was slightly higher (22%) than the sample and national average.

## Table 1

Imputed and Weighted Descriptive Statistics of Covariates

| | | | | |
|---|---|---|---|---|
| entry | | | | |
| Female | 0.49 | 0.48 | 0.51 | |
| Race | | | | |
| White | 0.58 | 0.66 | 0.28 | *** |
| Black | 0.16 | 0.12 | 0.31 | *** |
| Hispanic | 0.19 | 0.15 | 0.32 | *** |
| Asian and other | 0.07 | 0.07 | 0.08 | |
| Disability status | .17 | .16 | .18 | |
| Low birth weight | .08 | .07 | .11 | * |
| *Household Characteristics* | | | | |
| English at home | 0.88 | 0.91 | 0.75 | *** |
| Household Size | 4.51 (.03) | 4.36 (.03) | 5.03 (.07) | *** |
| Mother's marital status | | | | |
| Married | 0.68 | 0.77 | 0.35 | *** |
| Never Married | 0.15 | 0.10 | 0.32 | *** |
| Other | 0.18 | 0.13 | 0.33 | *** |
| Mother's age | 33.08 (.17) | 33.55 (.17) | 31.44 (.43) | *** |
| Mother depression | 5.72 (.15) | 5.34 (.14) | 7.06 (.41) | *** |
| Region | | | | |
| North | 0.18 | 0.19 | 0.13 | ** |
| West | 0.22 | 0.21 | 0.25 | |
| Midwest | 0.23 | 0.25 | 0.16 | *** |
| South | 0.37 | 0.35 | 0.45 | *** |
| Urbanicity | | | | |
| City | 0.37 | 0.35 | 0.45 | ** |
| Suburban | 0.42 | 0.44 | 0.31 | *** |
| Rural | 0.21 | 0.21 | 0.24 | |

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Note.

*$p < .05$;
**$p < .01$;
***$p < .001$.

Sample sizes varied within imputed datasets.

Table 1 displays sample descriptions by poverty status and significance levels were derived from ANOVAs. Compared to children not in poverty, children in poverty were less likely to be White and more likely to be either Black or Hispanic as well as more likely to be born with low birthweight. Children in poverty were less likely to have English be the primary language at home and tended to have more family member in the home. Children in poverty were less likely to have married mothers and more likely to have either never married mothers or mothers with an "other" marital status. Children in poverty tended to have younger mothers and mother with more depressive symptoms. The poor sample was less likely to live in the North or Midwest and more likely to live in the South as well as less likely to be in the suburbs and more likely to live in the city.

## Measures

### Mathematics and literacy achievement

Children's academic achievement was directly measured through math and literacy assessments created for the ECLS-K (Tourangeau et al., 2004, 2006). The math assessments included subjects such as number sense, number properties, geometry and spatial sense, data analysis, and algebra (Tourangeau et al., 2002). The reading assessments focused on skills such as letter and word recognition, vocabulary, and comprehension (Tourangeau et al., 2002). The same items were used in fall of kindergarten, spring of kindergarten, spring of first grade, spring of third grade, and spring of fifth grade. The assessments were expanded to included developmentally appropriate items for the spring of third and fifth grade wave (Tourangeau et al., 2004, 2006). In order to assess longitudinal outcomes, the current study used math and literacy Item Response Theory (IRT) scores. IRT scores estimate the score a child would have received if all of the test items had been administered (Tourangeau et al., 2002). Due to the common items in the routing test and in the second-stage test, the IRT scores can be placed on the same scale and be used to assess growth over time. Higher scores indicate better math or literacy skills. The IRT score internal reliabilities were relatively high for both math and literacy across all waves of assessment, ranging from .92 to .95 and .93 to .96 respectively (Tourangeau et al., 2004). Higher scores indicate better academic outcomes. Math and literacy scores were standardized within each wave of assessment.

### Resiliency thresholds at fall of kindergarten

For each academic domain, we used two mean scores to create the resilience thresholds, namely the mean of the children in poverty and the mean of children not in poverty. Children in poverty were then classified as being high- or low-threshold resilient based on where their scores fell in relation to these two means. Children in poverty were considered to exhibit high-threshold resilience if they were at or above the mean of children who were not in poverty (see Figure 1, Group B). Children were considered to be in the low-threshold resilience group if they were at or above the mean of children who were in poverty but were below the mean of children not in poverty (Figure 1, Group C). Children in poverty were considered to be non-resilient if they were below the mean of other children in poverty (Figure 1, Group D). Children who were not in poverty and scored at or above the mean of children who were not in poverty were the comparison group ( Figure 1, Group A). Children who were not in poverty and were below the mean of children who were not in poverty (Figure 1, Group E) were included for the imputation, however their results are not included in the tables or discussed because they were not the comparison group of interest.

### Control variables

The current study controlled for several childand family covariates in order to reduce the likelihood of spurious relationships and demographic variability. Control variables included child age at kindergarten entry (months), child race (White, Black, Hispanic, or Asian and other), child gender (female or male), if the child was a first-time kindergartener, disability status, low birth weight, language used at home (English or non-English), household size, highest household education (from

8th grade to doctorate degree), parents' marital status (married, never married, or other), mothers' age (years), mothers' depression (0–36; higher is more depressed), region (Northeast, Midwest, South, or West), and urbanicity (City, Suburb, or Rural).

### Analytic Approach

All analyses were conducted with Stata 14 (StataCorp, 2015). We imputed 50 datasets through the chained equations method to account for missing data. All models were clustered using the school-level id to account for non-independence of children's outcomes and all models were weighted with the longitudinal sampling weight to ensure the sample was nationally representative. We regressed later academic skills (spring of kindergarten, spring of first grade, spring of third grade, and spring of fifth grade) on different domains of resilience at kindergarten entry (not resilient, low-threshold resilience, and high-threshold resilience). Each of these outcomes were modeled in separate regressions to examine the unique effects between resilience groups and achievement at each time point. In all analyses, the reference group was children who were not poor and displayed at or above average academic skills for all children not in poverty at kindergarten entry. For simplicity, we refer to this reference group below as competent children not in poverty (this is similar to the high competence, low adversity group of earlier resilience studies cited in Luthar et al., 2000). We chose the competent children not in poverty as the reference group in order to examine how children who attained different thresholds of resilience performed in different academic domains compared to children who did not experience the risk of poverty. We did rotate the reference category in order to investigate significant differences between resilience groups on later achievement outcomes.

We also estimated the grade level discrepancies between children in the different resilience groups (not resilient, low-threshold resilience, and high-threshold resilience) compared to competent children not in poverty. To do this, we regressed each academic outcome at each time point (spring of kindergarten, spring of first grade, spring of third grade, and spring of fifth grade) on the child's age in months. This coefficient was then averaged across the time points, thereby creating an average monthly gain in either mathematics or literacy (see Bradbury, Corak, Waldfogel, & Washbrook, 2011). This average was multiplied by 9, for 9 months in a school year, to create an average school year gain in either mathematics or literacy. To estimate the grade discrepancies, the unstandardized coefficients from the first two sets of analyses were then divided by the average school year gain.

## Results

### Prevalence of Each Definition of Resilience

For mathematics achievement at the fall of kindergarten, about 59% of children in poverty were not resilient at all, 26% displayed low-threshold resilience, and 15% displayed high-threshold resilience. For literacy achievement, about 55% of children in poverty were not resilient, 31% displayed low-threshold resilience, and 14% displayed high-threshold resilience.

### Within-Domain Resilience Thresholds Predicting Academic Outcomes

We regressed later mathematics skills (spring of kindergarten, spring of first grade, spring of third grade, and spring of fifth grade) on mathematics resilience at kindergarten entry (not resilient, low-threshold resilience, and high-threshold resilience). As seen in the left side of Table 2, the not resilient group and the low-threshold resilience group performed significantly worse in later mathematic skills across all grades compared to competent children not in poverty (see Table 2, top left). The high-threshold mathematics resilience group was not significantly different from competent children not in poverty when predicting later mathematics skills. In addition, the not resilient and low-threshold

resilience groups were significantly lower in later mathematics skills compared to the high-threshold resilience group. The not resilient group also had significantly lower mathematics skills compared to the low-threshold resilience group.

## Table 2

Early resilience to poverty predicting later academic achievement

| | **Mathematics Achievement — Within Domain** | | | | **Literacy Achievement — Cross Domain** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Spring of KG** | **Spring of 1st grade** | **Spring of 3rd grade** | **Spring of 5th grade** | **Spring of KG** | **Spring of 1st grade** | **Spring of 3rd grade** | **Spring of 5th grade** |
| | **B (SE)** | **B (SE)** | **B (SE)** | **B (SE)** | **B (SE)** | **B (SE)** | **B (SE)** | **B (SE)** |
| Mathematics Resilience at Fall of Kindergarten | | | | | | | | |
| Not resilient | −1.49 (.05) | −1.34 (.06) | −1.44 (.06) | −1.38 (.06) | −1.18 (.05) | −1.31 (.06) | −1.38 (.06) | −1.33 (.06) |
| Low-threshold resilience | −.89 (.06) | −.79 (.07) | −.92 (.07) | −.77 (.08) | −.78 (.05) | −.75 (.08) | −.84 (.09) | −.70 (.09) |
| High-threshold resilience | −.10 (.12)[a] | −.13 (.10) [a] | −.15 (.10) [a] | −.08 (.09) [a] | −.23 (.11) | −.20 (.13) [a] | −.11 (.11) [a] | −.09 (.09) [a] |
| | Literacy Achievement — Within Domain | | | | Mathematics Achievement — Cross Domain | | | |
| | Spring of KG | Spring of 1st grade | Spring of 3rd grade | Spring of 5th grade | Spring of KG | Spring of 1st grade | Spring of 3rd grade | Spring of 5th grade |
| | B (SE) | B (SE) | B (SE) | B (SE) | B (SE) | B (SE) | B (SE) | B (SE) |
| Literacy Resilience at Fall of Kindergarten | | | | | | | | |
| Not resilient | −1.36 (.05) | −1.37 (.06) | −1.28 (.08) | −1.23 (.07) | −1.33 (.06) | −1.12 (.07) | −1.18 (.07) | −1.15 (.07) |
| Low-threshold resilience | −.91 (.05) | −.83 (.07) | −.80 (.08) | −.76 (.08) | −.79 (.06) | −.66 (.07) | −.71 (.09) | −.67 (.08) |
| High-threshold resilience | −.20 (.11) [a] | −.29 (.14) | −.25 (.12) | −.21 (.10) | −.22 (.14) [a] | −.17 (.11) [a] | −.21 (.12) [a] | −.17 (.12) [a] |

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*Note.* The reference group is children not in poverty who scored at or above the average on that achievement test at fall of kindergarten (i.e. competent children not in poverty)

[a]These groups were not significantly different from the average child not in poverty ( $p > .05$). All other groups were significantly different from each other.

We also regressed later literacy skills (spring of kindergarten, spring of first grade, spring of third grade, and spring of fifth grade) on literacy resilience at kindergarten entry (not resilient, low-threshold resilience, and high-threshold resilience). The not resilient, low-threshold resilience, and high-threshold resilience all performed significantly worse in later literacy skills compared to competent children not in poverty with one exception (see bottom left of Table 2). Children who exhibited high-threshold literacy resilience were not significantly different from competent children not in poverty in literacy skills at the spring of kindergarten. The not resilient, low-threshold resilience, and high-threshold resilience groups were also all significantly different from each other across all time points for literacy skills, with high-threshold resilience having higher literacy skills than low-threshold resilience, which had higher literacy skills compared to those who were not resilient.

Grade gaps between resilience groups (not resilient, low-threshold, and high-threshold) and competent children not in poverty are on the left side of Table 3. Across the four assessments, the high-threshold mathematics resilience group stayed within a grade level in math achievement as competent children not in poverty. In contrast, the low-threshold resilience group fell almost 3 grades behind their competent peers who were not poor in kindergarten in their math achievement, while the not resilient group fell over four grades behind. Compared to competent children not in poverty, the high-threshold literacy resilience group remained within one grade in terms of literacy skills, whereas the low-threshold literacy resilience group fell about 3 grades behind and the not resilient group fell over 4 grades behind across elementary school.

Table 3

Grade gaps (number of grade levels behind) between children who were poor and competent children not in poverty

| | **Mathematics Achievement — Within Domain** | | | | **Literacy Achievement — Cross Domain** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Spring of KG** | **Spring of 1st grade** | **Spring of 3rd grade** | **Spring of 5th grade** | **Spring of KG** | **Spring of 1st grade** | **Spring of 3rd grade** | **Spring of 5th grade** |
| Mathematics Resilience at Fall of Kindergarten | | | | | | | | |
| Not resilient | −4.7 | −4.3 | −4.6 | −4.4 | −4.3 | −4.8 | −5.0 | −4.8 |
| Low-threshold resilience | −2.8 | −2.5 | −2.9 | −2.4 | −2.8 | −2.7 | −3.1 | −2.5 |
| High-threshold resilience | −0.3 | −0.4 | −0.5 | −0.3 | −0.8 | −0.7 | −0.4 | −0.3 |
| | Literacy Achievement — Within Domain | | | | Mathematics Achievement – Cross Domain | | | |
| | Spring of KG | Spring of 1st grade | Spring of 3rd grade | Spring of 5th grade | Spring of KG | Spring of 1st grade | Spring of 3rd grade | Spring of 5th grade |
| Literacy Resilience at Fall of Kindergarten | | | | | | | | |
| Not resilient | −4.9 | −5.0 | −4.6 | −4.4 | −4.2 | −3.6 | −3.8 | −3.7 |
| Low-threshold resilience | −3.3 | −3.0 | −2.9 | −2.8 | −2.5 | −2.1 | −2.2 | −2.1 |
| High-threshold resilience | −0.7 | −1.0 | −0.9 | −0.8 | −0.7 | −0.5 | −0.7 | −0.5 |

## Cross-Domain Resilience Thresholds Predicting Academic Outcomes

We also examined cross-domain associations in order to determine whether mathematics resilience at kindergarten entry predicted later literacy skills and whether literacy resilience at kindergarten entry predicted later mathematics skills. The right side of Table 2 contain these cross-domain estimates. In regards to mathematics resilience predicting later literacy skills, the high-threshold math resilience group was significantly lower at the spring of kindergarten compared to competent children not in poverty, but this difference became not significant for spring of 1st grade through spring of 5th grade (see Table 2, right side). The low-threshold mathematics resilience and not resilient groups had significantly lower literacy skills across elementary school compared to competent children not in

poverty. The not resilient, low-threshold resilience, and high-threshold resilience mathematics groups were all significantly different from each other across all time points. In terms of grade gaps in literacy, the high-threshold mathematics group stayed within one grade level compared to competent children not in poverty (Table 3, right side). The low-threshold mathematics resilience group was over 2 grades behind in literacy across elementary school and the not resilient group was over 4 grades behind compared to competent children not in poverty.

For kindergarten literacy resilience predicting later mathematics skills, the high-threshold resilience group was not significantly different from competent children not in poverty (see Table 2, right side). The literacy low-threshold resilience and not resilient groups had significantly lower mathematics skills across elementary school compared to children in the high-threshold literacy resilience group and competent children not in poverty. Additionally, the literacy low-threshold resilience group performed significantly better than the not resilient group in terms of mathematics across all time points. In regard to mathematics grade gaps, children with high threshold literacy resilience remained within one grade level of competent children not in poverty, whereas children in the low threshold resilience group were about two grades behind and children in the not resilient group were over three grades behind (see Table 3, right side).

To illustrate the within-domain and cross-domain associations, predicted standardized coefficients have been plotted in Figures 2 and 3. Starting with mathematics scores across elementary school (Figure 2), the literacy and mathematics resilience groups displayed similar trends for later mathematics skills. Overall, children who exhibited high-threshold resilience in either mathematics or literacy at entry to kindergarten had higher mathematics skills across elementary school compared to children who fell into the low-threshold resilient or not resilient groups. For later literacy skills (Figure 3), literacy and mathematics resilience again followed similar trends across time; however, based on the regression tables high-threshold literacy resilience is only not significantly different from competent children not in poverty at the first time point, whereas high-threshold mathematics resilience is not significantly different from competent children not in poverty at the last three time points. We thus found clear cross-domain effects: early high-threshold mathematics resilience helped children stay on track with competent children not in poverty in literacy skills in the long-term, whereas high-threshold literacy resilience only provided short-term benefits. Additionally, both high-threshold mathematics and literacy were related to staying on par with competent children not in poverty in terms of later mathematic skills.

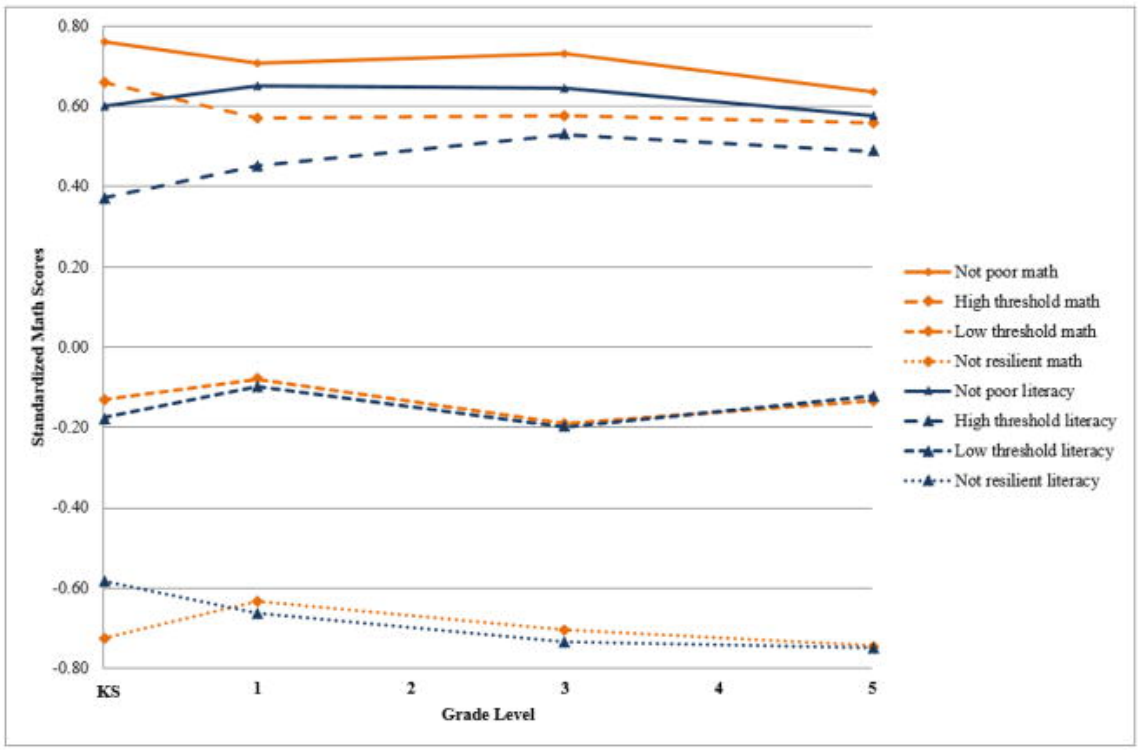


Figure 2

Mathematics scores across elementary school predicted by different thresholds and domains of resilience to poverty at the fall of kindergarten. KS = spring of kindergarten.

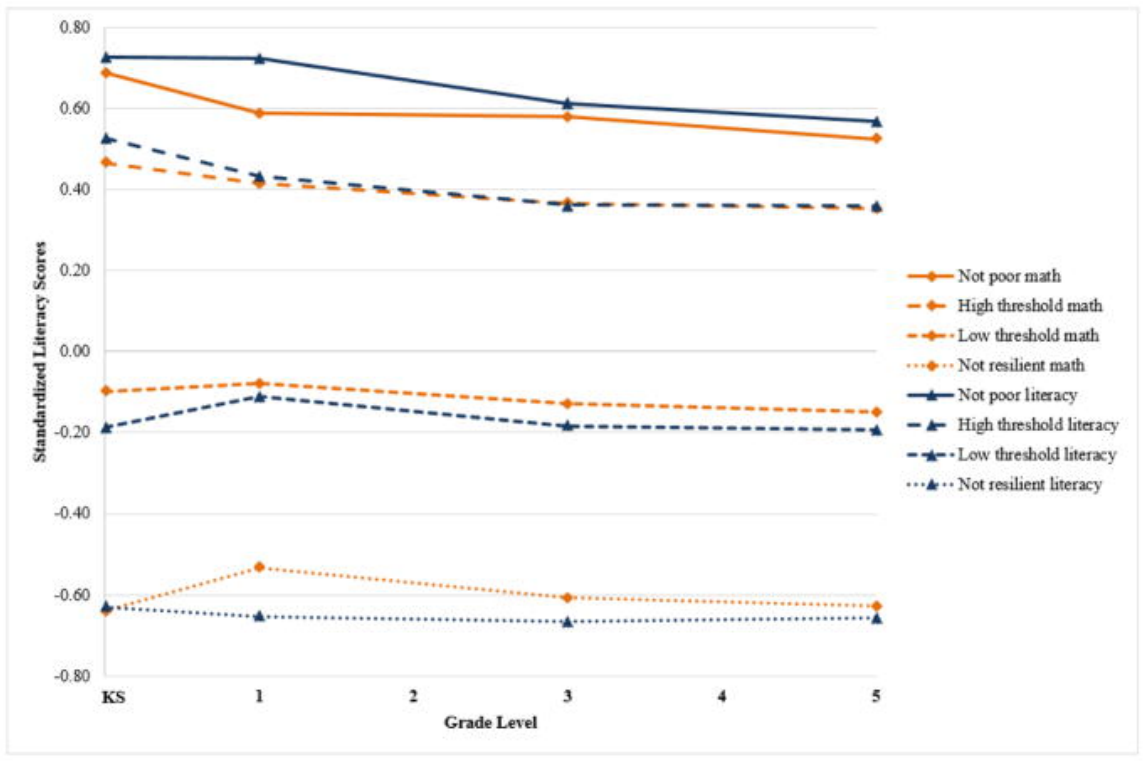


Figure 3

Literacy scores across elementary school predicted by different thresholds and domains of resilience to poverty at the fall of kindergarten. KS = spring of kindergarten.

## Discussion

Despite the increased risk of maladaptive developmental outcomes for children living in poverty (Berger et al., 2009; Brooks-Gunn & Duncan, 1997; McLoyd, 1998; Yoshikawa et al., 2012), some children are able to display positive outcomes and are considered resilient. Current research on resilience to poverty uses a variety of operationalizations for defining resilience, which can have important implications both for research and for the evaluation of programs targeted at children in poverty. Therefore, the current study explored how varying thresholds of resilience and developmental domains of resilience at kindergarten entry related to within-domain and cross-domain academic achievement across elementary school.

Our first main finding was that children from poor families who achieved high-threshold resilience—in other words, were at the same level of achievement at the fall of kindergarten as non-poor children—were generally not significantly different from competent children who were not in poverty across later years of elementary school. The one exception was high-threshold literacy resilience was still significantly lower than competent children who were not in poverty for the last three time points. Secondly, children who reached high-threshold resilience at kindergarten performed significantly better across elementary school than children who reached low-threshold resilience across both within-domain and cross-domain outcomes. These results provide evidence that the standard for defining resilience has implications for predicting children's future development. Knowing a child has reached low-threshold resilience is not a guarantee that he or she will reach his or her non-poor peers in terms of later achievement. Indeed, as our results make clear, children who demonstrated low-threshold resilience were typically much closer to their poor peers who fell below the low threshold than to their

peers not in poverty. Taken together, these findings suggest that the comparison group for a meaningful definition of resilience for children in poverty must be the normed standards of children not experiencing risks, not just the subpopulation of their peers also living in poverty. In order to truly know if social programs are promoting resilience in the lives of poor children, it may be better to use Masten's (2001) high-threshold definition of resilience (i.e., thriving in the face of adversity) rather than Rutter's (2006) low-threshold definition (i.e., doing better than peers in similar risky environments; e.g. Borman & Overman, 2004; Cicchetti, Rogosch, Lynch, & Holt, 1993). Some research on resilience, such as in the area of maltreatment, has more consistently defined resilience based on a comparison to children not at risk (Jaffee & Gallop, 2007; Walsh, Dawson, & Mattingly, 2010). Thus, when studying the risks of poverty or maltreatment, future research should continue to use this higher standard of resilience in which children display similar levels of adaptation as peers who do not experience those risks. However, there might be specific reasons, such as the impact of the studied risk (Luthar et al., 2000), for moving the threshold of resilience to be higher or lower than children who do not experience that risk. Future researchers must carefully consider what comparison group should be used when defining resilience, how these different levels of adaption might influence children's long-term development, and explicitly state how they are measuring resilience.

## Resilience Within and Across-Domains

Our study contributes several important findings with regard to within-domain and cross-domain development. First, it seems that mathematics resilience at school entry might be a better predictor of adaptive within-domain development than literacy resilience. These results are consistent with prior research demonstrating early math abilities are the strongest predictor of later mathematics (Duncan et al., 2007; Claessens et al., 2009). With regard the literacy resilience, it might be that the literacy skills learned at school entry provide short-term benefits, but skills learned later in school are necessary for continued positive outcomes. Another explanation could be that literacy skills are much more specialized. For example, Lonigan and colleagues (2013) found that children who were assigned to a meaning-focused intervention showed improvements in reading and children assigned to a code-focused focused intervention demonstrated improvements in phonological awareness or letter knowledge, but neither intervention demonstrated improvements across literacy skills. Future research should continue to explore how components of certain academic domains, such as phonological awareness or letter knowledge as opposed to literacy generally, are related to later development.

Second, we found consistent evidence of cross-domain promotion of skills across time. In other words, resilience in mathematics at school entry predicted higher literacy skills later in elementary school, and early resilience in literacy promoted later achievement in mathematics. It might be that the skills necessary for learning mathematics and literacy are more interdependent that previously thought, and that these skills are mutually reinforcing. This explanation is in line with the concept of "developmental cascades", which refers to the processes of interactions and transactions between developing systems and proposes that adaptation in one domain would spread across to another domain (Masten & Cicchetti, 2010). Sarama and colleagues (2012) made a similar argument, observing that sets of literacy and mathematics skills are learned at similar times and that one set of skills reinforces the other. Previous research has focused on investigating which academic domain, mathematics or literacy, might be most beneficial for academic development and this has led to conflicting evidence (Duncan et al., 2007; Clements et al., 2011; Sarama et al., 2012; Clements & Sarama, 2011; Purpura et al., 2011; Morgan et al., 2015). Based on the results of the current study, it appears that promoting either resilience in mathematics or literacy among children in poverty could lead to positive growth in both within-domain and cross-domain academic outcomes. Future research should continue to explore how resilience varies by developmental domains and how resilience in one or multiple domains relates to later development.

## Limitations and Conclusions

Several limitations should be taken into account when considering these results. First, poverty was the only risk factored considered, but poverty has many co-occurring risk factors that children must overcome in order to be resilient (Abelev, 2009; Yoshikawa et al., 2012). With this fact in mind, we controlled for several potential co-occurring factors in all of our analyses (race, home language, disability status, low birthweight, household size, mothers' marital status, mothers' depression, region, and urbanicity) but we acknowledge that there may be other, unmeasured factors associated both with poverty status and with our outcomes of interest. Future work should investigate how protective factors and risk factors co-occur among children who later display resilience and how protective and risk factors interact to promote resilience. Additionally, we only explored resilience among children in poverty as defined by falling below the federal poverty threshold rather than by how varying levels of poverty might influence resilience. Poverty is not a universal experience, however, and depth of poverty has been found to matter for children's academic outcomes (Cutuli et al., 2013). Therefore, it will be important for future research to extend our findings by considering how depth of poverty may be differentially linked to domains of resilience. The current study focused on academic domains of resilience and academic outcomes; however resilience can occur in other domains, such as emotional or behavioral development. Multiple domains of resilience should be considered in future research. This study investigated resilience only at school entry; however, both risks, in our case exposure to poverty, and resilience are likely to vary across time. Future research should investigate how resilience changes across time based on changing exposure to risks.

Despite these limitations, the current study has several important implications. This study was one of the first to demonstrate that children in poverty who display similar levels of functioning at school entry as competent children not in poverty are likely to stay on track academically across elementary school. This reinforces the importance of promoting school readiness at entry to kindergarten among children in poverty (Reardon, 2011). Additionally, this study provides evidence that children who achieve low-threshold resilience are still likely to fall behind across elementary school. Therefore, practitioners could direct programs and resources toward children who screen as not resilient and low-threshold resilient at school entry because these groups are more vulnerable academically. This study also suggests that investing in early mathematics and literacy skills have both within- and cross-domain benefits over time and that neither should be ignored. Finally, this study clearly demonstrated the implications of using different thresholds for defining resilience and the need to emphasize high-threshold resilience in future research. Holding disadvantaged children to a low standard does not do them any favors and may inadvertently lead to the misdirection of resources away from children who are doing well enough compared to their poor peers. As a society, we should want all children to perform to their capacity, and we can only ensure that if our goal for poor children is the same standard we have for non-poor children.

### Highlights

- Thresholds of resilience at school entry were related to elementary achievement.
- Achieving high-threshold resilience predicted staying on par with non-poor peers.
- Math and literacy resilience at school entry displayed cross-domain benefits.

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## Footnotes



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