Journal of Education and Human Development
December 2019, Vol. 8, No. 4, pp. 199-209
ISSN: 2334-296X (Print), 2334-2978 (Online)

Published by American Research Institute for Policy Development
DOI: 10.15640/jehd.v8n4a23
URL: https://doi.org/10.15640/jehd.v8n4a23

Student's SES and the Effect of Schooling on Cognitive Development

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Abstract

Schooling is considered the major factor underlying cognitive development. This study contributes to the investigation of this central issue by comparing, for the first time, the effects of schooling on the cognitive development of students differing in their socioeconomic status (SES). The findings reveal the existence of a sizeable interaction between schooling and the students' SES. Both the absolute and the relative (to the effect of age) effects of schooling are considerably higher among high-SES students.

Keywords: Cognitive Development, SES, Schooling Effect, Between-grade Regression Discontinuity Design.

1. Introduction

The studies on the effect of schooling on cognitive development published during the last 25 years support the conclusion that schooling is a major factor underlying children's cognitive development (Cahan & Cohen, 1989; Cliffordson & Gustafsson, 2008; Gambrell, 2013; Kyriakides & Luyten, 2009; Luyten, 2006; Stelzl, Merz, Ehlers, & Remer, 1995; Wang, Ren, Schweizer, & Xu, 2015). However, the available published studies have only examined the effect of schooling on cognitive development for the population as a whole and ignored the possible interaction between schooling and theoretically relevant characteristics of schools (e.g., physical conditions, class size, teachers' qualifications) and students (e.g., gender, family SES, cognitive level) in terms of the magnitude of the schooling effect, that is, the possible variability of the schooling effect between subpopulations of schools or students in the same educational system. Yet estimating the between-school and between-student variability of the schooling effect magnitude and identifying its correlates is an integral part of a comprehensive study of the effects of schooling on cognitive development and should not be ignored. Differences in the characteristics of schooling, the characteristics of students and their interaction may result in differential effects of schooling on cognitive development (Jabr & Cahan, 2014a; Jabr & Cahan, 2014b).This work contributes to the empirical investigation of this important question by estimating, for the first time, the interaction between schooling and students' socio- economic status (SES) in terms of the magnitude of the effect of schooling on cognitive development. The focus on SES as a key student characteristic in terms of the magnitude of the effect of schooling on cognitive development is based on the extensive theoretical literature and the ample empirical evidence regarding the effect of the socio-economic level of the family, as indicated by parental education and income (Davis-Kean, 2005), on students' cognitive development and school achievement (e.g., Alderman, 2011;Heckman, Pinto, Savelyev, & Yavitz, 2010).We hypothesize that this effect is at least partly due to the differential effect of schooling on children from different SES backgrounds.

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The family SES is likely to affect the magnitude of the schooling effect on children's cognitive development in two different ways. Firstly, through differential access to high quality schooling.

Children from high- SES families are more likely than their low- SES counterparts to attend better schools (Van Ewijk & Sleegers, 2010), that is, schools with higher financial resources (Baum, 2003) - reflected in better premises, smaller class size (Nathan, 2002), higher teacher/student ratio, better equipment, higher teachers' salaries, and more learning time (Smith, Roderick, & Degener, 2005),higher teachers' qualifications, experience, training, effectiveness and leadership (Haycock & Crawford, 2008).The relationship between children's SES and the quality of the schools they attend is further augmented by the resulting positive correlation between children's SES and the average SES level of the school's student population: children from higher SES families tend to study in schools catering to children with wealthier and better educated parents and vice-versa for children coming from lower SES families (VanEwijk & Sleegers, 2010).The composition of the school student population is likely to affect the shaping of school processes (e.g., mission, expectations, norms and values, class formulation, access to curriculum) as well as the disciplinary climate or atmosphere in a class (Hoxby, 2000), the teachers' style of teaching (Harker &Tymms, 2004) and peer competition (OECD, 2001), thereby increasing the differences between children from different SES levels in the quality of schooling they receive.

The second way in which the family SES can moderate the effect of schooling on children's cognitive development is by affecting their ability to benefit from the schooling provided to them (henceforth, ABS). Same-quality schooling may have considerably different effects on children's cognitive development, as a function of their ABS. All else being equal, the effect of schooling on the cognitive development of high ABS students can be expected to be stronger than its effect on low ABS students. ABS variability is thus a major potential explanation of differences in the effect of schooling on cognitive development. And the family's SES is a major factor in determining children's ABS. Children from wealthier and more educated families are more likely to have higher ABS. They generally benefit from higher stability and security, availability of health care, superior learning conditions, parental support and parental involvement in school activities (Davis-Kean, 2005). As a result, they tend to have higher levels of optimism, self-esteem, and achievement motivation (Cassidy & Lynn, 1991). In contrast, children from poorer and less educated families are less likely to have responsive parenting and stimulating learning environments. They are at risk of higher incidence of maternal depression and stress, lack of access to adequate nutrition, poor housing, dangerous neighborhoods and pollution (Alderman, 2011). Their parents often provide little support at home, are less likely to be involved in school activities (Vellymalay, 2010) and have lower expectations for their children's success (Davis-Kean, 2005).Hence the expectation that the effect of schooling will vary considerably between SES levels. This study empirically examines this question.

2. Method

2.1 Target Population and Sample

The target population of the study consisted of all fifth to ninth graders attending gender- segregatedfemale public schools in the Palestinian West Bank which included all of these grades in the 2012-13 school year. A stratified random sample of 67 schools (out of the total population of 256 schools) was selected from the three educational regions of the West Bank (north, center and south).From each sampled school, 60 students were randomly selected (12 students from each grade, 5^{th} through 9^{th}). Thus, the planned size of the sample of students was 4000 students, 1,200 per grade.

2.2 The Cognitive Test

Cognitive development was measured by the cognitive ability test battery used by Cahan and Cohen (1989). The battery consists of twelve subtests and a total of 178 items, covering a wide range of content (e.g., analogies, series, sentence completion, vocabulary) and varying in the nature of their items (verbal, numerical, and figural), selected from well-known tests of general ability: the Cognitive Ability Test (CAT; Thorndike & Hagen, 1971), the Lorge-Thorndike Test (L-T; Lorge& Thorndike, 1954), Standard Progressive Matrices (SPM; Raven, 1983), and Cattell and Cattell's Culture Fair Intelligence Test (CFIT; Cattell & Cattell, 1965). All of the verbal tests were translated into Arabic and adapted for the population.

2.2.1 Test administration. School counselors administered the entire test battery to the students as a group, in school during May 2013. The tests were given in a fixed order in a single, two-hour session with a 15-minute break. Students were given general explanations about the item format and the response sheet.

In addition, the administration of each subtest was preceded by a short explanation and an illustrative example of the particular task. All the sampled schools took part in the study. Of the participating students, 95% (3818 out of 4000) completed the entire battery of tests. The participation rate was stable across grade levels and did not vary considerably between schools.

2.2.2Cognitive test score. For each participant we computed a "total" cognitive test score (percent correct answers). The within- grade internal consistency reliability (Cronbach's Alpha) of this score (ranging between 0.96 and 0.97 across grades) is impressive; it equals the corresponding figures for the *individually –administered* WISC IV (Williams, Weiss, & Rolfhus, 2003) and K-ABC (Kamphaus, 2005) intelligence batteries.

2.3 Key Variables

In addition to the cognitive test score, the study's database includes three key variables: chronological age at test administration, schooling, and the student's family SES.

Chronological age at test administration. The exact birth date for each participant was obtained from the school records. On the basis of this information, the exact age on the day of test administration was computed for each child. The age was expressed in decimal form (for example 11.5 years means 11 years and 6 months).

Schooling . Since the cognitive test was administered at the very end of the school year (in May), the current grade level of each student was considered as indicative of the number of years of schooling (for example, a student in 9th grade had 9 years of schooling).

Family SES.A participant's SES was defined as the average of the family's (standardized) income and parental education. Information about father and mother education, as well as information about the family's income, was provided by the students' mothers.For882 out of the 3811 participants who took the cognitive test SES level could not be determined due to missing information about parental educational level or income(See Table 1).

2.4 Estimation of the Schooling Effect on Cognitive Development

2.4.1 The between-grades paradigm. The causal model underlying cognitive development includes two factors: chronological age (and the associated psycho-physiological development, life experience, and out-of-school learning) and schooling. Furthermore, these two factors are inexorably interrelated due to the compulsory nature of schooling (at least at the elementary level) in modern societies: older children are typically enrolled in higher grades and vice versa. This inextricable interdependence precludes straightforward disentangling of the unique contributions of chronological age and schooling to cognitive development. In view of the obvious impossibility of experimenting with school attendance, attempts have been made to examine the effect of schooling based on "natural experiments," the comparison between same-age children with different amounts of schooling. However, the selective nature of school attendance in these studies invalidates the causal conclusions regarding the schooling effect (Cahan & Cohen, 1989). The possibility that this variability was affected by self- or other forms of selection related to characteristics such as intelligence, parents' education or socioeconomic status cannot be ruled out retrospectively. The quasi-experimental between-grade regression discontinuity design (BGRD; Cahan & Davis, 1987) provided a satisfactory solution to this problem and has been repeatedly used for this purpose since its suggestion. This design was also adopted in this study to disentangle the independent effects of schooling and age on the overall cross-sectional increase in mean cognitive scores. The BGRD design relies on the following assumptions: (1) the "allocation" of children to birth dates is random; and (2) grade level is solely a function of chronological age; that is, admission to school is based on chronological age only, according to some arbitrary cut-off point, and progression through grades is automatic (i.e., there are no drop-outs and children are neither kept back nor advanced a grade). If these assumptions hold true, then the net effects of age and schooling are estimated by means of a between-grade regression discontinuity design, in which test scores are regressed on chronological age within grades. In this design, the effect of age is reflected in the slope of the within-grade regression of test scores on chronological age, and the effect of schooling is reflected in the discontinuity between these regressions (see Figure 1).

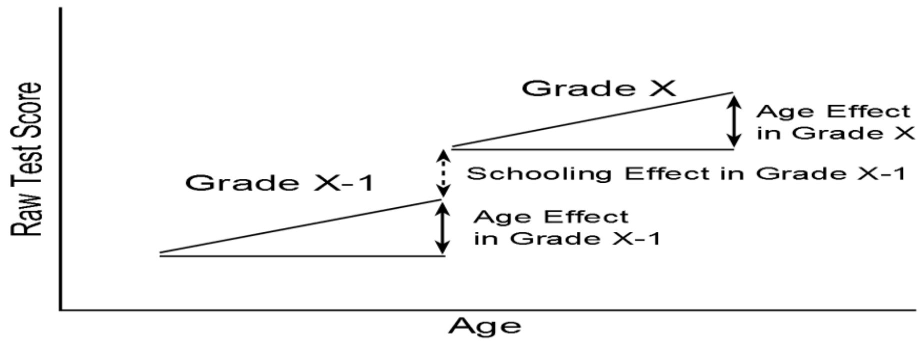

Figure 1.The effects of age **and schooling in the between-grade regression discontinuity design.**

Specifically, the estimated effect of a one-year difference in chronological age in a given grade equals the difference between the oldest and youngest students in that grade in mean scores, and the estimated effect of one year of schooling equals the differences in mean scores between the youngest children in any given grade (*X*) and the oldest children in the lower adjacent grade (*X*−1).

2.4.2 The truth of the assumptions. The truth of the first assumption cannot be empirically tested. However, since we tested students in five consecutive grades in a relatively homogeneous population, this assumption seems reasonable with respect to between-grade variability. As far as within-grade randomization is concerned, exceptions to this assumption can affect estimates of age and schooling effects only if they are monotonically related to birth date, which is very unlikely. The second assumption of the model is only partially true. First, because according to the official rule in the West Bank school system, the range of normative birth dates for admission to first grade in any given school year Y is 13 (rather than the customary 12) months, from January 1st of the year Y-6 to January 31st of the following year (i.e., Y-5). Thus, there is an overlap of one month (January) between the *normative* birth date ranges for any two adjacent school years.

Importantly, the parents of the January–born children have the privilege of choosing between Y and Y+1 for their child's enrollment in the first grade. Note, however, that this choice is not random: the children born in January of the year Y-6 whose enrollment in the first grade was in year Y-- and consequently are the youngest children in their grade-- are likely to be brighter, on average, than those whose enrollment in the first grade was delayed to year Y+1, and, therefore, are the oldest in their grade. Thus, at both extremities of the within-grade normative age range, selection affects the within-grade regression slopes in the same direction: because the mean test scores of the *youngest* children in each grade is positively biased, whereas the mean test score of the *oldest* children is biased in the opposite direction, the empirically obtained slope is attenuated, that is, smaller than the true one, thus leading to an underestimation of the age effect and an overestimation of the schooling effect. In order to cope with this problem, all the January-born students have been excluded from the analysis. Secondly, the second assumption of the BGRD design is only partially true also because the admission rule in the West Bank school system, like in other school systems, is not universally enforced: admissions are sometimes delayed or accelerated.

Consequently, in addition to the children born in January, who are distributed between adjacent grades, there are 'overage' and 'underage' children born in other months who, by age, ought to be in a higher or lower grade, respectively, and are 'missing' from the grade that corresponds to their chronological age according to the normative rule. More importantly, in this case as well delaying or accelerating admissions is not random. The children whose admission was delayed are likely to be less developed intellectually than others in their age group, and those whose admission was accelerated are likely to be more developed. Hence, the children who remain in the 'appropriate' grade are also selective in the opposite direction: on average, the cognitive level of the remaining youngest children in each grade is likely to be too high, whereas that of the oldest too low. In addition, the relative frequency of grade misplacement is related to the month of birth, being particularly high near the cut-off point: delays are especially frequent among the youngest children in each cohort and accelerations among the oldest. In particular, the relative frequency of acceleration is much higher among children born in February (see Appendix 1). There are two ways in which selective misplacement may affect the within-grade regression slopes (Cahan & Cohen, 1989). First, due to the existence of underage and overage children in each grade.

The direction of this effect cannot be established a priori, since age and selection counteract each other in this case: the underage children are also brighter, while the overage ones are generally duller.

Second, due to the missing children in each grade: at the lower extreme of the age range, the missing children are those that have been delayed; hence, the mean test score of the remaining children in the youngest groups is higher than the true one. At the higher extreme of the age range, selection operates in the opposite direction: the missing children are the brightest ones, whose admittance to school has been accelerated. Consequently, the mean test score of the remaining children in the oldest group is lower than the true one. Thus, the missing children at both extremities of the age range affect the within-grade regression slopes in the same direction: the empirically obtained slope is attenuated, that is, smaller than the true one, thus leading to an underestimation of the age effect and an overestimation of the schooling effect. In order to cope with this problem, following Cahan and Cohen (1989), two additional groups of subjects were excluded from the computation of the within-grade regressions: (a) students who were under- or over-aged; and (b) students born in February, where the proportion of missing students is highest (see shaded columns in Appendix 1). Table 1 gives the numbers and percentages of the excluded children.

Table 1 Numbers of Participants included in the Analysis

Planned Sample	4000	100%
Of these, completed the cognitive test	3811	95%
Of these, have valid SES data	2909	73%
Of these, enrolled in the right grade for their age	2552	64%
Of these, not born in January	2383	60%
Of these, not born in February and included in the main analysis of the estimation of the effects	2232	56%

Following the exclusion of these two groups, as well as of the January-born participants, each within-grade regression was based only on children born between March and December of the appropriate year for that grade and extrapolated to cover the entire age range. While there still is a small proportion of missing students in these birth months, this number does not vary considerably between the months and was, therefore, unlikely to affect the within-grade slope.

2.4.3 Averaging effects. The BGRD design described above was used to estimate the effect of one year of schooling in each of four grades (6 through 9)and the effect of age in each of the five grades (5 through 9), separately for each of the two SES subgroups resulting from the dichotomization of the SES around the sample median: "high SES" (50%) and "low SES" (50%). The "true" effects of one year of age and one year of schooling for each SES group were then estimated by averaging the obtained five age effects and four schooling effects, respectively (These averages are equivalent to the coefficients of age and grade level in the across-grade multiple regression of test scores on age and grade level).

3. Results

The estimated effects of age and schooling for the two SES groups (expressed in pooled-within- grades standard deviation units)are presented in the left hand column (A) of Table 2 and illustrated graphically by the two circles in Figure2. Each circle represents an SES group and the coordinates of each circle are the corresponding age (horizontal axis) and schooling (vertical axis) estimated effects for that group.

Table 2 Estimated Average Effects of 1 Year of Age and 1 Year of Schooling in Grades 5 through 9 on Cognitive Test Scores in low- and high-SES Students, by Analysis (in pooled within-grade SD units)

	Total (Across-School) (A)		Pooled Within-School (B)		Pooled within school Including School's ID (C)	
Student SES	Age	Schooling	Age	Schooling	Age	Schooling
Low SES*	0.30	0.0	0.29	0.02	0.32	0.0
High SES**	0.11	0.24	0.03	0.30	0.08	0.24

*SE ~ 0.10
**SE ~ 0.13

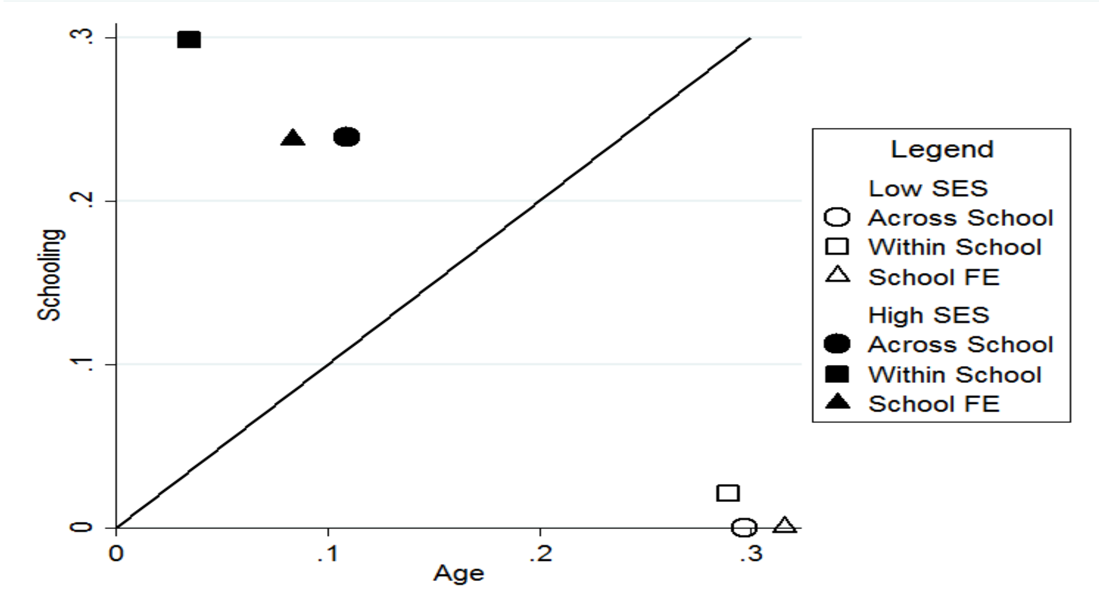

Figure 2. The estimated effects of age (horizontal axis) and schooling (vertical axis) on cognitive test scores (in pooled within-grade SD units) in the low- and high-SES groups in a total, across-school analysis (circles) and a within-school analysis (Dev.-SES; squares).

As illustrated by Figure 2 and Table 2, there is a clear statistical interaction between the students' SES and the effect of schooling on cognitive development: In the high-SES group,schooling has a sizeable effect (0.24SD) on cognitive test scores. Furthermore, this effect is more than double the corresponding age effect (0.11 SD), indicating that, in this group, cognitive development is mainly due to schooling. In contrast, in the low- SES group, the effect of schooling is null; cognitive development appears to be exclusively due to the effect of age (0.30 SD), that is, of maturation and out -of -school learning. Figure 3 illustrates the resulting difference between the two SES groups in the within- and between-grade rise of mean test scores as a function of age.

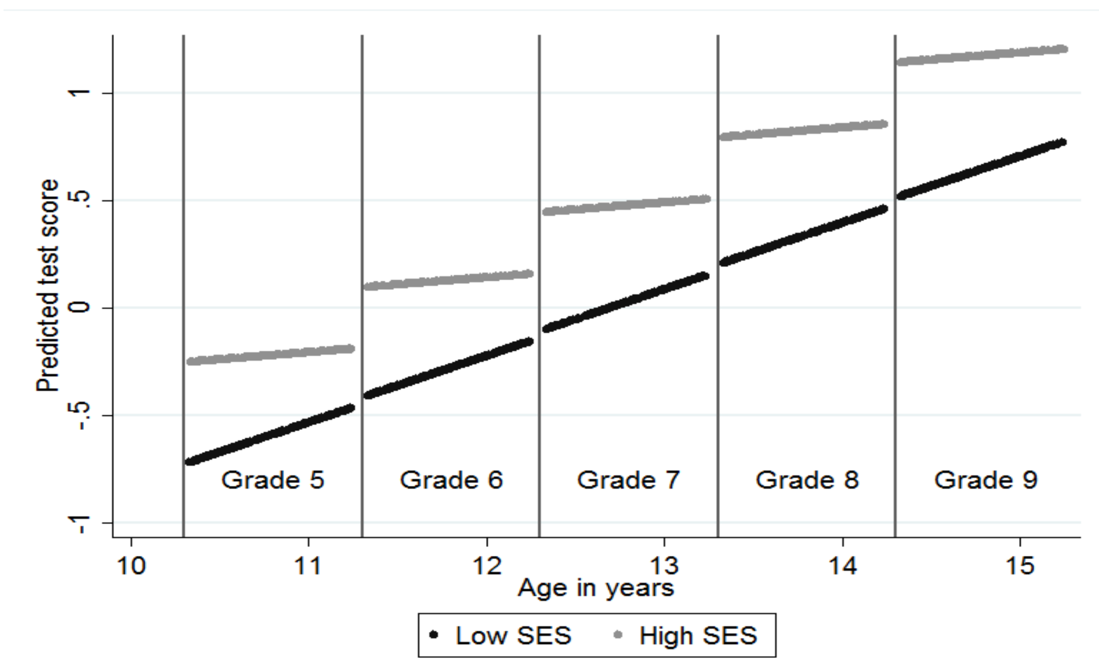

Figure 3. Average (across grades) within- and between-grade rise of mean test scores as a function of age in the two SES groups according to the BGRD design.

Note, however, that these results, in and of themselves, do not provide sufficient justification for their valid interpretation and causal explanation in terms of an *empirical* interaction between schooling and students' family SES (i.e., a differential effect of schooling on students from the two SES groups). This interpretation would be valid only if students from both groups receive same- quality schooling. If this condition is not met, then the differential effect of schooling on cognitive development in the two SES groups found in this study may reflect, to an unknown degree, the difference between the schooling provided to them rather than, or in addition to, a true interaction between students' SES and same-quality schooling in terms of the effect of schooling on cognitive development; that is, a differential reaction of low- and high- SES students to the *same* schooling.

As noted in the introduction, differential access to high quality education is one way in which SES can affect the magnitude of the schooling effect ;high- and low-SES students may be differently distributed between schools differing in the quality of schooling they provide: high -SES students may be concentrated in better schools, whereas low- SES students may typically attend schools providing lower quality schooling. The data base of this study – which does not include exhaustive information regarding the quality of schooling provided by each school -- does not allow for a direct empirical examination of this possibility. Yet, the low between-school SES variability (only 10% of the between-student SES variability lies between schools) –also reflected in the extremely weak correlation found between students' SES and the school's mean SES (r = 0.30)-- indicates that allocation to schools in our sample is only slightly related to the students' SES and supports the conclusion that differences in the quality of schooling provided to high- and low-SES students are not a viable alternative explanation of our results. Specifically, they do not preclude their causal attribution mainly to the differential effect schooling has on the cognitive development of high- and low-SES students; that is, to a true interaction between SES and schooling.

This conclusion is further supported by the results of a "within-school" (rather than total, across-school) analysis of the effect of schooling. This analysis substitutes, for each student, the deviation of her SES from the school mean SES (Dev.-SES) -- whose between school variability is null by definition -- for her SES. For the purpose of our analysis, Dev.-SES was dichotomized around the school median and the effects of age and schooling were estimated in each of the resulting two groups using the same method. The difference between the estimated effects of schooling in the low- and high- Dev-.SES groups can be validly interpreted as exclusively reflecting the within-school interaction between students' SES and schooling, unaffected by the possible between-school relation between SES and the quality of schooling. The results of this analysis (column (B) in Table 2 and the corresponding squares in Fig.2)fully replicate the results of the total, across-school initial analysis, indicating the existence of a substantial within-school interaction between students' SES and the effect of schooling. Similar results have been obtained also by an even more stringent test of the interaction hypothesis, which adds the schools' IDs to chronological age and grade level in the multiple prediction of cognitive test scores, thereby controlling for all and any between-school differences that could have affected differentially the magnitude of the schooling effect for low- and high-SES children (Column (C) in Table 2 and the corresponding triangles in Fig.2).

4. Discussion

The contribution of this study is in the empirical illustration of the sizeable between-student variability of the absolute and relative effects of schooling on cognitive development and of the relationship between the magnitude of the schooling effect and students' characteristics, in this case, the student's family SES. According to our results, both the absolute and relative effects of schooling are considerably lower in the low-SES group. Furthermore, surprisingly, schooling has no effect at all in this group; cognitive development appears to be entirely attributable to the effect of maturation and out-of-school learning. We interpreted these results as mainly reflecting the within-school interaction between students' SES and schooling, that is, the differential effect of schooling on students differing in their SES. According to this interpretation, high- SES students -- which, according to our theoretical model, have, on average, higher ABS -- benefit more from the same schooling. In the remainder, we discuss the robustness and generalizability of our results, the reinterpretation and possible causal explanations as well as some of their educational, policy and research implications. First is the issue of the robustness of our results. To what extent are these results independent of the methodological approach employed (the BGRD design), and, within this approach, of the steps taken in order to cope with the exceptions to this approach's assumptions? Unfortunately, our ability to examine the robustness of the results is limited.

First, because the quasi-experimental BGRD approach to the investigation of the schooling effect on cognitive development is widely accepted as the only available methodologically valid approach to the empirical study of this central issue. Hence, no across-method generalizability of the results can be examined. Secondly, examination of the results' robustness is also limited by the inevitability of two of the three decisions meant to cope with the exceptions to the BGRD design's second main assumption, namely that grade level is solely a function of chronological age: the exclusion of the students who (a) were under- or over-aged for their grade; or (b) were born in January (and, therefore, could choose between year Y and Y+1 for enrollment in the first grade; see Method section).The only arbitrary, and possibly arguable, decision we have made that could have affected the results is the exclusion of the February- born children, where the proportion of missing students is highest(see Appendix 1).In order to examine the effect of this decision, we have rerun our analyses including the February-born children. This resulted in a 0.01 SD decrease in the estimated effect of age in both SES groups and an increase of 0.01 and 0.03 SD in the estimated effect of schooling in the low- and high-SES groups, respectively (See Appendix 2).These minor differences support the conclusion that the sizeable interaction between SES and the absolute and relative magnitude of the schooling effect, found by our study, is not attributable to our decision to exclude the February-born children.

Second is the issue of the generalizability of our results. Of course, these illustrative results, which were obtained by comparing the estimated effects of schooling on cognitive development among low-and high-SES female students attending gender-segregated schools in a specific educational system, may not be universally generalizable across populations, subpopulations, educational systems and subsystems, as well as across other salient student characteristics, likely to affect students' ABS (such as student's ability level or motivation) or important in their own sake (e.g., race or gender).Hence the need for additional studies, to be conducted in other educational systems and to focus on additional student characteristics in addition to SES. Yet, in view of the relative homogeneity of the Palestinian educational system in terms of the factors likely to affect students' ABS and their negligible between-school variability (Jabr & Cahan, 2014b) – illustrated by the low between-school SES variability found in this study -- the interaction between schooling and student's SES in this system is likely to underestimate the interaction between schooling and relevant student characteristics in other, more heterogeneous, educational systems. Thus, the lesson to be learned from this study is that between-student variability of schooling effects is an integral and important feature of reality and should not be ignored or masked by the exclusive reporting of total-population effects. On the contrary, its very existence should be highlighted, its magnitude estimated and its correlates explored.

This conclusion is congruent with the emerging awareness in the psychological literature (e.g., Speelman & McGann, 2013) regarding the reality and psychological validity of between-individual variability, its theoretical and practical importance and the potentially misleading nature of exclusive reliance on total population means, as well as with the age-venerable "aptitude by treatment interaction" (ATI) concept (e.g., Snow, 1989).In addition, future studies should also explore the between-school variability of schooling effects on cognitive development and its (school-level) correlates. Of course, this endeavor requires large, in fact very large samples of schools. Indeed, the need for large samples, of both schools and students– like the sample of this study --is endemic to the empirical study of the variability of schooling effects and its correlates. This need is further enhanced by the necessity to use a quasi-experimental –rather than experimental – research design. The associated budgetary and logistical difficulties might explain the lack of such studies.

A second major issue is the causal explanation of our results. Is the considerable stronger effect of schooling on high-SES students found in this study attributable to the differential reaction of low- and high-SES students to the same schooling that is, to a true interaction between schooling and SES – as we tentatively suggested -- or to the differential schooling experienced by low- and high –SES students? The interpretation of our findings as reflecting a true sizeable interaction between schooling and students' SESis based on the assumption that low- and high-SES students receive the same schooling. In our study, this assumption is apparently supported by the extremely low between-school SES variability. By and large, our schools do not differ in the SES composition of their student populations: low- and high-SES students are more or less equally represented in each school. Hence our assumption that they receive the same schooling. However, this assumption may not be entirely true, due to possible within-school, and even within-class, interaction between students' SES and school treatment. Within-school differences between the schooling provided to low- and high-SES students may exist if allocation to same-grade parallel classrooms is directly or indirectly related to students' SES or if the schools implement a policy of ability grouping and allocation to the various ability groups is related to students' SES.

In both cases, the low- and high-SES groups in each school are likely to receive, on average, different treatments in terms of curriculum and pace as well as in terms of the social composition of the learning unit (be it a classroom or an ability group).Furthermore, within-school differences between the treatments provided to low- and high-SES students may exist even if allocation to classrooms is random or intentionally balanced and no ability grouping policy is implemented, due to teachers' differential treatment of low- and high-SES students, including stereotypical attitudes and expectations. Teachers, as representatives of the societal milieu, may perpetuate the stereotypical attitudes and approach towards these groups inside the educational setting. For instance, a teacher who attributes higher mathematical abilities to high-SES students may be more attentive to such students, initiate more interaction with them, or encourage them to be more competitive. Such differential treatment may have tremendous differential effects upon the schooling experiences, self-image, attitudes and motivation towards learning of low- and high-SES students and indirectly, upon their cognitive development. Of course, such alternative explanations of the results cannot be cavalierly dismissed. Uncertainty regarding the true underlying causal model is inevitable given the necessarily non-experimental, post-hoc nature of the research approach. While this uncertainty may be reduced by means of in-depth studies, it cannot be totally dispersed.

Whatever the true causal explanation of the considerably higher effect of schooling on the cognitive development of high-SES students revealed by our study, however, the social and policy implications of this finding are clear and unambiguous. Schooling is apparently less effective where it is most needed–among low-SES students, that is, among children from families with lower parental education and income. Thus, instead of acting as an equalizing factor, schooling appears to enhance the initial disadvantage of low-SES students. Coping with this unfortunate reality requires a multidimensional approach, simultaneously aimed at improving the school treatment provided to low-SES students and their ability to benefit from this treatment. As amply documented by the literature of the last three decades, this is likely to be a most costly endeavor. There is an increasingly growing consensus regarding the idea that the education of educationally disadvantaged (i.e., poor) children is considerably more expensive than the education of those with no disadvantage. The cost of educating a poor student is estimated to be 2-4 times the cost of educating a regular student (e.g., Carey, 2002; Downes & Pogue, 1994).

Appendix 1
Table A
Grade Placement by Month of Birth for the Five Cohorts

Cohort[2]	Month of Birth[1] Grade Placement[3]	1[4]	2	3	4	5	6	7	8	9	10	11	12	13
1/1/2002 – 31/1 2003	Lower [5]	–[6]	–	–	–	–	–	–	–	–	–	–	–	–
	Normative (grade5)	27	52	83	46	58	63	46	56	63	68	54	52	51
	Higher	49	**14**	**8**	**3**	**4**	**2**	**4**	**3**	**2**	**3**	**2**	**1**	**0**
1/1/2001 – 31/1/ 2002	Lower	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**1**	**0**	**6**	**4**	**8**	27
	Normative (grade 6)	16	46	64	42	61	50	64	56	62	66	59	59	48
	Higher	39	**11**	**8**	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**1**
1/1/ 2000 – 31/1/2001	Lower	**5**	**1**	**0**	**1**	**3**	**2**	**5**	**5**	**2**	**4**	**5**	**6**	17
	Normative (grade 7)	33	43	51	54	54	52	65	66	62	46	53	60	39
	Higher	40	**12**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
1/1/1999 – 31/1/2000	Lower	**3**	**5**	**4**	**7**	**3**	**5**	**2**	**3**	**7**	**1**	**5**	**9**	38
	Normative (grade 8)	12	39	57	60	47	54	50	60	61	64	49	79	40
	Higher	40	**8**	**6**	**1**	**0**	**2**	**0**	**0**	**0**	**1**	**1**	**0**	**0**
1/1/1998 – 31/1/ 1999	Lower	**2**	**4**	**6**	**5**	**5**	**6**	**5**	**6**	**5**	**7**	**6**	**10**	15
	Normative (grade 9)	18	34	52	61	64	59	48	56	51	70	54	59	40
	Higher	–	–	–	–	–	–	–	–	–	–	–	–	–

[1] The numbers 1-12 refer to the months January - December in the first year of the relevant cohort, and the number 13 refers to the month of January of the following year.
[2] This table does not include overage children born before 1/1/1998 and underage children born after 31/ 1/ 2003. These children (n=125) were excluded from the analysis. Additional 14 children with missing necessary data (e.g. grade level and birthdates) were excluded from the analysis.
[3] The absolute frequency of misplaced children is highlighted in bold font
[4] By the official rule for school entrance, for January -born children, the "higher" grade level in Table 3 as well as the "lower" level in column 13 is also "normative" (see above).
[5] The percentage of children in the first cohort who are placed in a lower grade (4) and the percentage of children in the last cohort who are placed in a higher grade (10) cannot be determined because these grade levels are not included in the study.
[6] Children born in the highlighted months (grey columns) were excluded from the analysis. See explanation p. 20-21.

Appendix 2

Table B

Estimated Average Effects of 1 Year of Age and 1 Year of Schooling in Grades 5 through 9 on Cognitive Test Scores in low- and high-SES Students Including the February-born Children (bold; in pooled within-grade SD units; original results in parentheses).

	Estimated Average Effects of 1 Year of	
Student SES	Age	Schooling
Low SES*	**0.28** (0.30)	**0.03** (0.0)
High SES**	**0.07** (0.11)	**0.28** (0.24)

Note. *SE ~ 0.09; **SE ~ 0.12

Acknowledgement

The analysis presented in this paper is part of the wider project "Determinants of Cognitive Development in Deprived Environments: Evidence from the West Bank" funded by the German Research Foundation (DFG) under grant number JU 2769/2. We are grateful to the PA Ministry of Education, test administrators, and the students who participated in the study and their parents for their time and effort.

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