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We show that the development of abstract reasoning and cognitive empathy (theory of mind) is severely hindered when children are deprived of the stimulation of a school environment. We document significantly lower abstract reasoning and cognitive empathy scores in elementary school children who returned from an extended school closure caused by the Covid-19 pandemic relative to proximate pre-pandemic cohorts. This developmental delay has a significant socioeconomic gradient, with underprivileged children experiencing more substantial delays. We also document a significant disruption in the development of socioemotional skills: 0.24 sd lower grit, 0.43 sd lower emotional empathy, 0.06 sd lower epistemic curiosity, and 0.24 sd higher impulsivity. About eight months of school exposure results in a remarkable recovery in abstract reasoning and theory of mind for all socioeconomic groups. However, the measured levels still indicate significant delays relative to the expected developmental trajectories. No notable improvements are observed in socioemotional skills except for curiosity. These findings reveal that the damage school closures inflicted on children goes beyond well-documented academic losses and highlight the crucial role of the school environment in fostering fundamental cognition and socioemotional development in children.

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Disruption to Schooling Impedes the Development of Abstract Reasoning and Theory of Mind in Children[‡]

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Abstract

We show that the development of abstract reasoning and cognitive empathy (theory of mind) is severely hindered when children are deprived of the stimulation of a school environment. We document significantly lower abstract reasoning and cognitive empathy scores in elementary school children who returned from an extended school closure caused by the Covid-19 pandemic relative to proximate pre-pandemic cohorts. This developmental delay has a significant socioeconomic gradient, with underprivileged children experiencing more substantial delays. We also document a significant disruption in the development of socioemotional skills: 0.24 sd lower grit, 0.43 sd lower emotional empathy, 0.06 sd lower epistemic curiosity, and 0.24 sd higher impulsivity. About eight months of school exposure results in a remarkable recovery in abstract reasoning and theory of mind for all socioeconomic groups. However, the measured levels still indicate significant delays relative to the expected developmental trajectories. No notable improvements are observed in socioemotional skills except for curiosity. These findings reveal that the damage school closures inflicted on children goes beyond well-documented academic losses and highlight the crucial role of the school environment in fostering fundamental cognition and socioemotional development in children.

Keywords: Abstract reasoning; Cognitive empathy; Socioemotional skills; School closures

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1 Introduction

It has been shown that early life stimulation is crucial for children's cognitive and socioemotional development (Heckman et al., 2006; Cunha and Heckman, 2007; Cunha et al., 2010; Doyle et al., 2009; Manning and Patterson, 2006; Almlund et al., 2011; Black et al., 2017). However, the role of formal education in shaping fundamental cognition and socioemotional skills is not well understood. Formal education, or schooling, is commonly viewed as a means to transmit knowledge and enhance academic abilities. However, while achieving this, schooling likely reinforces the development of fundamental cognition and shapes essential character skills in children. The formal educational process shapes children's cognitive function and socioemotional skills through multiple channels, but two stand out as the most prominent. First, there is an apparent direct channel where students learn abstract reasoning via curricular tasks, such as working on math and science problems and doing reading comprehension.[1] Social and emotional development is likely to benefit from direct teaching as children are taught good behavior in schools, typically with the guidance of a set curriculum and through pedagogical practices. The second channel relates to the learning externalities schools create whereby knowledge is disseminated, and behavioral norms are reinforced through peer interactions.[2] In this paper, we show that depriving children of school-related stimuli impedes the growth of their abstract reasoning, cognitive empathy (theory of mind), and socioemotional skills in a lasting manner. We also show that developmental delays are much more pronounced for socioeconomically underprivileged children.

Abstract reasoning is a human ability to reason through complex and abstract ideas and find solutions to unfamiliar problems, and as such, it is closely related to fluid intelligence. We measure abstract reasoning using Raven's Progressive Matrices (RPM) (Raven et al., 2000). RPM is a non-verbal test to measure general fluid intelligence and abstract reasoning as early as age five. Theory of mind is a sociocognitive ability, also known as cognitive empathy. It refers to the ability to recognize and understand the mental states of others and use this understanding to predict human behavior. We use the Reading the Mind in the Eyes test (RME-T) to measure the theory of mind performance (Baron-Cohen et al., 2001).

[1] For example, the role of formal education in the development of abstract thinking was put forward by Flynn (2000) and then Daley et al. (2003), Must et al. (2009), Rönnlund and Nilsson (2009), Flynn (2012), Liu et al. (2012), and Baker et al. (2015) as one of the explanations of the secular increase in fluid intelligence over time.

[2] A recent study by Alan and Mumcu (2022) shows peer learning constitutes a substantial part of learning in schools.

In addition to these two cognitive skills, we also consider several socioemotional (character) skills that are shown to be instrumental for children's learning processes and well-being. Specifically, we consider grit, the ability to persevere through challenging tasks and setbacks (Alan et al., 2019; Duckworth et al., 2016), emotional empathy (ability to respond to others' emotional state) (Alan et al., 2021), epistemic curiosity (urge to know and explore novel phenomena) (Kashdan et al., 2020; Alan and Mumcu, 2022) and impulsivity/patience (lack of emotional control and acting without thinking of consequences) (Alan and Ertac, 2018; Dohmen et al., 2010; Perez-Arce, 2017; Sleddens et al., 2013).

To document the developmental delays caused by the lack of school exposure, we leverage a setting where rich data from several cohorts of primary school students were collected as part of a large education project in Turkey. The project's objective was to measure a wide range of cognitive and noncognitive skills and evaluate interventions to improve some of these skills in the school environment. In addition to several randomized evaluations of various educational programs, this project resulted in a comprehensive database covering three cohorts of children aged 9-11 (grades 3 and 4) before the Covid-19 pandemic. These pre-pandemic data allow us to establish a benchmark, the expected cohort-to-cohort variation, for our outcomes of interest. To gauge the developmental delays in these outcomes, we collected another round of data from a new cohort of students when Turkish schools opened in September 2021 after about 1.5 academic years of closure. We augmented our pre-pandemic data with this new cohort, which we refer to as the "pandemic cohort". We then tracked these children and conducted one more round of data collection in May 2022 (at the end of the academic year) to assess the extent of recovery after about an 8-months of school exposure.

Children in our augmented sample have similar socio-demographic characteristics and are exposed to similar school and teacher characteristics across cohorts. Moreover, we show that in the pre-pandemic years, our outcomes of interest do not exhibit any significant cohort-to-cohort variation. We then show that our pandemic cohort lags severely behind previous cohorts in almost all skills we consider. The children of this cohort scored 0.51 sd lower in Raven's test (abstract reasoning test) and 0.28 sd lower in the RME test (cognitive empathy-theory of mind test) relative to the base pre-pandemic cohort. They also exhibited significantly lower grit (0.24 sd), lower emotional empathy (0.43 sd), lower epistemic curiosity (0.06 sd), and higher impulsivity (0.24 sd) relative to pre-pandemic cohorts. Tracking our pandemic cohort and measuring these skills again at the end of the 2021-2022 academic year, we observe significant improvements in abstract reasoning and cognitive empathy scores. How-

ever, the observed levels are still short of what is expected from the respective developmental stage. While we see promising improvements in abstract reasoning and cognitive empathy, we see no evidence of recovery in socioemotional skills. The pandemic cohort remains 0.34 sd and 0.23 sd behind in emotional empathy and grit, respectively, and becomes even more impulsive after eight months of schooling. Interestingly, they also become more curious than previous cohorts.

The documented cognitive delays have a significant socioeconomic gradient, with children of lower socioeconomic status (SES) exhibiting more substantial delays in abstract reasoning and cognitive empathy. For abstract reasoning, we record a 0.22 sd delay at the highest SES and 0.48 sd for the lowest SES relative to the most proximate cohort for grade 4 students. For cognitive empathy, we find no significant delay in the highest SES children but a significant delay (0.16 sd) for the lowest SES. While both 3rd and 4th graders remained behind what is expected from their developmental stage at the end of the academic year, high SES children recovered better in abstract reasoning. The damage on socioemotional development exhibits a similar socioeconomic pattern for emotional empathy and impulsivity, with low SES children lagging further behind high SES children. The striking finding is that the follow-up data show no evidence of recovery in socioemotional skills. Given the existing socioeconomic gaps we document in pre-pandemic cohorts, the lack of recovery implies further widened socioeconomic gaps in socioemotional skills.

Our paper makes two key contributions. First, we show that the development of basic cognition requires school-related stimuli, and disruptions to schooling severely disturb the developmental trajectory of abstract reasoning and theory of mind in children. There is now voluminous research on the impact of school closures on learning outcomes. Combining 42 studies across 15 countries, a recent meta-analysis by Betthäuser et al. (2023) documents large and persistent learning losses worth roughly one-third of a school year. The studies show that losses are much more pronounced for socioeconomically disadvantaged children and larger in math than reading in middle-income countries. Besides confirming these learning losses, our study reveals much deeper damage inflicted on children due to school closures. Second, we show that formal education plays an essential role in character building, particularly for socioeconomically disadvantaged children (Alan et al., 2019; Alan and Kubilay, 2023; Cappelen et al., 2020). By showing the lack of recovery in cognitive and emotional empathy and a further increase in impulsive behavior in children of underprivileged backgrounds, our results underscore the possible social consequences of disruptions to formal education in years to come (Alan and Kubilay, 2023).

2 Context and Data

Academic years run from September to June in Turkey. The first COVID-19 cases were recorded on March 11, 2020, and all schools were closed on March 13, 2020, until the end of the 2019-2020 academic year. The 2020-2021 academic year started on September 18, 2020, and after two weeks of face-to-face teaching, schools were closed again due to an alarming increase in cases, and this closure lasted until September 2021. In May and June 2021, only preschoolers, students with special needs, and 8th and 12th-grade students were allowed to receive face-to-face teaching. Therefore, from March 2020 until September 2021, Turkey experienced about 50 weeks of country-wide school closure, one of the highest among the OECD countries.[3] Given that the number of weeks within one academic year in Turkey is around 36 weeks, the length of disruption to schooling was about 1.5 academic years.

Throughout the closure period, the Turkish national TV broadcasted primary, secondary, and high school lecture videos through the Education Information Network (EBA). In addition to EBA, schools were encouraged to use various digital platforms to reach students, such as zoom. However, students from disadvantaged households had little or no capacity to access these digital platforms due to the lack of equipment and internet access. More importantly, while EBA was easy to access, the proper use of it required significant parental input, especially at the primary school level. It required monitoring lecture times, helping the child to follow the correct lectures, and handling homework assignments unmarked by a teacher. Therefore, as in most countries, school closures not only generated inequality in access to education across cohorts but also across socio-economic groups within cohorts (Hanushek and Woessmann, 2020; Maldonado and De Witte, 2021; Chetty and Hendren, 2020; Agostinelli et al., 2022; Engzell et al., 2021; Bacher-Hicks et al., 2021; Bailey et al., 2021; Betthäuser et al., 2023; Parolin and Lee, 2021; Kogan and Lavertu, 2021).

Our data come from a large field project launched in the Fall of 2015. The project involved three randomized controlled trials (RCTs) aiming at improving social and emotional skills in primary and post-primary school children. A large number of state schools located in Turkey's most ethnically diverse and economically active provinces were enlisted to be part of the project. Each RCT included randomly selected schools within this pool and involved at least two data collection rounds, baseline and endline. By 2019, these data collection efforts resulted in rich data on three cohorts of 3rd and 4th graders and a cohort of 5th

[3]Source: https://en.unesco.org/covid19/educationresponse#schoolclosures

and 6th graders. Unfortunately, the project was halted in the spring of 2020 due to the pandemic, preventing us from doing fieldwork to collect data.

Our pre-pandemic database contains three cohorts of more than 15,000 3rd 4th-grade students and a single cohort of 5th and 6th-grade students from 165 primary and 77 post-primary schools in the provinces of Mersin, Sanliurfa, Istanbul, and Sakarya.[4] Schools for the educational project were chosen based on their infrastructural and socio-demographic characteristics to ensure that they are homogeneous within districts and socio-demographic characteristics of districts are similar across provinces. Because the project only included state schools and Turkey's higher-income families tend to send their children to private schools, our sample represents Turkey's middle, lower-middle, and low-income households. Our first pre-pandemic cohort (2015), which we take as the base cohort for cognitive outcomes, refers to the 3rd and 4th graders of the 2015-2016 academic year. The second cohort (2018) is the same graders of the 2018-2019 academic year, and the third cohort (2019) is the same graders of the 2019-2020 academic year. These pre-pandemic data were collected at the beginning of each academic year as baseline data for the RCTs mentioned above, therefore free from the effect of any intervention. These data allow us to establish expected cohort-to-cohort variation (our benchmark) in the skills we study. Furthermore, because we measured these skills at grades 3, 4, 5, and 6 at baseline, the pre-pandemic data also provided us with the expected developmental trajectory (age profile) of these skills.

We complemented our rich pre-pandemic database with the data we collected in September 2021 from the new cohort of 3rd and 4th graders in schools in our database in the province of Mersin. We refer to this fourth cohort (the academic year of 2021-2022) as the "pandemic cohort". We collected data from this cohort by following the protocol we used to build the pre-pandemic database. Specifically, we visited the schools in person and spent around two-three lecture hours collecting data in every classroom with the help of trained field assistants. Our combined data allow us to assess the extent of developmental delays relative to our pre-pandemic benchmark. We then followed our new cohort and collected the same data just before the end of the academic year (May 2022) to assess the degree of recovery against our benchmark developmental trajectory.

To measure abstract reasoning, we implemented a sub-scale of the Raven's Progressive Matrices (Raven et al., 2000). The test is progressive in the sense that it gets harder within

[4]The planned RCT for grades 5 and 6 was launched in the Fall of 2019 by collecting baseline data but interrupted by the pandemic.

sub-scales. Raven's test is thought to reflect one's fluid (general) intelligence, and since it is a non-verbal test, considered to be free from language bias. To measure cognitive empathy (theory of mind), we implemented a sub-scale of the Reading the Mind in the Eyes test developed by (Baron-Cohen et al., 2001). The test aims to measure the ability to recognize mental states expressed by human eyes. It involves presenting a photograph of the eye region of an actual human showing a particular emotional state and asking participants to choose one from four mental state options. Both fluid intelligence and cognitive empathy are often misquoted as "innate" abilities and thought to be formed and set very early in life (3 for fluid intelligence, 4-5 for the theory of mind behavior). However, research shows an age-dependent positive developmental trajectory for both, and our data corroborates this. We provide example questions for each test in the appendix (see Figure B1 and B2).

Tangential to the paper's primary focus, we also measure learning losses concerning math and verbal skills. We present these results in the appendix only to show that academic losses recorded in Turkey, a middle-income country, are similar to those documented in previous studies such as those discussed in Betthäuser et al. (2023). Because there are no centralized objective tests in the grade levels we consider in this study, we designed math and Turkish tests based on the requirements of the national curricula for each grade level in the education projects. To measure the learning losses of the pandemic cohort, we use the same tests we used for the previous cohorts, both at the beginning and the end of the academic year. As in abstract reasoning and cognitive empathy, we measure the losses by comparing the test scores of the pandemic cohort with previous cohorts' scores on the same tests.

The primary objective of the education project that led to the collection of these data was to identify ways to enhance achievement-related socioemotional skills. We collected data on these skills using item response questionnaires and constructed measures of epistemic curiosity (Kashdan et al., 2009), grit (Duckworth and Quinn, 2009), impulsivity (Sleddens et al., 2013) and emotional empathy. For character skills data, we only have two pre-covid cohorts (2018-2019 and 2019-2020 academic years), so our base pre-pandemic cohort refers to students in the 3rd and 4th grades in the 2018-2019 academic year. To measure the effect of school closures on these skills, we implemented the same survey items for the pandemic cohort in September 2021 and again in May 2022, just before the summer holiday began. We provide all our survey items in the appendix (see Table A1).

3 Internal Validity

The key assumption behind attributing the differences between the pandemic cohort and pre-pandemic cohorts to the lack of school exposure is that the pandemic cohort has the same potential outcomes as the pre-pandemic cohorts. This assumption is likely to be valid in our context for a number of reasons. First, cohorts in our data are close to each other, and the pandemic cohort is only two years apart from the last pre-pandemic cohort. Second, as mentioned above, schools in our database are all chosen for a particular education project and share almost identical infrastructural features. Third, all public schools take students only from their catchment areas in Turkey, and catchment area socio-demographic characteristics are unlikely to change over a few years. Finally, teacher characteristics are similar across state schools as public school teachers are centrally appointed, and the pandemic had no effect on the number and the composition of teachers. In fact, over 80% of the teachers of the original project were still working in the same schools at our final measurement phase.

Table 1 Panel 1 provides the statistical evidence of the validity of our assumption. It shows the balance across cohorts with respect to student demographics and classroom/teacher characteristics, taking the 2015 cohort as the reference for abstract reasoning and academic skills and 2018 for other skills. As can be seen from the joint F-test results on pre-covid cohorts (column 5), students are statistically similar in demographics, classroom, and teacher characteristics. Column 6 includes the pandemic cohort in the tests. As expected, this addition does not affect the balance regarding demographics and school/teacher characteristics.

Panel 2 presents the balance tests for our outcomes of interest. The test results in column 5 confirm that there is no significant cohort-to-cohort variation in the outcomes we consider in pre-pandemic data. Pre-pandemic cohorts were similar in terms of fundamental cognitive and sociocognitive skills (abstract reasoning and cognitive empathy), academic achievement (math and verbal abilities), and socioemotional skills. However, we see a very different picture when we include the pandemic cohort in this analysis. All cognitive and socioemotional outcomes rejected the F-test of equality except for curiosity. In what follows, we detail cohort differences in outcomes of interest using a conditional mean analysis. First, we assess how the pandemic cohort of 3rd and 4th graders differs from previous cohorts conditional on demographics, teacher and classroom characteristics, and school fixed effects (cohort comparisons). We then assess the extent to which the pandemic cohort recovered after eight months of school exposure (panel comparisons). Note that the covariate adjustment is only

to gain additional precision. The fact that all our results hold without covariate adjustments is another assurance of the internal validity of our results.

Table 1: Balance Across Cohorts

	(1)	(2)	(3)	(4)	(5)	(6)
	2015	2018	2019	2021	Prob >F*	Prob >F
Panel 1						
Student Demographics						
Male	0.515	0.514	0.512	0.509	0.731	0.849
Age in month	109.345	109.143	109.950	109.129	0.507	0.498
Number of Sibling	2.870	2.864	2.864	2.999	0.918	0.135
Working Mother	0.311	0.288	0.288	0.316	0.436	0.187
Teacher/Classroom Characteristics						
Female	0.777	0.679	0.692	0.625	0.162	0.093
Year of Experience	18.766	19.094	19.068	19.860	0.969	0.726
Age	43.926	42.971	42.956	43.801	0.779	0.701
Class Size	35.328	31.307	31.998	31.827	0.217	0.295
Share of Male in the Class	0.515	0.514	0.512	0.509	0.730	0.852
Panel 2						
Cognitive Skills						
Abstract Reasoning	0.000	-0.059	-0.055	-0.527	0.902	0.000
Cognitive Empathy (ToM)		0.000	-0.047	-0.268	0.619	0.000
Mathematics Score	0.000	-0.039	-0.033	-0.559	0.994	0.000
Verbal Score	0.000	-0.045	-0.009	-0.350	0.877	0.000
Socioemotional Skills						
Emotional Empathy		0.000	0.024	-0.427	0.459	0.000
Grit		0.000	-0.046	-0.242	0.173	0.000
Impulsivity		0.000	0.016	0.239	0.817	0.000
Curiosity		0.000	0.023	-0.064	0.524	0.123

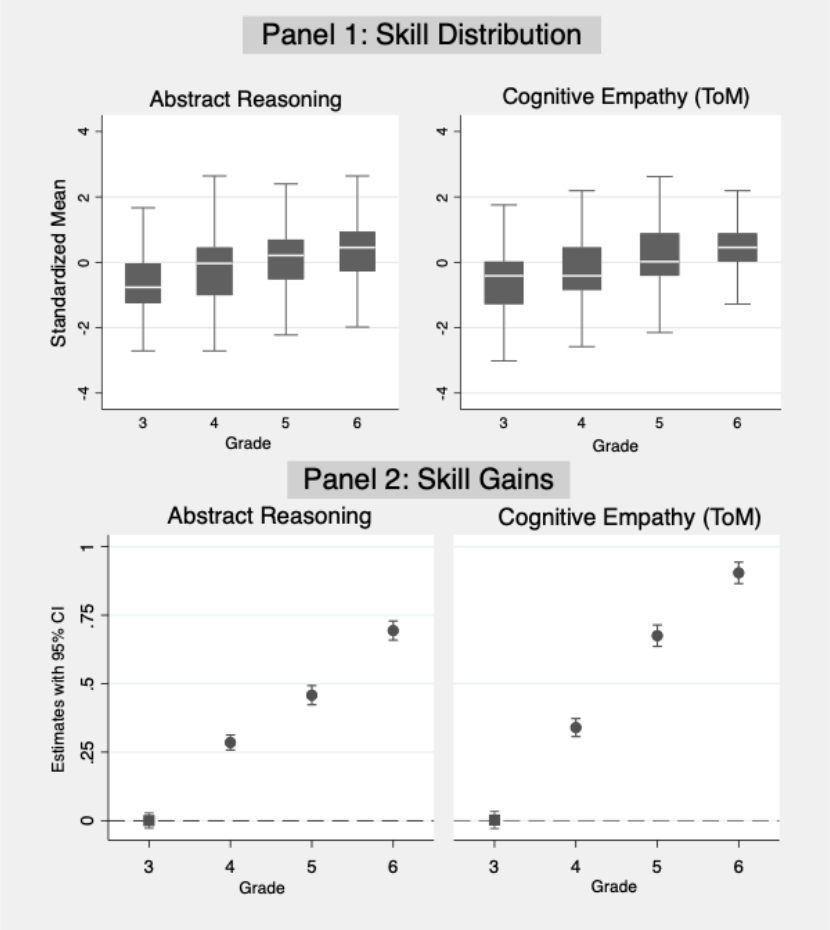
Note: The table presents balance across cohorts. Columns 1-4 Panel present the means of the respective variable. Columns 5 and 6 present the p-values obtained via joint F-test from the regressions of the respective variable on cohort dummies by taking either 2015 or 2018 as the reference cohort, depending on the data availability. Column 5 excludes the pandemic cohort, and Column 6 includes it. Variables in Panel 2 are standardized to have a mean 0 for the years 2015 and 2018, based on the available data. Total sample size 21,155 (n=1,157 in 2015, n=4,928 in 2018, n=10,690 in 2019, and n=4,400 in 2021).

Remeasuring our pandemic cohort in May 2022, we can document the extent of recoveries. However, the skills we consider are likely to keep developing for our age groups. Therefore, we need another cohort comparison to assess whether the pandemic cohort's recovery was sufficient, i.e., whether children caught up with what was expected from their grade levels at the end of the academic year. Figure 1 Panel 1 shows the developmental trajectory of our outcomes of interest. For this, we take the 2018-2019 cohort and plot the skill levels for grades 3,4,5, and 6, representing the developmental trajectory of these skills within a limited age range. Panel 2 presents the age profile of skill gains in standard deviation terms, taking grade 3 as the reference. As seen in Panel 1, abstract reasoning and cognitive empathy are increasing with age, with substantial heterogeneity within each age range. Depicted age profiles of Raven's and RME-T scores are consistent with the existing studies.[5]

[5]Pind et al. (2003) documents the age profile of Raven's test, increasing until the mid-twenties. Dorris et al. (2022) show a hump-shaped developmental trajectory for cognitive empathy, using RME-T, increasing

The positive age trajectories we document also imply possible high malleability of these cognitive skills, including their vulnerability to negative shocks in early developmental stages. Unfortunately, we cannot plot an age profile for socioemotional skills as we measured these skills only for grades 3 and 4. Absent any established age profile for these skills in the literature, it is hard to infer a developmental trajectory as a benchmark. Nevertheless, our data suggests some emotional maturity is expected going from grade 3 to 4: a decline in impulsivity and an increase in grit, emotional empathy, and curiosity (see Figure A1 in the appendix).

Figure 1: Age Profile of Cognitive Outcomes



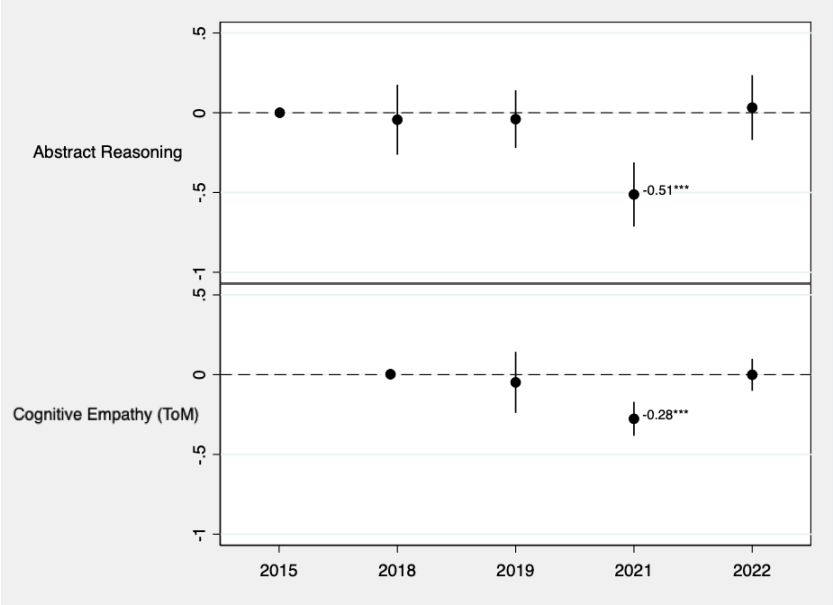
Note: Panel 1 shows the developmental trajectory of abstract reasoning and cognitive empathy (ToM) using the 2018-2019 cohort for grades 3,4,5, and 6. Panel 2 presents the age profile of skill gains in terms of standard deviations, with grade 3 as the reference point. Total sample size is 19,544 for abstract reasoning and 17,382 cognitive empathy (ToM).

between the ages 6 and 12, then forming a dip during adolescence, followed by another hump-shaped trajectory, with a peak around the mid-30s. The age profile we document for RME-T is consistent with this study.

4 Results

We first document the effect of disruption to schooling on our cognitive outcomes of interest, abstract reasoning, and cognitive empathy. To do this, we compare cohort means of respective outcomes controlling for student demographics, classroom and teacher characteristics, and school fixed effects. We take those in grade 3 or 4 in the 2015-2016 academic year as the reference category for abstract reasoning and those in grade 3 or 4 in the 2018-2019 academic year for cognitive empathy. Figure 2 depicts the estimated mean differences relative to the 2015 cohort in abstract reasoning and relative to the 2018 cohort in cognitive empathy.

Figure 2: Cohort Profiles of Abstract Reasoning and Cognitive Empathy



Note: The figure illustrates the estimated coefficients and 95% confidence intervals obtained from regressing the standardized outcomes on year dummies. The base year is 2015 for abstract reasoning and 2018 for cognitive empathy (ToM). Data on the latter are not available for 2015. This figure uses the test results from the start of each academic year for all years except 2022 to illustrate the recovery of the pandemic cohort. The full set of covariates of student demographics and classroom/teacher characteristics given in Table 1 is used in the regression analysis. Student demographics includes gender, age in months, number of siblings, and a dummy variable for students whose mother is working. The classroom/teacher characteristics consist of gender, years of teaching experience, age of the teacher, class size, and the share of male students in the class. Standard errors are clustered at the school level. Asterisks indicate that the estimated coefficient is statistically significant at 1% ***, 5% **, and 10% * levels. The sample size is 15,217 for abstract reasoning and 14,386 for cognitive empathy.

First, note that consistent with the unconditional means shown in Table 1, there is no significant cohort-to-cohort variation in these two outcomes for pre-pandemic cohorts. The estimated developmental delay for the pandemic cohort in abstract reasoning and cognitive empathy is 0.51 and 0.28 standard deviations, respectively. These estimates indicate a sub-

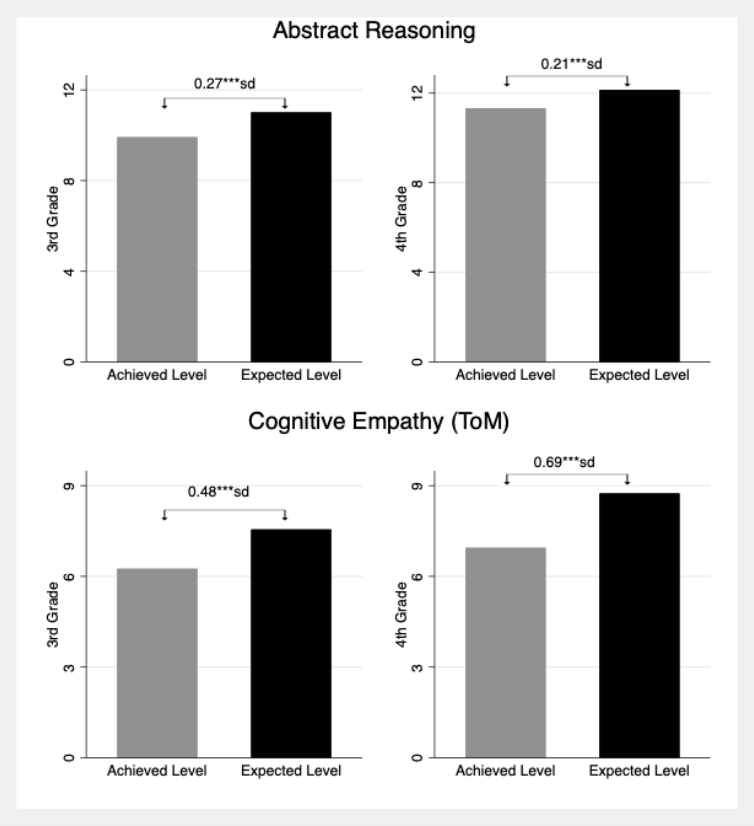
stantial disturbance to fundamental cognitive and sociocognitive development. Fortunately, our panel analysis, comparing the September 2021 test results with those of May 2022, reveals a remarkable recovery in both these skills. We observe that in May 2022, after about eight months of exposure to the school environment, the pandemic cohort reached the level expected from their grade levels at the beginning of the academic year. Note that our findings for the academic skills (math and verbal) show the same pattern (see Figure A2 in the appendix). Recorded losses (0.54 sd in math, 0.35 sd in verbal ability) imply one school year's worth of loss in crystallized intelligence consistent with the losses documented for countries with similar lengths of school closures (Vegas, 2022; Hevia et al., 2022; Ardington et al., 2021; Lichand et al., 2022; Kogan and Lavertu, 2021).

However, as we document in Figure 1, abstract reasoning and cognitive empathy are still on a positive developmental trajectory for the age range we consider. Depicted level differences in Figure 2 use the test results taken at the beginning of respective academic years, except for the estimates for 2022. The estimates of 2022 indicate recovery, but this recovery should be assessed against what is expected at the end of an academic year since 2022 test results were taken at the end of the 2021-2022 academic year. Figure 3 depicts this cohort comparison. It compares the achieved levels in May 2022 with what was expected from grade 3 and grade 4 at the end of the 2021-2022 academic year. Expected levels are calculated using the respective grades of the 2018 cohort (2018-2019 academic year). Comparing the recovered levels against what is expected based on the developmental profile, we find that the pandemic cohort of grade 3 students remains 0.27sd (10%) and 0.48 sd (17%) behind the expected level of abstract reasoning and cognitive empathy, respectively. The picture is similar for the grade 4 students. The pandemic cohort of grade 4 students remains 0.21 sd (7%) and 0.69 sd (21%) behind the expected level of abstract reasoning and cognitive empathy, respectively.

We next repeat our analysis for socioemotional skills. There is now a large and growing literature showing how the school environment helps socioemotional development in children. Alan and Ertac (2018) show how impulsive behavior can be reduced using a combination of pedagogical and curricular interventions. Alan et al. (2019) show that grit can be developed in the classroom, and doing so leads to increased and persistent math achievement. In a recent paper, Alan and Mumcu (2022) show that a particular pedagogical training of teachers can stimulate children's curiosity and, in turn, improve achievement scores. Recently, several papers highlighted the importance of social skills, such as perspective-taking (Alan et al., 2021), cooperation, and altruism (Cappelen et al., 2020), and show that these skills respond

to school stimuli. The question is, then, what happens to socioemotional development when students are deprived of their teachers and peers for an extended period?

Figure 3: Recovery of Abstract Reasoning and Cognitive Empathy

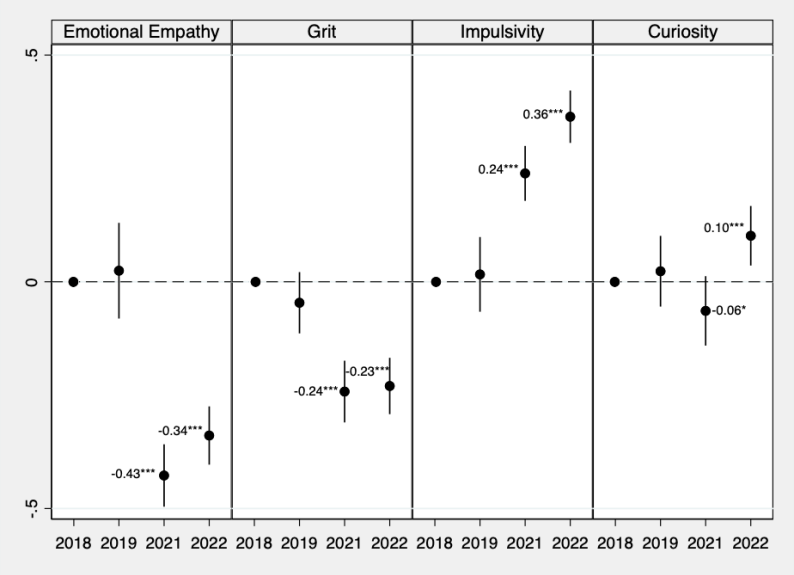


Note: The figure compares the pandemic cohort's achieved levels of abstract reasoning and cognitive empathy at the end of the academic year (May 2022) with the 2018 cohort's achieved levels measured at the end of the 2018-2019 academic year. The figure also provides estimated differences in standard deviation units. Asterisks indicate that the estimated coefficient is statistically significant at the 1% ***, 5% **, and 10% * levels.

Figure 4 presents the same analysis we conducted for cognitive outcomes for emotional empathy, grit, impulsivity, and curiosity. Note that the 2018 cohort is the based cohort in this analysis as we do not have data on these skills for the 2015 cohort. Consistent with Table 1 results, while we see no difference across pre-covid cohorts in these socioemotional skills, we record a significant decline in emotional empathy and grit for the pandemic cohort. The loss is 0.43 sd for the former and 0.24 sd for the latter. We observe a weakly significant decline in curiosity but a large and significant increase (0.24 sd) in impulsivity. Unlike the recoveries we observe in all cognitive outcomes, we record no notable recovery in socioemotional skills after eight months of school exposure. We estimate even further deterioration (increase) in impulsivity but a significant increase in epistemic curiosity in children.

Recent evidence documenting learning losses due to school closures highlight that losses exhibit a significant socioeconomic gradient, with children from lower socioeconomic segment suffering deeper and more persistent losses (Maldonado and De Witte, 2021; Agostinelli et al., 2022; Kogan and Lavertu, 2021; Dorn et al., 2020; Chetty and Hendren, 2020).

Figure 4: Cohort Profiles of Socio-Emotional Outcomes

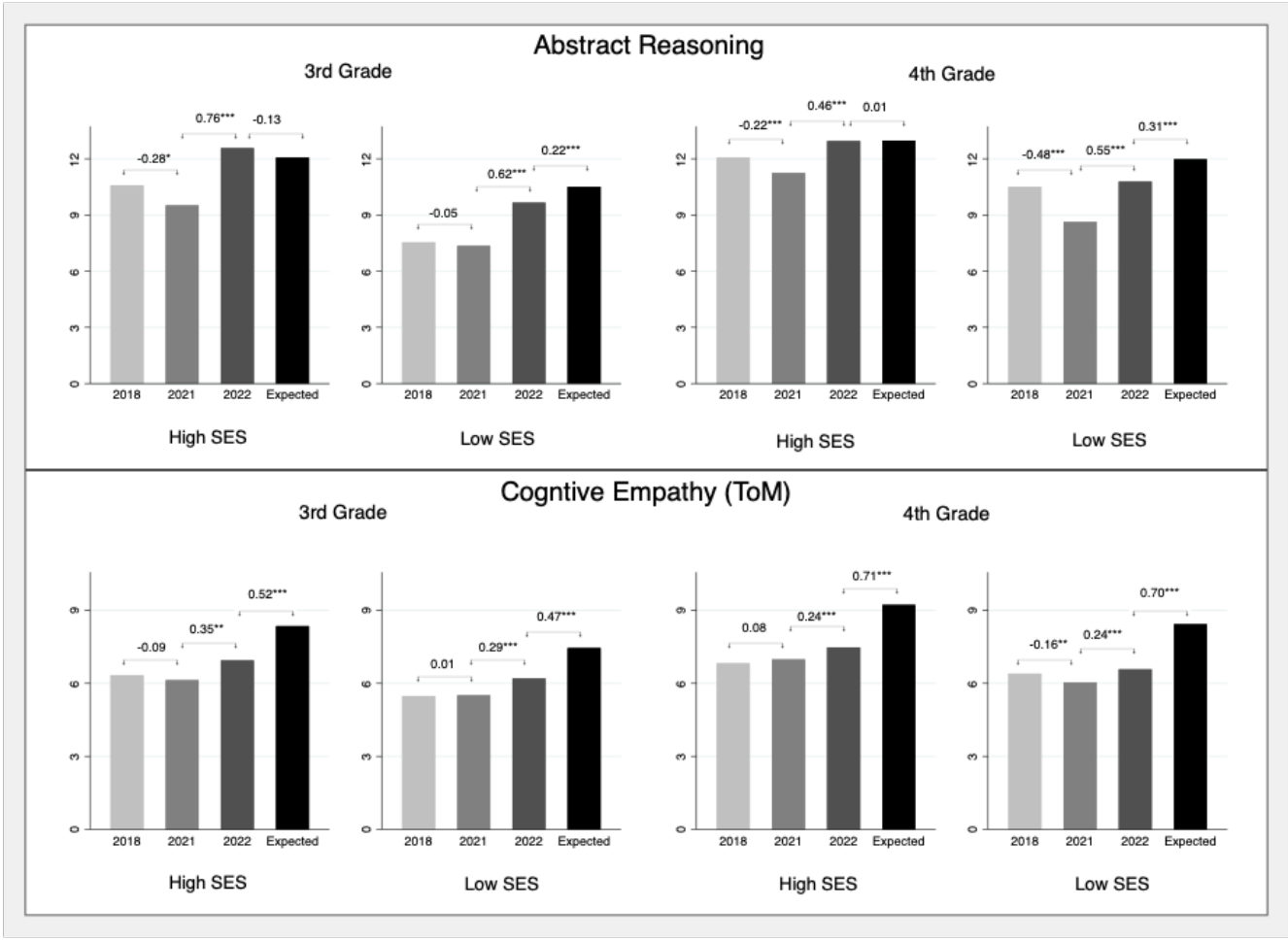


Note: The figure illustrates the estimated coefficients and 95% confidence intervals obtained from regressing the standardized outcomes on year dummies. The base year is 2018 for all outcomes. The results refer to the start of the respective academic year for all years except 2022 to illustrate the recovery of the pandemic cohort. The full set of covariates of student demographics and classroom/teacher characteristics given in Table 1 is used in the regression analysis. Student demographics includes gender, age in months, number of siblings, and a dummy variable for students whose mother is working. The classroom/teacher characteristics consist of gender, years of teaching experience, age of the teacher, class size, and the share of male students in the class. Standard errors are clustered at the school level. Asterisks indicate that the estimated coefficient is statistically significant at the 1% ***, 5% **, and 10% * levels. The sample size is 15,217 for abstract reasoning and 14,386 for cognitive empathy. The sample size is 15,253 for curiosity, 15,126 for emotional empathy, 13,363 for grit, and 13,389 for impulsivity.

Although our sample provides a much more limited socioeconomic gradient than these studies, there is some variation we can exploit to complement them. For this, we leverage the fact that there are significant socioeconomic differences across districts within provinces of Turkey. We can capture this variation using the socioeconomic development index calculated by the Turkish Ministry of Industry and Technology (Acar et al., 2019), covering about 1000 districts. According to this index, our highest SES district corresponds to the 70th from the top and our lowest to the 188th from the top. Therefore, neither high nor low SES status in our data represents Turkey's high and low SES. Nevertheless, observing any SES differences in developmental delays in our data would be informative of the severity of damage inflicted on underprivileged children due to school closures.

Figure 5 depicts the socioeconomic differences in abstract reasoning and cognitive empathy using our highest and lowest SES levels for a sharp comparison.

Figure 5: SES Differences in Cognitive Delays



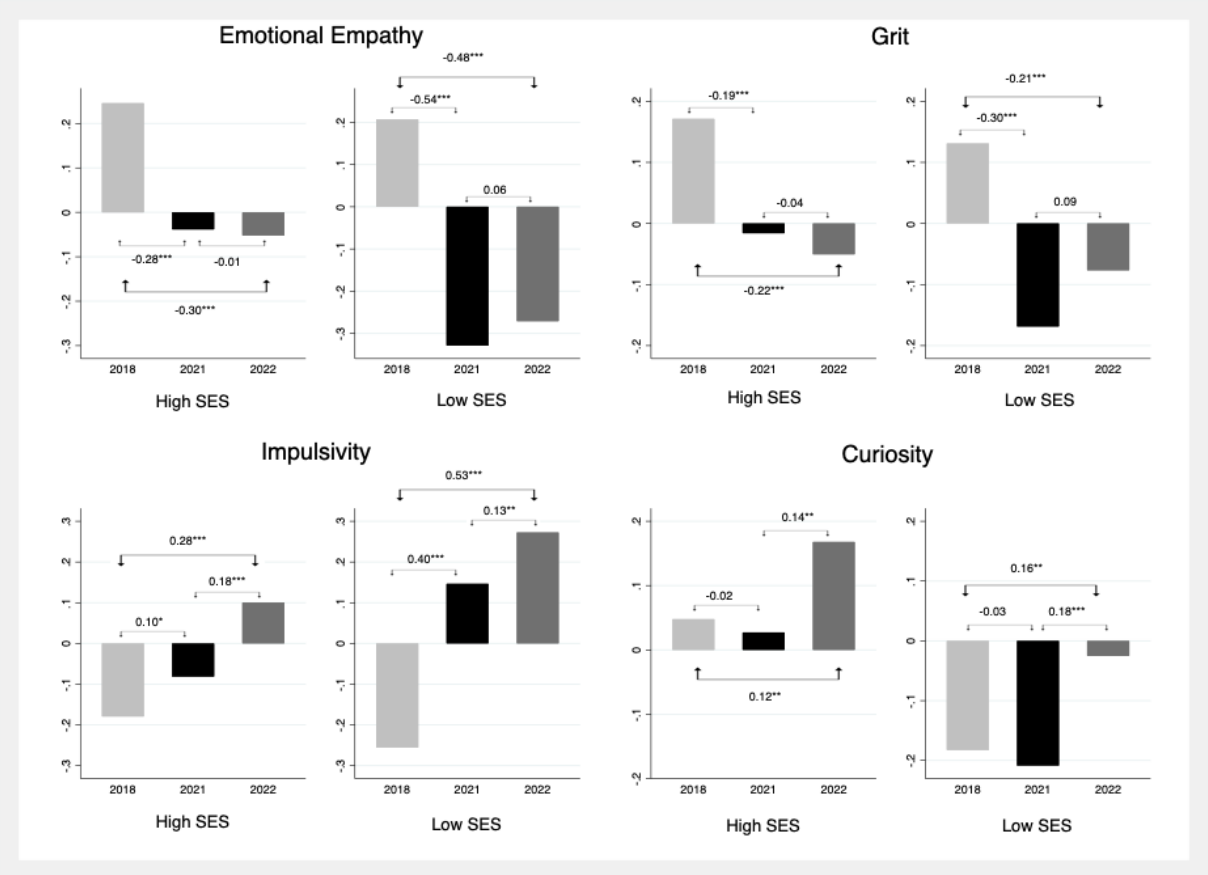
Note: This figure shows the socioeconomic differences in abstract reasoning and cognitive empathy (ToM) for the highest and lowest SES levels. The difference between the first two bars illustrates the developmental delay in the corresponding skill by comparing the 2018 cohort with the pandemic cohort (cohort comparison). The difference between the second and third bars indicates the degree of recovery achieved by the pandemic cohort (panel comparison). Finally, the difference between the third and last bar indicates the extent of persistence in delays (cohort comparison). Values give estimated differences in standard deviation units. Standard errors are clustered at the school level. Asterisks indicate that the estimated coefficient is statistically significant at the 1% ***, 5% **, and 10% * levels.

Each figure panel presents four bars. The difference between the first two bars depicts the developmental delay in the respective skill by comparing the 2018 cohort with the pandemic cohort. The difference between the second and third bars shows the extent of recovery the pandemic cohort achieved (panel comparison). Finally, by comparing the third and the last bar, the latter being the level expected for the respective age group, we assess the extent of persistence in delays (cohort comparison). First, note the existing SES differences in

these skills in pre-pandemic times. High SES children have higher abstract reasoning and cognitive empathy than low SES noting the 2018 cohort, and this pattern continues as they age, noting the expected levels. For abstract reasoning, we observe significant developmental delays in both low and high SES groups, especially older children (grade 4). However, while high SES children seem to have recovered entirely, low SES children still lag behind what was expected from their developmental trajectory. The results are somewhat different for cognitive empathy. We observe that much of the delays come from low SES fourth graders. What is striking here is the lack of recovery in both SES levels and both age groups. All pandemic children lag significantly behind in their development of cognitive empathy.

Figure 6 presents the socioeconomic gradient for socioemotional skills.

Figure 6: SES Differences in Socioemotional Skill Development



Note: This figure shows the socioeconomic differences in socioemotional skills for the highest and lowest SES levels. The difference between the first two bars illustrates the difference in the respective skill comparing the 2018 cohort with the pandemic cohort (cohort comparison). The difference between the second and third bars indicates the degree of recovery achieved by the pandemic cohort at the end of academic year (panel comparison). The figure also provide the coefficients of regressing the standardized outcomes on year dummies for each pair of years are on the figure. Values give estimated differences in standard deviation units. Standard errors are clustered at the school level. Asterisks indicate that the estimated coefficient is statistically significant at the 1% ***, 5% **, and 10% * levels.

As mentioned above, we do not have an expected age profile for these skills, so we only look at the losses (cohort comparisons) and recoveries (panel comparisons), corresponding to the first 3 bars of Figure 5. Figure panels clearly show that there are significant SES differences in socioemotional skills even in normal times (2018 cohort). Low SES children are significantly less empathetic, less gritty, less curious, and more impulsive. The lack of school stimuli adversely affected both groups, but the higher damage inflicted on the low SES group is evident in these figures. Documented disruptions exhibit a significant socioeconomic gradient for all socioemotional skills considered. We observe larger impacts on low SES children's curiosity, emotional empathy, and grit. Similarly, we observe increased impulsivity in both SES, but much more significantly for the low SES group. Except for epistemic curiosity, none of the socioeconomic skills recovered, suggesting widened socioeconomic gaps in these vital skills.

5 Discussion of Mechanisms

It is clear that the school closures severely hindered the cognitive and socioemotional development of the pandemic cohort. While we observe a remarkable recovery for cognitive skills, the delays persist, and we observe no notable recovery for socioemotional skills. We attribute these effects to not being exposed to school-related stimuli for an extended period. The lack of school-related stimuli can generate these delays through different mechanisms for different skills. For abstract reasoning, an obvious direct effect would be through the lack of exposure to complex and abstract tasks that primary school curricula offer (Flynn, 2012; Daley et al., 2003; Must et al., 2009; Baker et al., 2015; Rönnlund and Nilsson, 2009; Bratsberg and Rogeberg, 2018; Teasdale and Owen, 2000; Liu et al., 2012). For sociocognitive and socioemotional skills, the social environment the school offers (peer interactions and student-teacher interactions) may be more relevant.

The deprivation of school stimuli came with over-exposure to parental inputs during the pandemic. The effect of this substitution on the development of skills depends on the quality of parental inputs. Differential parental ability to support virtual learning has been shown to be the primary driver of the socioeconomic gradient observed in learning losses (Agostinelli et al., 2022; Dorn et al., 2020; Contini et al., 2021). High-SES parents have more resources to reduce the adverse effects of the lack of school inputs. On the other hand, low-SES parents lack these resources and may even reinforce the delays through low-quality (harmful) input.

Starting from the 2018 cohort, we collected information on parenting styles from the children themselves. For this, we gave students item response questions and constructed four parenting styles: obedience-demanding parenting, warm (permissive) parenting, punishment-oriented parenting, and reasoning-oriented (responsive) parenting.[6] Figure A3 in the appendix shows the difference between the 2018 cohort and the pandemic cohort in their perception of their parents' parenting styles. Note first the existing SES differences for each parenting style. Low SES parents are more obedience-demanding and tend to use harsh punishment tools more than high SES parents. High SES parents seem to be warmer (more permissive) toward their children and tend to reason with them more. Therefore even if there was no change in parenting styles, to the extent that parenting styles affect child development, extended exposure to parental input might have had different effects on high and low-SES children.

Nevertheless, we do observe a general deterioration in parent-child interactions as reported by children for both high and low SES. The observed changes are consistent with the findings we discuss in Figure 5 and Figure 6: School closures adversely affected the development of both high and low SES children, but the latter experienced more damage. Consistent with this, Figure A3 shows that the low SES pandemic cohort reported that their parents were more obedience demanding and less willing to reason than the low SES of the 2018 cohort. The reported parental tendency of punishment is higher for the pandemic cohort for both SES levels. Moreover, high SES parents seemed to have abandoned the habit of reasoning with their children during the lockdown. Unfortunately, the evidence on the causal link between parenting styles and the developmental trajectory of cognitive and socioemotional skills is weak. Several studies document a strong association between responsive, authoritative parenting and positive cognitive and socioemotional outcomes (Steinberg et al., 1992; Radziszewska et al., 1996; Kaufmann et al., 2000; Carlo et al., 2018; Kong and Yasmin, 2022). Our results on the SES differences in cognitive delays and parenting styles are consistent with our claim that substituting school inputs with low-quality parent-child interactions is likely to be an important driver of our results.[7]

[6]Literature highlights three broad parenting styles based on the level of parental control and warmth. These are authoritarian (corresponding to obedience demanding and harsh punishment tendency), permissive (warmth), and authoritarian (reasoning tendency with elements of soft punishment) (Baumrind, 1966; Dornbusch et al., 1987; Paulson, 1994; Steinberg et al., 1990).

[7]Another channel could be sources that are not directly related to school closures, such as the loss of family members or family economic hardship imposed by the pandemic. While we acknowledged the role of this particular channel, given the documented recoveries upon 8-month school exposure, we believe that the lack of school stimuli is the primary driving force of the effects we document.

Another mechanism, especially for the cognitive outcomes, could be that children's test-taking abilities eroded during the pandemic, and part of the delays we measure may reflect this erosion. There could be two reasons for this erosion. First, if children are regularly exposed to tests, they get better at them controlling for the content knowledge. The lack of schooling (lack of test taking in particular) may have led to some erosion in test-taking ability. Second, the erosion may be related to the loss of socioemotional skills. Test-taking requires the ability to concentrate for an extended period, i.e., it requires patience, perseverance, and motivation, which were adversely affected by the lack of schooling. The first reason remains valid in our context. However, given that we observe recovery in cognitive skills despite high impulsivity and low grit, the most important channel that explains the delays seems to be the lack of school inputs (exposure to peers and teachers) combined with low-quality parental input.

6 Conclusion

We show that the development of abstract reasoning and cognitive empathy requires school-related stimuli, and the cohort deprived of the school environment experienced severe delays in the development of these skills. Furthermore, we document that their socioemotional development was also significantly disrupted. The documented delays and disruptions exhibit a socioeconomic gradient, with underprivileged children experiencing more severe delays and disruptions. Despite some recovery in abstract reasoning and cognitive empathy after an 8-month school exposure, the achieved levels indicate persistent delays.

Our findings show that the damage the school closures inflicted on children goes beyond academic losses, as widely documented in the literature. We show that school inputs are crucial to encourage the development of cognition and sociocognition and are vital for socioemotional development. The fact that we find no evidence of recoveries in socioemotional skills is of particular concern. The disruption to the development of cognitive and emotional empathy and heightened impulsivity may have significant societal consequences in years to come. This paper shows that the pandemic-related school closures revealed the broader purpose of fair access to public schooling, which goes beyond building human capital. Schooling is instrumental in building fundamental cognitive and socioemotional skills, especially for the underprivileged segment of society, and, as such, it has a significant role in building social cohesion between socioeconomic segments and ensuring social mobility. Therefore our study

underscores the importance of maintaining access to education during crises, especially for underprivileged children.

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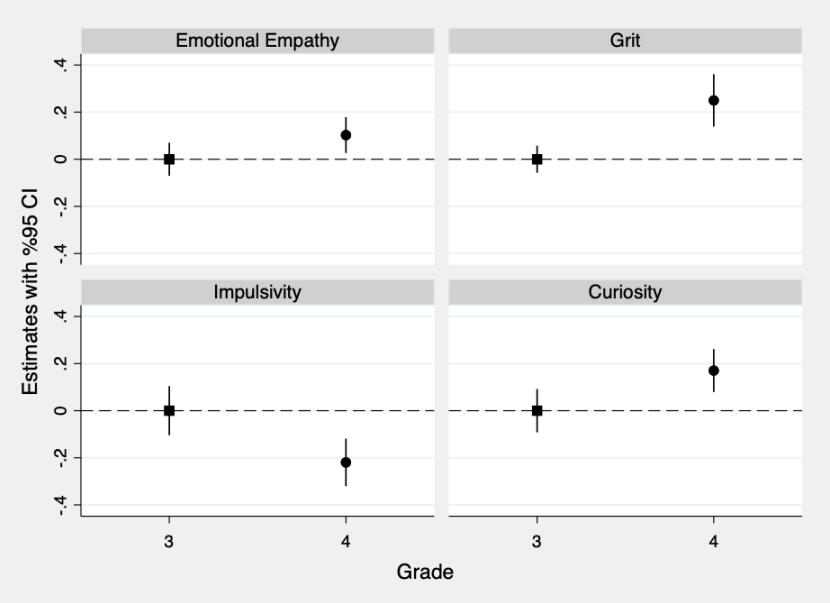
Appendix

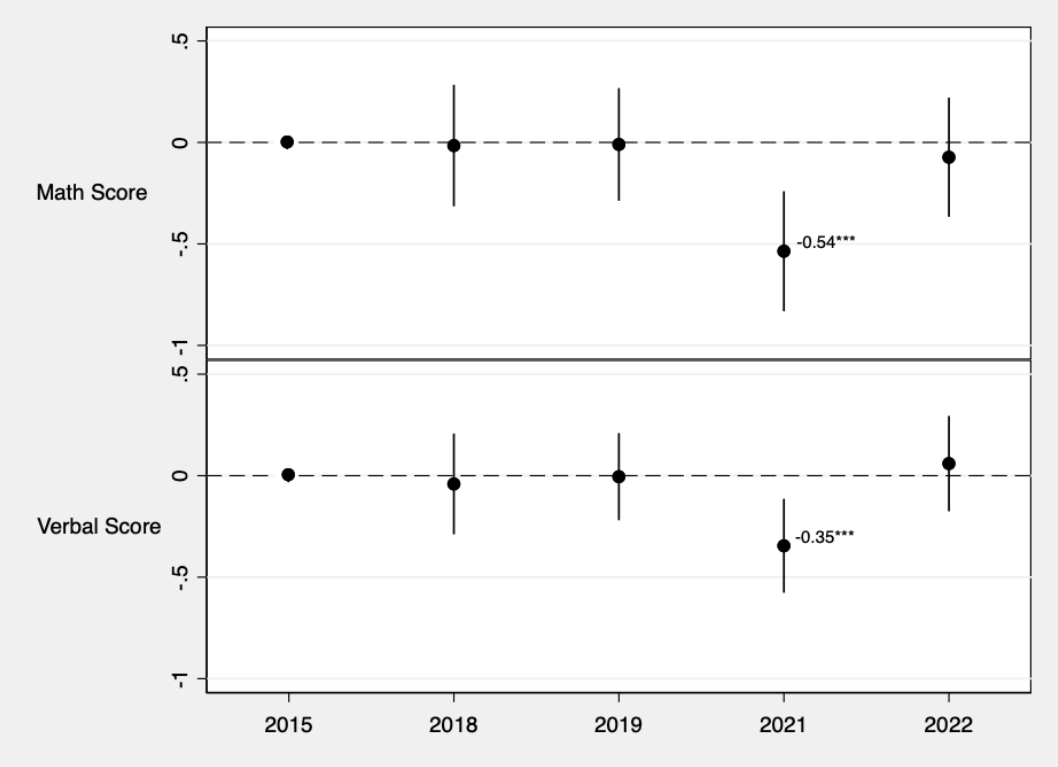
A Additional Figures

Figure A1: Change in Socioemotional Skills from Grade 3 to Grade 4



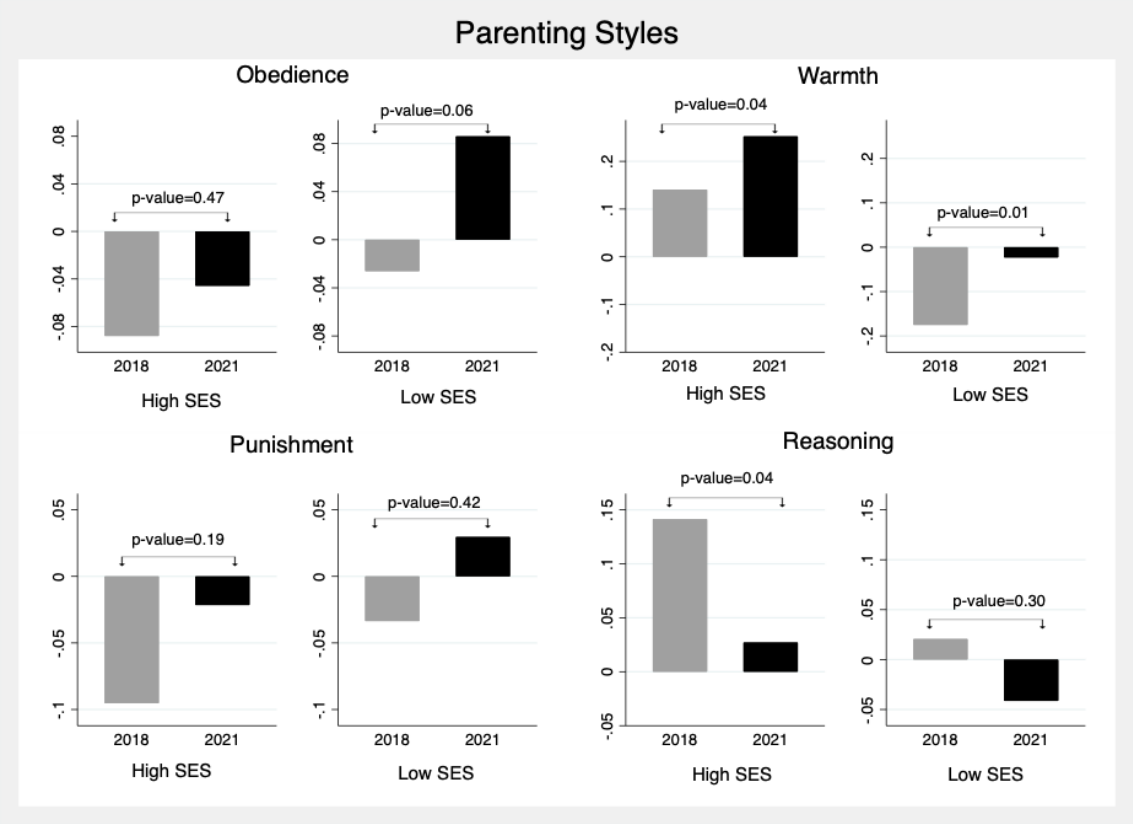
Note: The figure illustrates gains in socioemotional skills going from grade 3 to grade 4. The point estimates give OLS coefficients of the regression of socioemotional skills (impulsivity, grit, emotional empathy and curiosity) on grade dummy. All coefficient estimates indicate standard deviation effects with a 95% confidence interval, calculated by clustering at the school level.

Figure A2: Cohort Profiles of Academic Outcomes (Math and Verbal Test Scores)



Note: The figure illustrates the estimated coefficients and 95% confidence intervals obtained from regressing the standardized outcomes on year dummies. The base year is 2015. This figure uses the test results from the start of each academic year for all years except 2022 to illustrate the recovery of the pandemic cohort. The full set of covariates of student demographics and classroom/teacher characteristics given in Table 1 is used in the regression analysis. Student demographics includes gender, age in months, number of siblings, and a dummy variable for students whose mother is working. The classroom/teacher characteristics consist of gender, years of teaching experience, age of the teacher, class size, and the share of male students in the class. Standard errors are clustered at the school level. Asterisks indicate that the estimated coefficient is statistically significant at 1% ***, 5% **, and 10% * levels. Sample size is 15,245 for math score and 15,247 for verbal score.

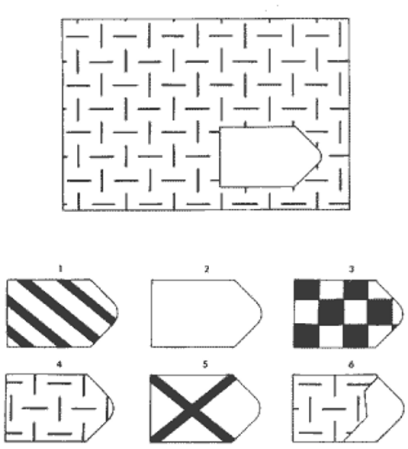
Figure A3: Parenting Styles: SES Gradient



Note: This figure shows the socioeconomic differences in parenting styles (obedience, warmth, punishment, and reasoning). The outcomes are standardized, so the y-axis shows values in standard deviation units. The difference between the two bars illustrates the change in the corresponding parenting styles when comparing the 2018 cohort with the pandemic cohort. The p-values of regressing the standardized outcomes on year dummies are given in the figure for each parenting style.

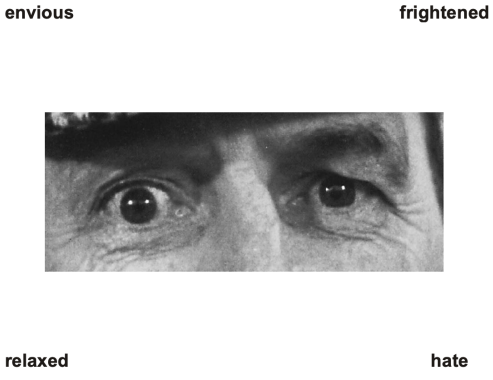
B Data Inventories

Figure B1: Sample Question: Raven's Progressive Matrices



Note: The questions ask what shape is needed to complete the pictures correctly. There are multiple options provided for each question, and the student is asked to select the correct one. In the sub-scale of the Raven's Progressive Matrices that we employ, there are 23 questions.

Figure B2: Sample Question: Reading the Mind in the Eyes



Note: The questions inquire about the emotion conveyed by the eyes. There are four options provided for each question, and the student is asked to select the correct one. The sub-scale of the Reading the Mind in the Eyes that we use contains 14 questions.

Table A1: Student Survey Inventory: Socioemotional Skills

4-point likert scale: completely agree, agree, disagree, completely disagree	
Inventory	**Items**
Emotional Empathy	When I see someone being treated unfairly, I feel very much pity for them. I often have tender, concerned feelings for people less fortunate than me. When I see someone being taken advantage of, I feel protective towards them. I would describe myself as a pretty soft-hearted person. Sometimes I don't feel very sorry for other people when they are having problems.
Grit	I am diligent. Setbacks discourage me. I finish whatever I begin. I often set a goal but later choose to pursue a different one. I cannot focus on a subject long time. I easily lose interest.
Impulsivity	I get on nerves when close to solving but can't figure it out. I cannot focus on a subject long time. I easily lose interest . I decide what to do quickly and then go and do it right away. Waits turn when playing a game I get into trouble because I do things without thinking first. I tend to say the first thing that comes to mind, without stopping to think about. I cannot help it, but I touch things without getting permission. I call out answers in class before the teacher calls on me I interrupt people when they are talking. I decide what to do quickly and then go and do it right away. I control temper in conflict situations.
Curiosity	Mysteries make me curious. I have always questions in my mind. I look up meaning of a word if I do not know the word. I daydream and fantasize, with some regularity, about things that might happen. I get frustrated if I cannot figure out the solution. Therefore, I work even hard.

Table A2: Student Survey Inventory: Parenting Styles

4-point likert scale: completely agree, agree, disagree, completely disagree	
Inventory	**Items**
Obedience	My mom asks me to do something without explaining why. My dad asks me to do something without explaining why. My mom does not allow me to question her decisions. My dad does not allow me to question her decisions. My mom expects me obey her rules without any questions. My dad expects me obey her rules without any questions.
Warmth	When I am scared or sad, my mom hugs and comforts me. When I am scared or sad, my dad hugs and comforts me. My mom jokes and plays games with me. My dad jokes and plays games with me. My mom hugs and kisses me. My dad hugs and kisses me.
Punishment	My mom uses physical punishment when I do something wrong. My dad uses physical punishment when I do something wrong. My mom takes away a privilege when I go against a rule. My dad takes away a privilege when I go against a rule. My mom sometimes spansks me when I do not obey rules My mom sometimes spansks me when I do not obey rules
Reasoning	My mom gets angry with me when I do something wrong, but she never explains why. My dad gets angry with me when I do something wrong, but she never explains why. My mom tells me how people feel. My dad tells me how people feel.