Military deployments and children's academic achievement: Evidence from Department of Defense Education Activity Schools

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A R T I C L E   I N F O

A B S T R A C T

Household disruptions – such as divorce, relocation, and parental absence – have long concerned researchers interested in the educational attainment of children. Here, we consider a plausible source of exogenous variation in work-related parental absences—military deployments to Iraq and Afghanistan in the 2002–2005 period. Combining the standardized test scores of children enrolled in Defense Department schools with their military parent's personnel data, we evaluate the effect of a soldier's deployment on the academic achievement of his or her children. We find that deployments have modest adverse effects in most academic subjects, with lengthy deployments and deployments during the month of testing associated with the largest detrimental effects. Evidence also suggests that these adverse effects may persist for several years.

1. Introduction

In recent years, the question of how various types of household disruptions – such as marital dissolution, household relocations, and changes in maternal labor supply – affect children's academic achievement have occupied researchers for two primary reasons. First, family disruptions have potentially large welfare effects on children via human capital accumulation and lower lifetime earnings. Second, these questions are technically difficult to answer because parents might easily be taking the academic performance of their child into consideration when making decisions that affect their children's schooling environment. For example, recent papers by Gruber (2004) and Katz, Kling, and Liebman (2001) have highlighted the need for careful empirical analysis in this area.

Despite the significant interest in how well children manage family disruptions, research on the closely related question of how work-related parental absences affect children is relatively scarce. Theory provides little firm guidance on the expected direction of the effect. On one hand, a parent's absence could disrupt a child's learning by reducing direct supervision of the child's academic work, by reducing general parental time with children, by disrupting parental roles within the household, and so on. On the other hand, a parental absence could lead to improved academic outcomes if the child develops a greater sense of responsibility or if the parental absence is correlated with higher household income. This question appears to lend itself more readily to empirical analysis.

Interestingly, the small body of existing research on work-related absences has focused disproportionately on military populations, mainly because of the unique nature of military service with its intermittent deployments. Pisano (1992) studied the effects of military deployments to the Gulf War in 1990 and found small adverse affects in reading scores for 158 sixth grade girls. Angrist and Johnson (2000) found that absences due to Gulf War deployments impacted marital dissolution and spousal labor supply, but did not affect child disability rates. Using deployments to the Balkans in the late-1990s, Lyle (2006) found modest

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adverse effects in math scores for approximately 13,000 military children living in Texas.

In one sense, deployments may seem a narrow military matter, but as the largest single employer in the United States, with 2.2 million personnel spread over 50 states and over 150 countries, the U.S. Department of Defense's deployment policies affect numerous American communities and hundreds of thousands of families. More than 43% of military households have children, and about 84% of these children are under the age of 14. Moreover, both the frequency and duration of deployments have increased as a result of the Global War on Terror: the U.S. Army increased the share of its active forces deployed from 8% in 2001 to 38% in 2007 and the average length of an Army deployment increased from 6 months to 15 months during that same period. As of February 2007, 700,000 children of military service members have experienced a parental absence as a result of a military deployment.[1] The stress that deployments place on military members and their families has important implications for the long-term viability of the all-volunteer force, the bedrock of U.S. national security system for more than three decades.

This paper expands on existing research in four separate and significant ways. First, ours is the only paper to consider child outcomes in the post-9/11 environment, which has seen a significant increase in troop deployments. The paper has an immediate relevance in the current debate about the impact of deployments on military households. Second, the data set used in this paper is much larger and more geographically diverse than those used in previous work, enhancing the validity and relevance of the estimates presented here. Third, this paper is the first to consider academic achievement across five separate academic subjects, as well as total academic achievement. These results lend added depth to our understanding of how parental absences affect child outcomes. Fourth, we consider several new dimensions of a parent's deployment, including how the length of the deployment and the timing of the deployment come into play. In short, none of the previous studies has presented nearly so comprehensive a picture of children's academic achievement during a parent's absence, and none has captured child outcomes in the current operational environment facing military parents.

Using the test scores and personal characteristics of roughly 56,000 school-age children enrolled in Department of Defense schools between 2002 and 2005, together with administrative data on their military parent's service record, we find that a parent's deployment in the past year reduces his or her child's total test score by 0.42% points. We also estimate the marginal adverse effect of an additional month of deployment to be 0.11% points. Further analysis shows that the effects are most significant for math and science; they are less pronounced, though still statistically significant, for language arts, social studies, and reading. Evidence also suggests that the timing and duration of a parent's deployment matters, and that the adverse effect

may persist for several years. Overall, we find that parental absences, within this military context, are associated with slightly lower academic achievement for children.

2. Department of Defense Schools and the U.S. Army

The Department of Defense has provided "on post" schools for selected military bases in the United States and abroad since the end of the Second World War.[2] The Department of Defense Educational Activity (DoDEA) school system comprises 223 schools in 7 U.S. states, 2 U.S. territories, and 13 foreign countries and contains just over 100,000 students from pre-kindergarten to 12th grade. Approximately two-thirds of children enrolled in the DoDEA system attend a school located outside the United States and about 45% of the students are from Army households. Our sample contains 56,116 observations for DoDEA-enrolled children of enlisted Army personnel between 2002 and 2005.

DoDEA administers the Terra Nova Multiple Assessment Test in March of each year. Widely used across the United States, the Terra Nova is a set of testing instruments that asks a battery of questions designed to "measure concepts, processes, and objectives taught throughout the nation". Although there are some "open-ended" questions, the majority are traditional multiple choice questions. All children in grades 3 through 11 within the DoDEA system must take the Terra Nova test. For each child, we observe a normal curve equivalent (NCE) total score and five sub-scores in math, science, language arts, social studies, and reading. The NCE ranges from 1 to 99 and is an equal interval metric, making it suitable for regression analysis.

To each child's academic record, we merge his or her parent's administrative data, including deployment history. We infer deployment status from a form of supplemental compensation called hostile fire pay (HFP), which soldiers receive only under specific, well-defined criteria—deployments to hostile operational theatres.[3] We link receipt of monthly HFP with the months of a standard school year, which begins in August and proceeds through March when students take the Terra Nova exams. Accordingly, we construct several deployment variables from HFP data: *ever deployed* equals one if the military parent receives any HFP during the current school year and zero otherwise; *months deployed* equals the number of months that the military parent receives HFP during the current school year; and several variables are constructed to capture the precise months during which the military parent is receiving HFP. We also observe the child's gender and race, as well as the military parent's gender, marital status, education level, occupational specialty, rank, and AFQT score.

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[1] Figures for the share of the active force deployed, the average length of an Army deployment, and the number of children affected by Army deployments come from Army data files (TAPDB).

[2] See U.S. Department of Defense Education Activity (2005) for more details.

[3] Other studies have used family separation allowance (FSA) to classify absences. Our identification strategy does not permit the use of FSA because it includes discretionary episodes of absences such as schooling, which could introduce bias from the potential endogenous relationship between absences characterized by FSA and children' academic achievement.

Table 1
Summary statistics by deployment metric.

	A. Population	B. Ever Deployed in the School Year		C. Months Deployed in the School Year		D. Deployed at the Time of the Exam		E. Months Deployed in the Past 5 Years	
		No	Yes	1–3	4–8	No	Yes	1–8	9+
	(1)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Total NCE score	57.07 {14.14}	57.04 {14.17}	57.15 {14.06}	57.17 {14.05}	57.13 {14.06}	57.16 {14.15}	56.63 {14.12}	57.06 {14.16}	56.99 {13.94}
Math NCE score	55.50 {15.99}	55.52 {16.00}	55.43 {15.96}	55.51 {15.95}	55.35 {15.98}	55.60 {15.99}	54.99 {15.97}	55.50 {15.95}	55.35 {15.91}
Science NCE score	54.90 {15.68}	54.83 {15.71}	55.10 {15.61}	55.06 {15.59}	55.16 {15.63}	54.95 {15.67}	54.65 {15.73}	54.91 {15.73}	55.26 {15.76}
Language arts NCE score	57.37 {15.39}	57.35 {15.41}	57.44 {15.31}	57.46 {15.29}	57.43 {15.33}	57.45 {15.39}	56.96 {15.38}	57.35 {15.47}	57.29 {15.13}
Social studies NCE score	55.86 {15.05}	55.78 {15.06}	56.09 {15.04}	56.07 {15.05}	56.12 {15.03}	55.90 {15.06}	55.66 {15.03}	55.81 {15.07}	56.05 {15.06}
Reading NCE score	56.78 {15.26}	56.70 {15.29}	56.98 {15.17}	56.92 {15.22}	57.05 {15.12}	56.85 {15.27}	56.39 {15.21}	56.76 {15.36}	56.77 {15.08}
Male child	0.49 {0.50}	0.49 {0.50}	0.49 {0.50}	0.49 {0.50}	0.49 {0.50}	0.49 {0.50}	0.49 {0.50}	0.49 {0.50}	0.49 {0.50}
White child	0.37 {0.48}	0.36 {0.48}	0.41 {0.49}	0.42 {0.49}	0.41 {0.49}	0.37 {0.48}	0.40 {0.49}	0.40 {0.49}	0.41 {0.49}
Black child	0.32 {0.47}	0.34 {0.47}	0.28 {0.45}	0.29 {0.45}	0.28 {0.45}	0.33 {0.47}	0.30 {0.46}	0.30 {0.46}	0.28 {0.45}
Parents married	0.92 {0.27}	0.92 {0.28}	0.94 {0.24}	0.94 {0.23}	0.93 {0.25}	0.92 {0.27}	0.94 {0.24}	0.93 {0.27}	0.93 {0.25}
Father is in the Army	0.88 {0.32}	0.86 {0.35}	0.95 {0.22}	0.95 {0.22}	0.95 {0.22}	0.87 {0.34}	0.95 {0.22}	0.92 {0.27}	0.94 {0.23}
Parent is a high school graduate	0.71 {0.45}	0.71 {0.46}	0.74 {0.44}	0.73 {0.45}	0.75 {0.43}	0.71 {0.45}	0.74 {0.44}	0.73 {0.45}	0.75 {0.43}
Parent has some college	0.20 {0.40}	0.21 {0.41}	0.19 {0.39}	0.20 {0.40}	0.18 {0.38}	0.21 {0.41}	0.19 {0.39}	0.20 {0.40}	0.18 {0.38}
Parent is a college graduate	0.07 {0.25}	0.07 {0.25}	0.06 {0.24}	0.06 {0.24}	0.06 {0.24}	0.07 {0.25}	0.06 {0.23}	0.06 {0.24}	0.06 {0.23}
Parent has a graduate degree	0.01 {0.09}	0.01 {0.10}	0.01 {0.08}	0.01 {0.08}	0.01 {0.07}	0.01 {0.10}	0.01 {0.07}	0.01 {0.09}	0.01 {0.07}
Parent AFQT (Cat 1 & 2)	0.31 {0.46}	0.31 {0.46}	0.32 {0.46}	0.32 {0.47}	0.31 {0.46}	0.31 {0.46}	0.30 {0.46}	0.32 {0.46}	0.31 {0.46}
Parent AFQT (Cat 3A)	0.26 {0.44}	0.27 {0.44}	0.26 {0.44}	0.26 {0.44}	0.25 {0.44}	0.27 {0.44}	0.26 {0.44}	0.26 {0.44}	0.27 {0.44}
Parent AFQT (Cat 3B)	0.36 {0.48}	0.36 {0.48}	0.36 {0.48}	0.35 {0.48}	0.37 {0.48}	0.35 {0.48}	0.37 {0.48}	0.36 {0.48}	0.36 {0.48}
Combat arms branch	0.32 {0.47}	0.31 {0.46}	0.36 {0.48}	0.35 {0.48}	0.36 {0.48}	0.32 {0.46}	0.34 {0.47}	0.35 {0.48}	0.38 {0.49}
Combat support branch	0.16 {0.47}	0.16 {0.37}	0.17 {0.37}	0.17 {0.38}	0.16 {0.37}	0.17 {0.37}	0.16 {0.37}	0.17 {0.37}	0.16 {0.37}
Combat service support branch	0.44 {0.50}	0.44 {0.50}	0.42 {0.49}	0.41 {0.49}	0.42 {0.49}	0.43 {0.50}	0.44 {0.50}	0.42 {0.49}	0.41 {0.49}
Observations	56,116	41,760	14,356	7,513	6,843	46,665	9,451	17,746	12,899

Standard deviations are in brackets. Childrens Terra Nova normal curve equivalent scores (range 1–99) are from the Department of Defense Education Activity (DoDEA) testing years 2002–2005 in grades 3–11. The Army personnel data are from the Office of Economic and Manpower Analysis (West Point, New York). Deployment metrics are constructed from Army data on receipt of hostile fire pay. The "current school year" is defined as 1 August of the previous year through 31 March of the current year. The "past 5 years" are defined as 5 years back from the date of the exam. There are 51,362 observations that have been in the Army for 5 years to comprise the "past 5 years" sample. Both the "current school year" sample and the "past 5 years" sample include only mainstream children. The number of months deployed is determined by dividing the sum of hostile fire pay over the period by the monthly hostile fire pay allowance. The omitted race category is "other" race; the omitted education level is "high school dropout"; the omitted AFQT grouping is "category 4 and 5".

The final merged data are specified at the level of the individual child. Table 1 displays descriptive statistics for the children and parents in our sample. Panel A contains the means and standard deviations for the full sample of 56,116 observations. Overall, the students in our sample earned an average total NCE score of 57.07 (on a scale of 1–99), with a standard deviation of 14.14. Our sample is equally divided between boys and girls; about one-third of the children are black; more than 90% have married parents; more than one-quarter have a parent with at least some post-secondary education; about one-third have a parent with an AFQT score placing them in the top half of the ability distribution; and about 60% have a parent who serves in a combat support occupation.

Panel B compares children with parents who deploy during the current school year to children whose parents do not deploy. About 26% of the children have a parent deployed in the current school year. Panel C compares children with parents who deploy for a short duration during the current school year to those with parents who deploy longer. Panel D considers whether the parent is deployed at the time of the test. Approximately 17% of the children have a parent deployed at the time of the exam. All three panels show that a child's math score declines as the duration of the parent's deployment increases, though scores in other subjects appear to rise slightly in Panels B and C. Only a deployment during the month of the test (Panel D) appears to be consistently negatively correlated with test scores across the range of subjects. In Panel E, we provide summary statistics for the effect of a parent's deployment history over the past 5 years.[4]

Our identification strategy turns on the claim that a soldier's deployment status is exogenous to the academic achievement of his or her children, which we believe to be true for three reasons. First, the Army rarely deploys individual soldiers; it deploys units. In recent years, the most common "unit of deployment" has been the company (approximately 125 soldiers). Second, the Army's senior commanders use two primary criteria when making deployment decisions affecting companies and higher-level units: the exigencies of the operational environment and the availability and readiness of suitable units. As a rule, they do not take into consideration the welfare of an individual enlisted soldier and his or her child, nor do they consider the average characteristics of units and families. Third, a soldier has little control over the unit to which he or she is assigned. When a soldier completes basic training, the Army's Human Resources Command assigns him or her to an initial unit; as a matter of policy, the soldier is reassigned to a different unit every 3 or 4 years.[5]

Table 1 offers initial empirical support for our exogeneity assumption. It shows that the probability of a deployment does not differ much across a wide variety of parent and child controls. However, to explore the small

correlations between the deployment variables and some of the control variables, we provide a set of supplemental regression estimates in Table 2. In these specifications, we regress a parent's deployment status on various controls (including the child's race, gender, and grade). Although the strictest possible test would require all coefficients of the control variables to be statistically indistinguishable from zero, such a test is implausibly stringent in a quasi-experimental setting. Rather, we believe that the small point estimates coupled with the fact that the parent's characteristics explain only 1–2% of the total variation in deployment status for all deployment variables support our claim that a parent's deployment status is exogenous to a child's characteristics. We test our exogeneity assumption further using a set of instrumental variables as outlined in the next section.

3. Empirical framework

To investigate more formally how military deployments affect the academic achievement of military children, we employ a basic linear model using pooled data from 2002 through 2005:

$$A_{it} = \alpha + \theta_t + \lambda_{it} + \delta D_{it} + \beta X_{it} + \varepsilon_{it}. \qquad (1)$$

Here the left-side variable, A_{it}, is one of the following outcomes: the NCE score in math, science, language arts, social studies, reading, or the total composite score across all five subjects. The α term is a constant; θ_t are year dummies for 2003–2005; λ_{it} are dummies for grade levels 4 through 11. The coefficient δ on the variable of interest, D_{it}, represents the effect of a military parent's deployment on the NCE score(s) of his or her child i in time period t. The vector X_{it} captures other covariates including the child's gender and race, as well as the marital status, gender, civilian education level, AFQT score, and occupational specialty of the child's military parent. We cluster all standard errors for OLS estimates at the level of the individual child.

As mentioned earlier, the primary threat to the validity of our identification assumption is the possibility that a soldier's deployment may be correlated with other potential determinants of his or her child's academic achievement. For example, the Army may select certain soldiers to deploy based on characteristics that are also correlated with the academic achievement of their children. Alternatively, parents who are willing to deploy may be the same ones with the lowest academic expectations for their children. In each case, we must contend with a correlation between a parent's deployment history and some unobserved determinant of the child's subsequent academic achievement, which could confound the interpretation of the estimates.

As a first step toward addressing this concern in our empirical work, we control for all observable characteristics that the Army could use to assign soldiers to deployments. For example, the Army could weigh the AFQT scores of soldiers when making deployment decisions and the AFQT score of a military parent could be correlated with his or her child's academic performance during the parent's deployment. Because we use the full set of the Army's own administrative records, our data reflect the individual-level characteristics available to the Army for making

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[4] Children in our DoDEA sample are representative of the overall population of Army children and are uniformly representative within each school year in our sample.

[5] See Lyle (2006) for a more detailed description about military assignment mechanisms.

Table 2
Covariate correlations between measures of parental deployment and control variables dependent variable: measure of parental deployment metric.

	Population Mean {Std. Dev.}	A. Current school year		B. Past 5 years		C. Instrumental variables	
		Ever deployed (1)	Months deployed (2)	Ever deployed (1)	Months deployed (2)	One-third of unit deployed (1)	Average months deployed for the assigned unit (2)
Male child	0.493 {0.500}	−0.001 (0.004)	0.001 (0.017)	−0.003 (0.005)	−0.036 (0.059)	−0.001 (0.003)	−0.005 (0.014)
Black child	0.322 {0.467}	−0.026 (0.005)	−0.119 (0.023)	−0.039 (0.006)	−0.374 (0.077)	−0.009 (0.004)	−0.092 (0.019)
Other race child	0.304 {0.460}	−0.013 (0.005)	−0.029 (0.022)	−0.017 (0.006)	−0.116 (0.074)	−0.003 (0.003)	−0.035 (0.018)
Parents married	0.921 {0.269}	0.000 (0.007)	−0.043 (0.033)	−0.011 (0.009)	−0.256 (0.107)	−0.009 (0.005)	−0.055 (0.027)
Father is in the Army	0.881 {0.323}	0.142 (0.006)	0.600 (0.025)	0.218 (0.009)	2.141 (0.088)	0.069 (0.004)	0.357 (0.021)
Parent is a high school drop out	0.006 {0.080}	0.069 (0.025)	0.314 (0.126)	0.080 (0.028)	0.825 (0.369)	0.033 (0.020)	0.295 (0.111)
Parent has some college	0.204 {0.403}	−0.017 (0.005)	−0.105 (0.021)	−0.039 (0.007)	−0.493 (0.072)	−0.023 (0.003)	−0.122 (0.017)
Parent has a college degree	0.067 {0.249}	−0.029 (0.008)	−0.160 (0.036)	−0.058 (0.011)	−0.584 (0.132)	−0.036 (0.005)	−0.181 (0.028)
Parent has a graduate degree	0.009 {0.093}	−0.077 (0.020)	−0.431 (0.081)	−0.108 (0.028)	−1.622 (0.272)	−0.076 (0.011)	−0.383 (0.068)
Parent AFQT (Cat 1 & 2)	0.309 {0.462}	−0.001 (0.005)	−0.008 (0.023)	0.002 (0.007)	−0.032 (0.081)	−0.005 (0.004)	−0.016 (0.019)
Parent AFQT (Cat 3B)	0.358 {0.479}	0.006 (0.005)	0.054 (0.022)	0.008 (0.007)	0.135 (0.076)	0.008 (0.003)	0.043 (0.018)
Parent AFQT (Cat 4 & 5)	0.068 {0.253}	−0.025 (0.008)	−0.107 (0.035)	−0.027 (0.012)	−0.298 (0.124)	−0.010 (0.006)	−0.090 (0.029)
Combat support branch	0.165 {0.371}	−0.008 (0.006)	−0.064 (0.026)	−0.044 (0.008)	−0.412 (0.096)	−0.018 (0.004)	−0.055 (0.021)
Combat service support branch	0.435 {0.496}	−0.009 (0.005)	−0.014 (0.021)	−0.048 (0.006)	−0.558 (0.071)	−0.008 (0.003)	0.015 (0.017)
Special branch	0.080 {0.272}	−0.061 (0.008)	−0.258 (0.034)	−0.161 (0.011)	−1.620 (0.111)	−0.046 (0.005)	−0.276 (0.027)
Intercept		−0.006 (0.010)	−0.103 (0.045)	0.293 (0.014)	1.795 (0.153)	0.004 (0.007)	0.142 (0.037)
Partial R^2 for child controls		0.09	0.12	0.07	0.13	0.08	0.16
R^2		0.10	0.13	0.10	0.15	0.09	0.16
Observations	56,116	56,116	56,116	56,116	56,116	56,116	56,116

Standard errors (in parenthesis) account for clustering at the individual child level because some children appear in multiple years. All regressions are estimated by OLS and contain a constant, dummies for the year of exam, dummies for grade levels 4 through 11, and the full set of child and parental controls as described in Table 3 notes. See notes in Table 1 for additional sample description.

deployment assignments. We therefore include these controls in our regressions to strengthen the case for a causal interpretation.

Second, we test the exogeneity of individual-level deployments by using a set of instrumental variables based on unit-level deployments. For two of our deployment metrics, we construct instruments using battalion-level deployment data. The instrument for *ever deployed* equals one if the parent's battalion had more than one-third of its soldiers deploy during the current school year and zero otherwise.[6] The instrument for *months deployed* equals the average number of months deployed for all soldiers in the parent's battalion. We anticipate a positive correlation between battalion-level *months deployed* and individual-level *months deployed*, since soldiers assigned to battalions with longer deployments are more likely to deploy for longer periods than soldiers assigned to battalions with shorter deployment durations.[7]

4. Empirical results

Table 3 contains OLS and 2SLS estimates of the impact of a parent's deployment during the current school year on a child's total NCE score following the specification in Eq. (1). Panel A shows estimates for the *ever deployed* variable; Panel B shows the estimates for the *months deployed* variable. We begin by noting how the coefficients on the *ever deployed* variable in Panel A change significantly between the parsimonious specification in column (1) to the fuller specification in column (2), which includes child controls. However, the estimates change very little between the specification in column (2) and that in column (3), which adds parent controls. This result suggests that parental characteristics, which the Army could theoretically use to assign deployments, have little effect on the estimated treatment effect. The relative stability of δ also suggests that the effect of other less relevant unobserved variables should be quite minor. From the estimates in column (3), we see that a child whose parent deploys during the current school year scores 0.42% points, or 3% of a standard deviation, lower on his or her total Terra Nova score than a child whose parent does not deploy.

To test whether we can apply a causal interpretation to these results, we estimate a 2SLS specification using the battalion-level instrumental variable described earlier. As column (4) shows, the sign on the first stage of this specification is positive and significant: a child whose parent is assigned to a battalion in which more than one-third deploys is 69.8% more likely to have his or her parent deploy than a child whose parent is assigned to a unit in which less than one-third deploys. The partial R^2 on

the first stage is 0.28, which means that the instrument explains approximately 28% of the variation in individual-level deployments. A Hausman specification test fails to reject the null hypothesis that the OLS estimates are statistically equivalent to the 2SLS estimates.

In Panel B of Table 3, we observe how the length of a parent's deployment during the current school year, measured by *months deployed*, affects a child's academic performance. Again, we see that estimates of δ are only slightly sensitive to the inclusion of the parental control variables. Likewise, 2SLS estimates in column (4) and results from the Hausman test support our exogenous deployment assumption. Estimates in column (3) indicate that a 1-month increase in the length of a parent's deployment reduces a child's total NCE score by 0.11% points. This means that a deployment spanning the full 8 months preceding the test reduces the total NCE score by 0.90% points, or 5% of a standard deviation.

We conducted several additional robustness tests to further validate our claim that a parent's deployment status is exogenous to a child's academic achievement. First, for the sample of children who appear in at least 2 years of the data, we regress each child's prior-year scores on current-year deployments. The estimates were statistically insignificant and reject the concern that the same children's parents are deploying year after year or that prior-year scores predict current-year deployments. We also construct a fixed-effects specification using the children who appear in the data over successive years, finding no statistically significant difference between the fixed-effect estimates and the OLS ones. From still other robustness tests, we reject the concern that dual military families or those stationed overseas drive the estimates.[8] We also find stable estimates of our deployment effects when we include unit level average child and parent characteristics as controls in both the full OLS and 2SLS specifications. Consequently, we use OLS to estimate Eq. (1) for the rest of this paper.

Table 4 extends the analysis by showing the effects of a broader set of deployment metrics on the five separate subject areas tested by the Terra Nova. Each estimate is from a separate OLS regression with the full set of control variables. The *ever deployed* variable (Panel A) is statistically significant for math, science, and language arts scores. A parent's deployment during the current school year lowers a child's math NCE score by 0.76% points, nearly twice the effect on the total NCE score. A similar pattern holds for the *months deployed* variable (Panel B): an 8-month deployment, the span the covers our specification, lowers a child's math score by 1.50% points compared with 0.90 for the total NCE score. To get a sense for how longer deployments affect children's education outcomes, we project our estimated effect beyond the 8 months of data in our sample. If the marginal effect of a month deployed remained the

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[6] We use the ratio of one-third because most battalions consist of three main companies, any one of which can be deployed separately as part of a task force. See Lyle (2006) for more details.

[7] Although smaller, estimates of the covariate regressions between the battalion-level deployment measures and the control variables in Panel C of Table 2 reveal a pattern of correlations similar to that of the parent-level deployment measures in Panel A. As further support of our exclusion restriction, parental characteristics explain less than 1 percent of the total variation in battalion-level deployments.

[8] To test if dual military families affect our estimates, we compare the coefficient on our deployment variable using the full sample of children with the deployment coefficient using a sample excluding children from dual military households. The coefficients and standard errors are nearly identical across both samples, suggesting that unobserved characteristics associated with children from dual military families are not biasing the results. We conduct a similar test on the children in overseas schools, and find the same result.

Table 3

Effect of a parent's deployment on a child's total NCE score during the current school year dependent variable: child's total NCE score.

	A. Ever deployed				B. Months deployed			
	OLS (1)	OLS (2)	OLS (3)	2SLS (4)	OLS (1)	OLS (2)	OLS (3)	2SLS (4)
Ever Deployed	−0.041 (0.155)	−0.450 (0.168)	−0.419 (0.149)	−0.557 (0.235)				
Months Deployed					−0.058 (0.029)	−0.130 (0.029)	−0.112 (0.028)	−0.136 (0.033)
Male child		−2.046 (0.165)	−2.159 (0.162)	−2.159 (0.162)		−2.046 (0.165)	−2.158 (0.162)	−2.158 (0.162)
Black child		−7.028 (0.194)	−5.124 (0.211)	−5.128 (0.211)		−7.032 (0.194)	−5.126 (0.211)	−5.129 (0.211)
Other race child		−1.856 (0.197)	−0.885 (0.199)	−0.887 (0.199)		−1.854 (0.197)	−0.883 (0.199)	−0.884 (0.199)
Parents married			1.100 (0.290)	1.100 (0.290)			1.096 (0.290)	1.094 (0.290)
Father is in the Army			1.176 (0.271)	1.196 (0.272)			1.183 (0.271)	1.198 (0.271)
Parent is a high school drop out			0.380 (0.872)	0.389 (0.873)			0.385 (0.872)	0.393 (0.873)
Parent has some college			1.589 (0.198)	1.586 (0.198)			1.584 (0.198)	1.581 (0.198)
Parent has a college degree			3.627 (0.333)	3.623 (0.333)			3.621 (0.333)	3.617 (0.333)
Parent has a graduate degree			4.692 (0.871)	4.682 (0.870)			4.677 (0.871)	4.666 (0.870)
Parent AFQT (Cat 1 & 2)			2.946 (0.221)	2.946 (0.221)			2.946 (0.221)	2.946 (0.221)
Parent AFQT (Cat 3B)			−1.356 (0.210)	−1.355 (0.210)			−1.356 (0.210)	−1.351 (0.210)
Parent AFQT (Cat 4 & 5)			−2.457 (0.353)	−2.461 (0.353)			−2.459 (0.353)	−2.462 (0.353)
Combat support branch			−0.087 (0.252)	−0.088 (0.252)			−0.091 (0.252)	−0.093 (0.252)
Combat service support branch			−0.885 (0.196)	−0.886 (0.196)			−0.883 (0.196)	−0.883 (0.196)
Special branch			0.524 (0.333)	0.516 (0.333)			0.521 (0.333)	0.515 (0.333)
1st stage				0.698 (0.004)				1.024 (0.004)
R^2 (partial for 2SLS)	0.01	0.06	0.09	0.28	0.01	0.06	0.09	0.63
Observations	56,116	56,116	56,116	56,116	56,116	56,116	56,116	56,116

Standard errors (in parenthesis) account for clustering at the individual child level because some children appear in multiple years. All regressions contain a constant and dummies for the year of exam and for grade levels 4 through 11. Race dummies control for white, black, and other race. Education dummies control for high school dropout, high school graduate, some college, college degree, and graduate degree. AFQT dummies controls for the five primary AFQT groups. Occupational dummies control for combat arms, combat support, combat service support, and special branch. The two instruments used in the 2SLS estimation are constructed from the unit of assignment (see main text for details). Hausman test statistics have the following p-values: Panel A—(3) and (4) = 1.000; Panel B—(3) and (4) = 1.000. The omitted race is white, the omitted education level is high school graduate, the omitted occupational group is combat arms, and the omitted AFQT group is cat 3A. Clustering standard errors at the unit level for 2SLS regressions does not change the statistical significance of estimates. The inclusion of rank controls does not impact the estimates of the deployment effects. See notes in Table 1 for additional sample description.

Table 4
Effect of a parent's deployment on a child's subject scores in the current school year dependent variable: child's NCE score, by subject area.

	Math (1)	Science (2)	Language arts (3)	Social Studies (4)	Reading (5)	Total (6)
A. Deployments in the current school year						
Ever deployed in current school year	−0.755 (0.170)	−0.723 (0.163)	−0.338 (0.161)	−0.266 (0.160)	−0.127 (0.159)	−0.419 (0.149)
B. Deployment duration in the current school year						
Months deployed during current school year	−0.188 (0.032)	−0.169 (0.031)	−0.090 (0.031)	−0.074 (0.030)	−0.042 (0.030)	−0.112 (0.028)
C. Deployed during the month of the exam						
Deployed in March	−0.921 (0.177)	−0.813 (0.172)	−0.679 (0.169)	−0.519 (0.167)	−0.594 (0.167)	−0.747 (0.155)
D. Timing of deployment in the current school year						
Deployment ending: August–October	−0.143 (0.398)	−0.468 (0.392)	0.034 (0.379)	−0.280 (0.384)	−0.267 (0.378)	−0.122 (0.349)
Deployment ending: November–January	−0.786 (0.322)	−0.663 (0.303)	0.033 (0.299)	0.010 (0.301)	0.316 (0.293)	−0.170 (0.275)
Deployment ending in February or deployed in March	−0.800 (0.181)	−0.725 (0.174)	−0.362 (0.172)	−0.308 (0.170)	−0.252 (0.171)	−0.488 (0.160)
Observations	56,116	56,116	56,116	56,116	56,116	56,116

Standard errors (in parenthesis) account for clustering at the individual child level because some children appear in multiple years. All regressions are estimated by OLS and contain a constant, dummies for the year of exam, dummies for grade levels 4 through 11, and the full set of child and parental controls as described in Table 3 notes. See notes in Table 1 for additional sample description.

same outside of our sample, we would expect a 15-month deployment (the current average within the Army) to have a − 2.82% point effect for the math NCE score and − 1.68% point effect for the total NCE score.

For deployments during the month of the exam (Panel C), we find a negative and statistically significant effect across all five subjects and for the total composite score. A child whose parent is deployed during the month of the exam experiences a 0.92% point reduction in his or her math score relative to a child whose parent is not deployed during that time. Regressions focusing on the timing of a parent's return (Panel D) reveal that a child whose parent returns well before the test date (between August and October) scores about the same as a child whose parent does not deploy at all that year. However, a child whose parent returns later (between November and January) scores 0.79% points lower in math and 0.66% points lower in science than a child whose parent does not deploy that year. A child whose parent returns in February or is still deployed in March experiences the largest adverse effects.

On balance, these findings suggest at least two interpretations. We call our first interpretation the "disruption" effect. The estimates in Panels A through C suggest that a parental deployment disrupts a child's academic performance, particularly if the absence occurs during the month in which the child is tested. The estimates in Panel D lead to a second possible interpretation, what we call a "catching up" effect. It appears that a child whose parent returns earlier in the school year has time to "catch up" before taking the exam in March.

To explore the question of whether the adverse effects of a parent's deployment fully dissipate over time, we estimate how a soldier's deployment history over the past 5 years affects his or her child's academic achievement. In these specifications, we restrict our sample to children whose military parent has been in the Army for at least 5 years. In Panel A of Table 5, the deployment metric of interest is *ever deployed in the past 5 years*, which equals one if the parent has received HFP at any point during the 5 years preceding the test and zero otherwise. For all five subjects and the total score, we observe a statistically significant negative effect, indicating that these children experience a decline in academic achievement that results from deployments from as far back as 5 years. In Panel B, the deployment metric of interest is *months deployed in the past 5 years*, and the results are similar. The effects are statistically significant for the same six outcome measures in Panel A.

Panel C shows OLS estimates in which D_{it} contains a set of dummy variables capturing the year of the parent's last deployment. The omitted category in each specification is children whose parents have not deployed at all in the past 5 years. For nearly all of the test subjects, deployment effects persist for up to 4 years after a parent returns from a deployment. For example, a parental deployment ending 3–4 years before the test date reduces a child's math score by 0.91% points in the current year. Only 4–5 years after the parent's return do the adverse effects become statistically insignificant. Taken together, these results suggest that the penalty associated with deployments dissipates quite slowly.

Table 5
Effect of a parent's development during the past 5 years dependent variable: child's NCE score, by subject area.

	Math (1)	Science (2)	Language arts (3)	Social studies (4)	Reading (5)	Total (6)
A. Deployed in the past 5 years						
Ever deployed in the past 5 years	−0.991 (0.178)	−0.790 (0.166)	−0.694 (0.169)	−0.614 (0.164)	−0.590 (0.164)	−0.784 (0.158)
B. Deployment duration in the past 5 years						
Months deployed in the past 5 years	−0.085 (0.016)	−0.067 (0.015)	−0.066 (0.015)	−0.047 (0.015)	−0.045 (0.015)	−0.067 (0.014)
C. Timing of last deployment in the past 5 years						
Last deployment ending 0–1 years ago	−1.054 (0.196)	−0.844 (0.185)	−0.679 (0.186)	−0.550 (0.182)	−0.496 (0.182)	−0.768 (0.174)
Last deployment ending 1–2 years ago	−1.106 (0.293)	−1.024 (0.278)	−1.071 (0.277)	−0.891 (0.277)	−0.895 (0.274)	−1.040 (0.256)
Last deployment ending 2–3 years ago	−0.880 (0.344)	−0.552 (0.326)	−0.584 (0.335)	−0.757 (0.320)	−0.671 (0.328)	−0.741 (0.307)
Last deployment ending 3–4 years ago	−0.910 (0.362)	−0.789 (0.355)	−0.794 (0.346)	−0.635 (0.341)	−0.629 (0.341)	−0.823 (0.316)
Last deployment ending 4–5 years ago	−0.407 (0.396)	−0.155 (0.387)	−0.070 (0.380)	−0.375 (0.376)	−0.653 (0.370)	−0.400 (0.343)
Observations	51,362	51,362	51,362	51,362	51,362	51,362

Standard errors (in parenthesis) account for clustering at the individual child level because some children appear in multiple years. All regressions are estimated by OLS and contain a constant, dummies for the year of exam, dummies for grade levels 4 through 11, and the full set of child and parental controls as described in Table 3 notes. See notes in Table 1 for additional sample description.

5. Conclusions

The effect of household disruptions such as parental absences on children's schooling has broad implications for educational policy, labor market dynamics, and even national security. Like other research on the impact of household disruptions, this paper follows a careful empirical design, using military deployments as a source of variation in work-related parental absences.

This paper offers the most complete picture to date of how deployments are affecting the academic achievement of the hundreds of thousands of children whose parents serve in the U.S. military and, by inference, the welfare of military households in the post-9/11 world. On one level, our findings show that the effects of a parental deployment during the current school year are relatively modest and tend to dissipate after a parent's return. We may consider these estimates as a lower bound on parental deployments since DoDEA schools are likely more equipped to manage deployments than non-military schools. We may also consider these estimates as an upper bound on the work-related parental absences literature, since military deployments may induce more stress and anxiety than the typical parental absence. The paper also delivers some cautionary evidence. Our results show that certain academic subjects pose more trouble for a child whose parent is absent and that the length and timing of a parent's deployment-induced absence matters. In addition, the cumulative effects of a parent's deployment appear to linger over time. To the extent that the accumulation of human capital is a building process, a child who falls behind in 1 year may fall further and further behind with subsequent years of education. These findings underscore the need for schools, especially those serving students who are prone to parental absences, to consider programs that mitigate the effects of parental absences on children's educational attainment.

Acknowledgements

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