Ever Failed, Try Again, Succeed Better

Results from a Randomized Educational Intervention on Grit

Sule Alan, Teodora Boneva, Seda Ertac

December 2015

"Ever tried. Ever failed. No matter. Try again. Fail again. Fail better."

- Samuel Beckett

Non-Cognitive Skills and Their Malleability

- Non-cognitive skills and individual differences in these skills matter
  - Heckman et al. (2006), Borghans et al. (2008), Kautz et al. (2014)
- Evidence that non-cognitive skills are malleable (e.g. Perry Pre-school, OneGoal)
  - Alan and Ertac (2014), Heckman et al. (2010), Almlund et al. (2011), Kautz and Zanoni (2014)
- Non-cognitive skills and preferences influenced by childhood environment
  - Borghans et al. (2008), Alan et al. (2013)

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"Focus on non-cognitive traits, particularly self-control and perseverance early on, to reduce educational achievement gaps." (U.S. Department of Education Report, 2013)

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Our Specific Focus: Grit

- Defined as perseverance in a productive task, related to conscientiousness and setting long-term goals
- Influences the motivation to set a goal, exerting effort towards that goal, persevering in response to negative performance feedback
- An important non-cognitive skill that predicts outcomes (e.g. high school dropout rates, job retention, college GPAs)
  - Duckworth et al. (2007), Maddi et al. (2012), Eskreis-Winkler et al. (2014)
- Beliefs are important in determining gritty behavior. Suggestive evidence that beliefs about malleability of intelligence is important.
  - Dweck et al. (2007), Aronson et al. (2002), Good et al. (2003)

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Educational Intervention - What We Do

- Design an educational intervention to foster gritty behavior
- Randomly assign schools (unit of randomization) to treatment and control
- Train the teachers to educate students
- Measure impact of intervention on:
  - Behavior/outcomes in an incentivized experiment
  - Grades in core subjects
  - Self-reported beliefs and behaviors

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Educational Intervention - Three Main Questions

- Evaluation design:
  - Baseline data collection-Spring 2013
  - Intervention-Fall 2013
  - Outcome data collection-Spring 2014

▸ Design

1. Can the educational intervention change measured beliefs and behaviors related to grit?
2. Does the educational intervention affect actual outcomes such as grades?
3. Are there factors that moderate the impact of the intervention?

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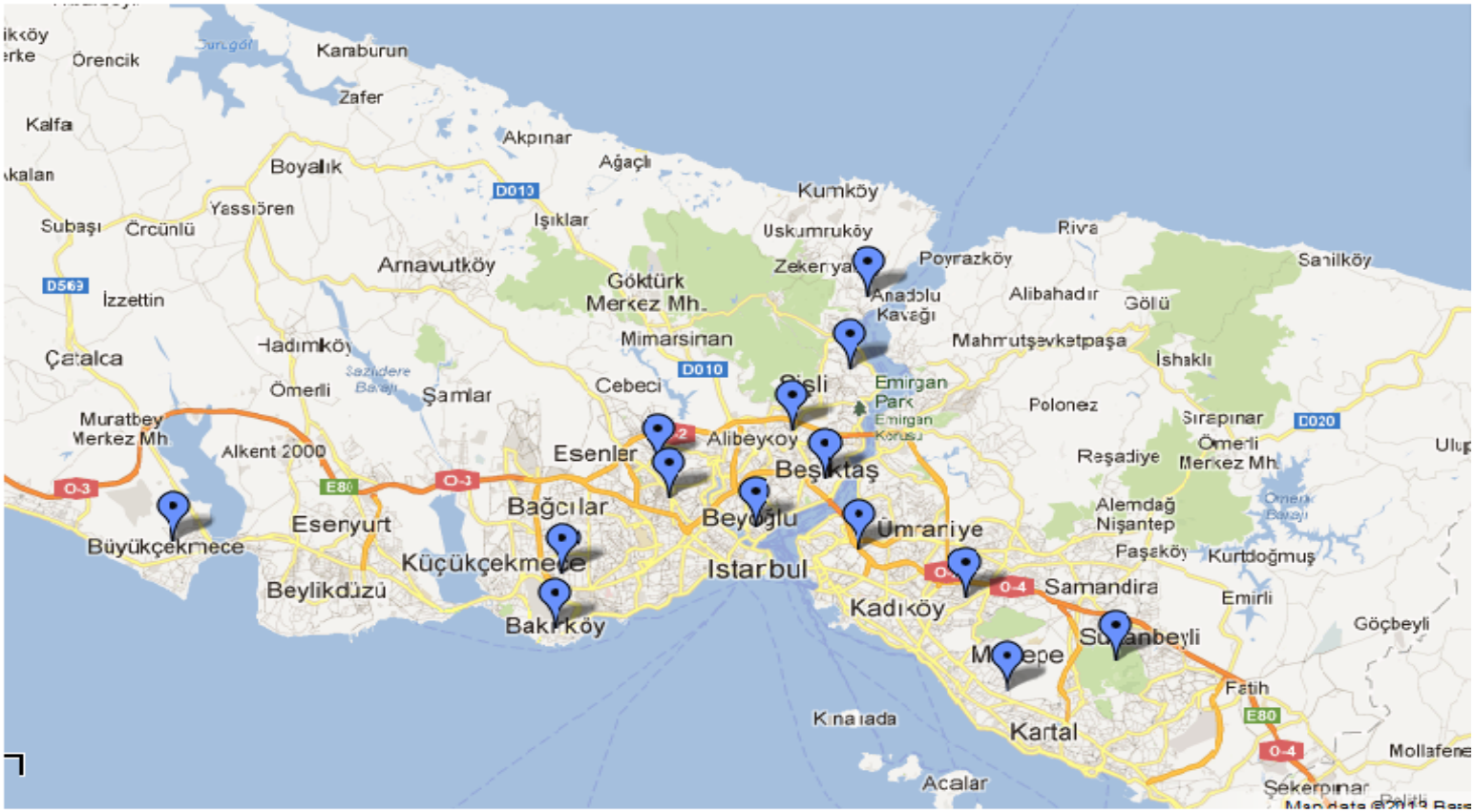
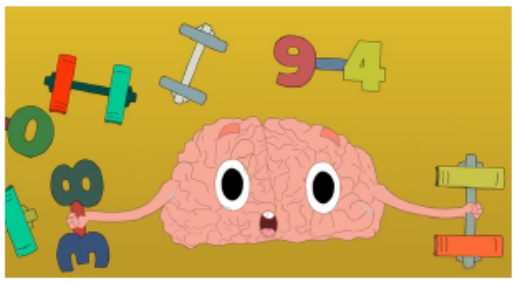
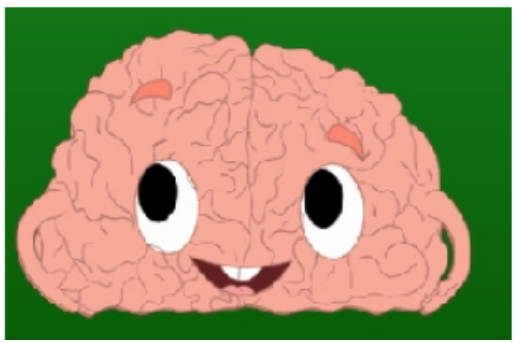
Istanbul


Karaburun
Örencik
Zafer
Kalfa
Akpınar
Ağaçlı
Boyalık
Yassıören
Çrcünlü
Subaşı
Işıklar
Kumköy
Uskumruköy
Riva
Poyrazköy
Sahilköy
Arnavutköy
Göktürk
Merkez Mh.
Zekeriya
Anadolu
Kavağı
Alibahadır
Gölü
İzzettin
Mimarsinan
Mahmutşevketpaşa
İshaklı
Çatalca
Hadımköy
Cebeci
Emirgan
Park
Polonez
Ömerli
Şamlar
Muratbey
Merkez Mh
Alkent 2000
Esenler
Alibeyköy
Beşiktaş
Sırapınar
Reşadiye
Ömerli
Merkez Mh
Bağcılar
Beyoğlu
Ümraniye
Alemdağ
Nişantep
Büyükçekmece
Esenyurt
Küçükçekmece
Istarbul
Paşaköy
Kurtdoğmuş
Samandıra
Emirli
Beylikdüzü
Bakırköy
Kadıköy
Göçbeyli
Fatih
Kınalıada
Kartal
Mollafene
Acalar
Şekerpınar

Educational Intervention - The Training

- Ministry of Education allows 5 hours per week for extra-curricular projects
- Voluntary participation; we have 60% yes, 20% busy with existing projects, 5% said no due to possible transfers, rest "private circumstances"
- Videos, classroom activities, praise/feedback type, performance attribution





The Data

- ~ 2150 students in 4th grade of elementary school, about 1700 present for the experimental task and surveys
- 36 schools, 64 classes
- 15 in treatment, 21 in control
- public schools, most students from lower SES backgrounds
- average age: 10 years

▸ Randomization balance

Incentivized Experiment

- Mathematical real-effort task
- Find pairs of numbers in a grid that sum up to 100
- Target for success: 3 pairs in 90 seconds
- 2 versions: Difficult (4 gifts) and Easy (1 gift)

17	86	23	12
71	42	27	38
51	62	83	30
77	59	46	67
81	58	29	54

80	7
70	95
5	20
10	30
93	90

Two Visits, One Week Apart

Visit 1

- Initial task to measure task-specific skill
- 5 rounds of number-search task
- In each round:
  - Choose between difficult (high-reward) and easy (low-reward) task
  - Play the chosen task
  - Receive feedback
- For random subset of classes:
  - Irrespective of their choice students have to play difficult in first round
- One round randomly selected for payment
- At the end of round 5:
  - Students asked which task they want to choose for visit 2
  - Can take practice material to study

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Incentivized Experiment

Visit 2 (one week later)

- Play the chosen task
- For random subset of classes:
  - Irrespective of their choice students have to play difficult

Experimental Task

Experimental Measures

- Initial task-specific skill (control variable)
- Initial choice of task difficulty (outcome measure)
- Perseverance in task after performance feedback (outcome measure)
- Choice of task difficulty under a "skill accumulation opportunity" (outcome measure)
- Actual success, payoffs (outcome measure)

PLUS

- Pre- and post-treatment student questionnaire (perseverance, beliefs about malleability of skills, self-confidence)
- Baseline teacher questionnaire for each student
- Official school grades

▸ Baseline Associations

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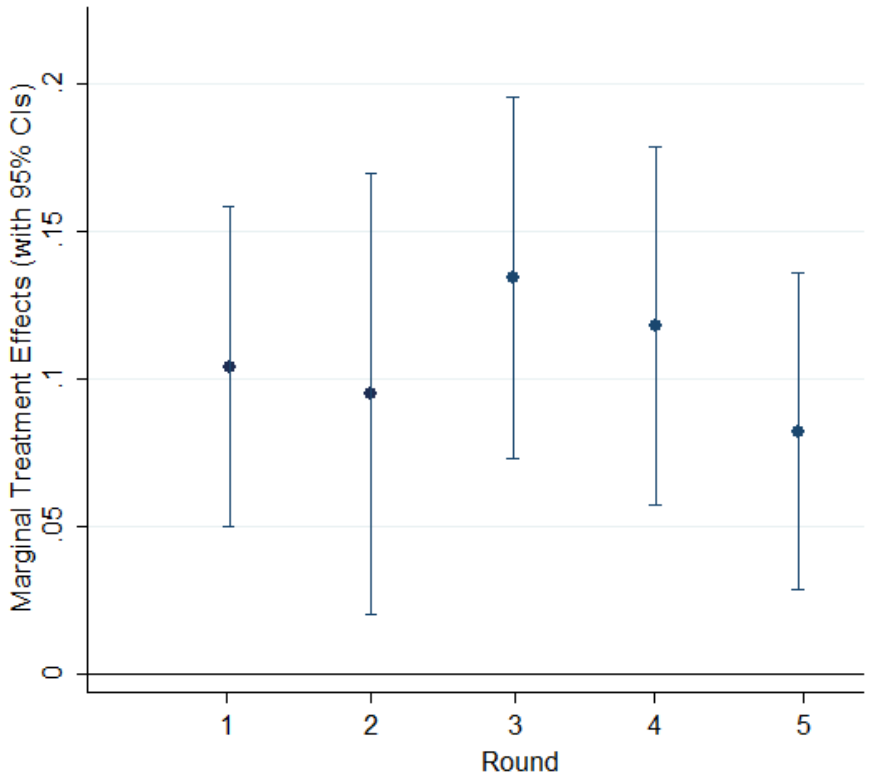
Results - Choice of Difficult Task

Table 1: Treatment Effect on Choice of Difficult Task

	(1) Round 1	(2) Round 2	(3) Round 3	(4) Round 4	(5) Round 5
Treatment	0.104***	0.095**	0.135***	0.118***	0.082***
	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
Task Ability	0.047***	0.061***	0.064***	0.068***	0.066***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Gender (Male=1)	-0.013	0.100***	0.070***	0.048**	0.078***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Raven Score	0.014	0.030**	0.029*	0.042***	0.037**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Malleability (pre)	0.009	-0.008	-0.004	-0.007	0.012
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Perseverance (pre)	-0.013	0.014	-0.005	0.027*	0.012
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Math Score	0.001*	0.001	0.002***	0.002**	0.002**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Risk Tolerance	0.018**	0.012	0.013*	0.012*	0.007
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Control Mean	0.73	0.55	0.43	0.42	0.41
N	1716	1715	1715	1714	1717

Results - Choice of Difficult Task

Figure 1: Treatment Effect on Choice of Difficult Task



Results - Choice after Failure, Imposed Sample

Table 2: Choice after Failure

	Difficult
Treatment	0.178***
	(0.06)
Task Ability	0.032***
	(0.01)
Gender (Male=1)	0.131***
	(0.04)
Raven Score	0.044**
	(0.02)
Malleability (pre)	-0.013
	(0.03)
Perseverance (pre)	-0.001
	(0.04)
Math Score	-0.000
	(0.00)
Risk Tolerance	0.012
	(0.02)
Control Mean	0.36
N	558

Results - Treatment Effect on Success

Table 3: TE on Success Round 1, Difficult Imposed

	Success
Treatment	0.039
	(0.04)
Task Ability	0.083***
	(0.01)
Gender (Male=1)	0.031
	(0.02)
Raven Score	0.041*
	(0.02)
Malleability (pre)	-0.006
	(0.01)
Perseverance (pre)	-0.006
	(0.02)
Math Score	0.003***
	(0.00)
Risk Tolerance	-0.002
	(0.01)
Control Mean	0.29
N	817

Results - Treatment Effect on Payoffs

Table 4: Treatment Effect on Payoffs (Overall)

	(1) Round 1	(2) Round 2	(3) Round 3	(4) Round 4	(5) Round 5
Treatment	0.085	0.020	0.033	0.109	0.054
	(0.11)	(0.06)	(0.08)	(0.10)	(0.09)
Task Ability	0.301***	0.162***	0.246***	0.190***	0.190***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Gender (Male=1)	0.207**	0.128*	0.192***	0.103	0.135*
	(0.09)	(0.07)	(0.06)	(0.06)	(0.08)
Raven Score	0.130**	0.132***	0.079**	0.077	0.084
	(0.06)	(0.03)	(0.04)	(0.05)	(0.05)
Malleability (pre)	-0.024	0.048	0.013	-0.026	0.011
	(0.05)	(0.04)	(0.04)	(0.05)	(0.04)
Perseverance (pre)	0.006	-0.034	0.010	0.004	0.066
	(0.06)	(0.04)	(0.04)	(0.05)	(0.05)
Math Score	0.011***	0.008***	0.006***	0.006***	0.004**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Risk Tolerance	0.024	0.036	0.057***	0.011	0.044*
	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)
Control Mean	1.54	1.06	1.45	1.28	1.34
N	1714	1704	1710	1709	1711

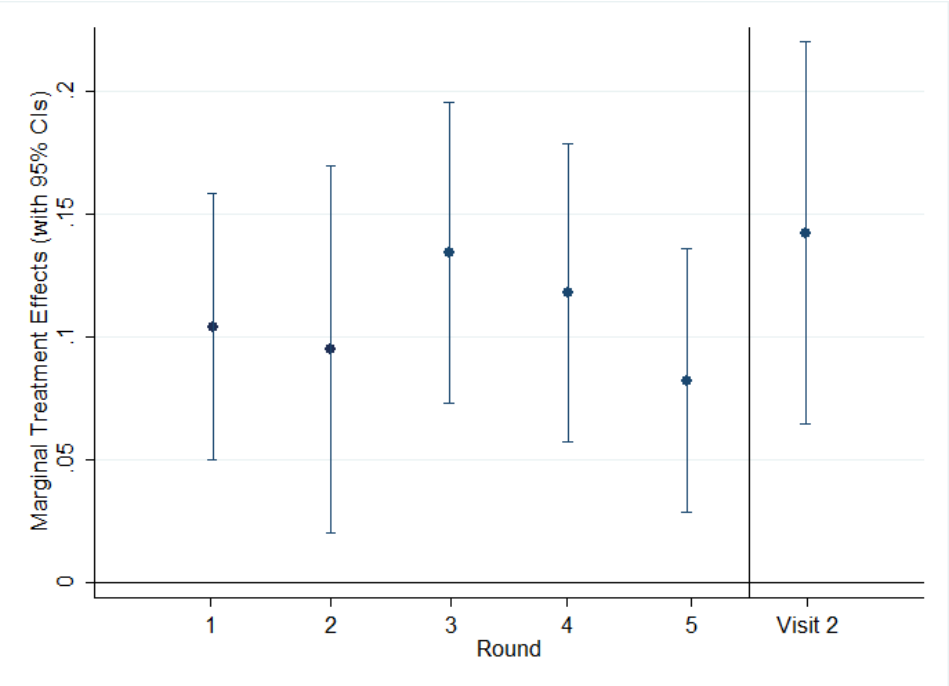
Results - Plan for Next Week: Goal-Setting

Table 5: Plan for Next Week

	Difficult
Treatment	0.142***
	(0.04)
Task Ability	0.055***
	(0.01)
Gender (Male=1)	0.010
	(0.02)
Raven Score	0.023
	(0.01)
Malleability (pre)	0.009
	(0.02)
Perseverance (pre)	0.045***
	(0.02)
Math Score	0.002**
	(0.00)
Risk Tolerance	0.013
	(0.01)
Control Mean	0.45
N	1689

Results - Plan for Next Week: Goal-Setting

Figure 2: Treatment Effect on Choice of Difficult Task



1st Visit–Summary of Results

1. Treated students choose the difficult task significantly more over the 5 rounds
2. Treated students are more likely to persevere after failure
3. No differences in success or payoffs
4. Treated students are more likely to set ambitious goals for the following week

Results - Evidence for Skill Accumulation

Table 6: Success (Imposed) and Payoffs in Second Visit

	Success	Payoff			
	Imposed	All	Imposed	Not Imposed	Total
Treatment	0.086***	0.300***	0.337**	0.229*	0.362**
	(0.03)	(0.09)	(0.13)	(0.12)	(0.14)
Task Ability	0.079***	0.283***	0.298***	0.263***	0.512***
	(0.01)	(0.02)	(0.03)	(0.02)	(0.02)
Gender (Male=1)	0.022	0.073	0.090	0.042	0.267**
	(0.03)	(0.08)	(0.13)	(0.08)	(0.10)
Raven Score	0.038**	0.184***	0.152**	0.227***	0.274***
	(0.01)	(0.05)	(0.06)	(0.07)	(0.08)
Malleability (pre)	0.019	0.096**	0.077	0.116*	0.090
	(0.02)	(0.04)	(0.06)	(0.06)	(0.06)
Perseverance (pre)	0.008	0.011	0.026	-0.005	0.012
	(0.02)	(0.05)	(0.06)	(0.07)	(0.06)
Math Score	0.003***	0.013***	0.015***	0.011**	0.018***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Risk Tolerance	0.008	0.039*	0.037	0.042	0.068**
	(0.01)	(0.02)	(0.03)	(0.04)	(0.03)
Control Mean	0.50	1.91	2.00	1.76	3.32
N	1004	1736	1004	732	1563

Question: Is Being Gritty a Good Thing for Everyone?

1. Calculate the probability of success in the two tasks, using the empirical distribution
2. Classify choices as payoff-maximizing or not (under-choose/over-choose the difficult task)

Payoff-maximizing choice:

$$Pr(Success_{Diff})\pi^{High} \gtreqless Pr(Success_{Easy})\pi^{Low}$$

TE on Expected Payoff-Maximizing Choices

Table 7: Optimality Analysis

	Optimal (Visit 1)	Optimal (Visit 2)
Treatment	-0.011	0.092**
	(0.03)	(0.04)
Task Ability	0.060***	0.034***
	(0.01)	(0.01)
Gender (Male=1)	0.031*	0.018
	(0.02)	(0.02)
Raven Score	0.042***	0.031*
	(0.02)	(0.02)
Malleability (pre)	0.010	0.020
	(0.01)	(0.02)
Perseverance (pre)	-0.027*	0.043**
	(0.02)	(0.02)
Math Score	0.004***	0.000
	(0.00)	(0.00)
Risk Tolerance	-0.001	0.014
	(0.01)	0.01
Control Mean	0.65	0.52
N	1704	1578

Results - Optimality

Visit 1

- No treatment effect on percentage of optimal choices.

Visit 2

- Treated students are more likely to make optimal choices.

Results - Treatment Effect on Official School Grades

Table 8: Effect of Treatment on % Students with Top Grades

	(1) Math	(2) Turkish	(3) Life/Social Sc.	(4) All
Treatment	0.020	0.007	0.047	0.032**
	(0.02)	(0.03)	(0.03)	(0.02)
Gender (Male=1)	0.022	-0.046***	0.023*	0.012
	(0.01)	(0.01)	(0.01)	(0.01)
Raven	0.062***	0.047***	0.037***	0.057***
	(0.01)	(0.01)	(0.01)	(0.01)
Math (pre)	0.006***	0.003***	0.003***	0.005***
	(0.00)	(0.00)	(0.00)	(0.00)
Life/Social Sc. (pre)	0.006***	0.006***	0.008***	0.006***
	(0.00)	(0.00)	(0.00)	(0.00)
Turkish (pre)	0.001*	0.005***	0.005***	0.004***
	(0.00)	(0.00)	(0.00)	(0.00)
Class size (ln)	0.038	0.071	-0.037	0.031
	(0.03)	(0.05)	(0.06)	(0.03)
Control Mean	0.18	0.16	0.18	0.12
N	2149	2148	2149	2132

A Potential Mechanism

Visit 1

Student i has a "true" production function which takes the standard CES form

$$q^1_{i,k} = A[\alpha a^{\rho}_{1,i,k} + \beta_{i,k} E^{\rho}_{i,k}]^{\frac{1}{\rho}} \varepsilon_{i,k}$$

intervention has likely increased the perceived marginal product of effort E

$$\beta_{i,k,d=1} \geq \beta_{i,k,d=0}$$

A Potential Mechanism

Visit 2

CES ability accumulation technology, Cunha, Heckman and Schennach (2010)

$$a_{2,i} = \Psi[\gamma a_{1,i}^{\sigma} + \lambda_i I^{\sigma}]^{\frac{1}{\sigma}},$$

intervention has likely increased the perceived marginal product of effort I

$$\lambda_{i,d=1} > \lambda_{i,d=0}.$$

2. visit production function

$$q_i^2 = A[\alpha a_{2,i}^{\rho} + \beta_i E_i^{\rho}]^{\frac{1}{\rho}} \epsilon_i,$$

student i is more likely to succeed if treated:

$$Pr(q_i^2 \geq \bar{q})_{d=1} > Pr(q_i^2 \geq \bar{q})_{d=0},$$

Results - Post-Treatment Survey

Table 9: Treatment Effect on Post-Treatment Survey

	Malleability	Perseverance	Confidence
Treatment	0.373***	0.294***	-0.018
	(0.07)	(0.06)	(0.05)
Gender (Male=1)	0.031	-0.190***	0.054
	(0.04)	(0.03)	(0.05)
Raven Score	0.103**	0.071***	0.004
	(0.04)	(0.02)	(0.03)
Malleability (pre)	0.202***	0.007	-0.033
	(0.03)	(0.03)	(0.03)
Perseverance (pre)	0.199***	0.360***	-0.014
	(0.04)	(0.03)	(0.03)
Confidence (pre)	-0.023	0.093***	0.440***
	(0.02)	(0.02)	(0.03)
Math Score	0.008***	0.008***	0.010***
	(0.00)	(0.00)	(0.00)
Risk Tolerance	-0.007	-0.012	0.008
	(0.01)	(0.01)	(0.01)
N	1690	1612	1675

▸ Kernel Densities

Summary

Educational Intervention:

- affected behavior in incentivized experimental task (taking up challenges, perseverance, skill accumulation)
- affected grades in core subjects
- changed students' self-reported beliefs about the malleability of ability and the role of effort and self-reported behaviors related to grit

Results suggest that grit is a malleable non-cognitive skill that can be fostered through a targeted educational intervention in the school environment.

Baseline Associations

Table 10: Associations in Control Group

	(1) Math Score	(2) Math Score	(3) Math Score	(4) Math Score
Raven	7.257***	7.342***	7.339***	6.816***
	(0.54)	(0.50)	(0.46)	(0.35)
All Difficult Visit 1	5.695***			
	(1.41)			
Plan Difficult Visit 2		4.835***		
		(1.38)		
Malleability (pre)			2.872***	
			(0.59)	
Perseverance (pre)				3.797***
				(0.49)
R-squared	0.28	0.27	0.30	0.33
N	715	708	677	594

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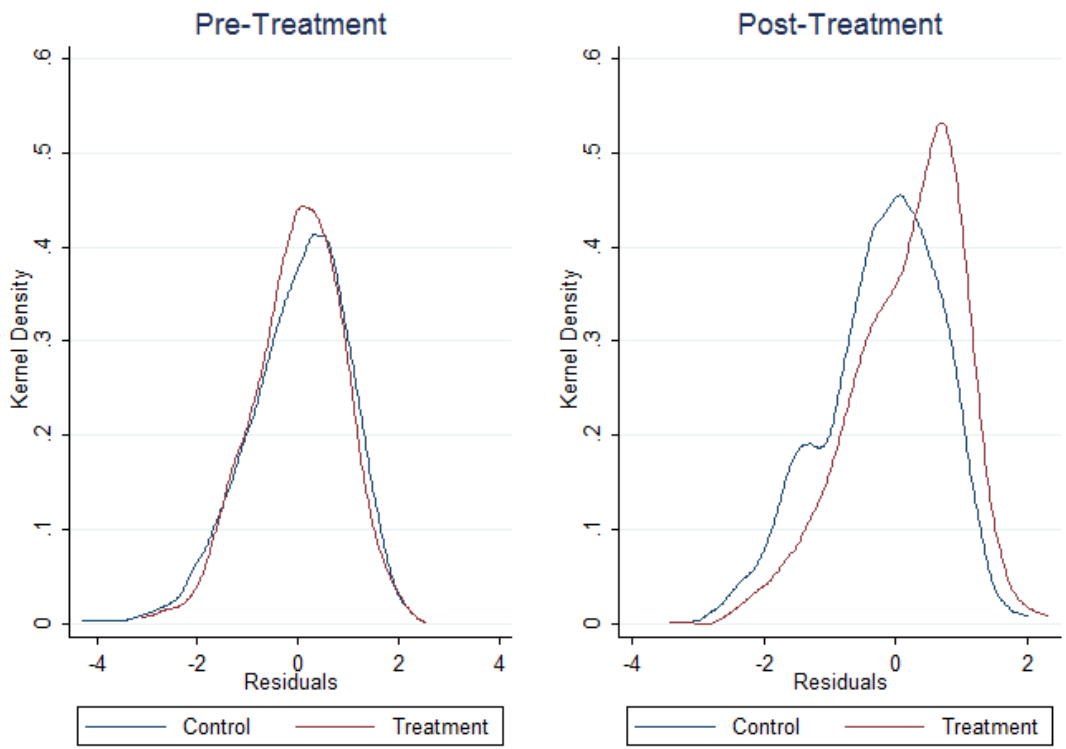
Results - Pre/Post-Treatment Survey

Figure 3: Beliefs about Malleability



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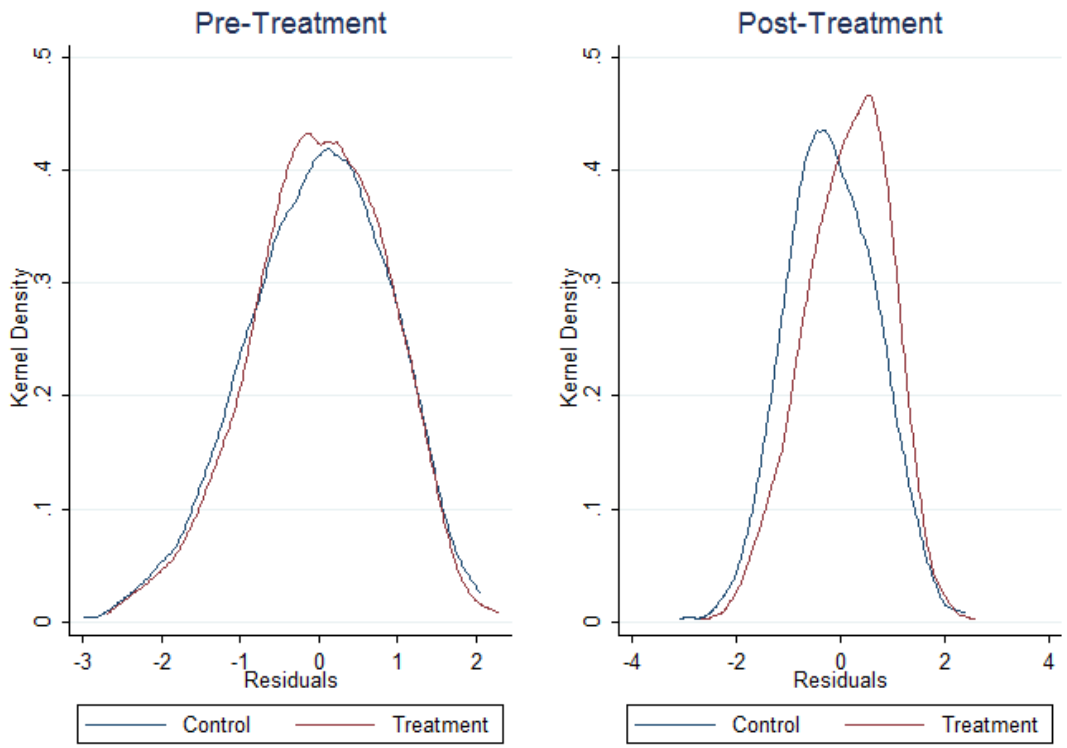
Results - Pre/Post-Treatment Survey

Figure 4: Behaviors Related to Perseverance



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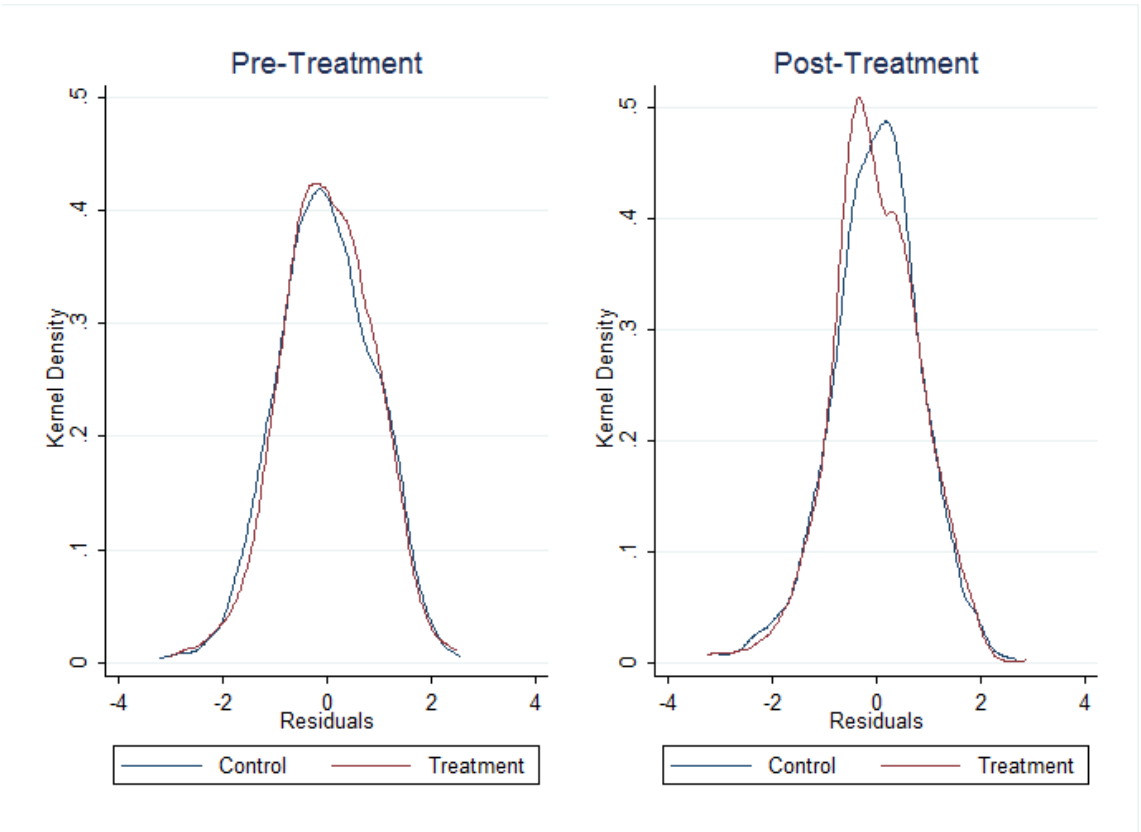
Results - Pre/Post-Treatment Survey

Figure 5: Confidence



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Results - Choice Easy vs. Choice Difficult

Table 11: Success and Payoffs in Second Visit for Difficult Imposed

	Choice Easy		Choice Difficult	
	Success	Payoff	Success	Payoff
Treatment	0.106**	0.428**	0.034	0.088
	(0.05)	(0.20)	(0.04)	(0.16)
Task Ability	0.078***	0.304***	0.067***	0.266***
	(0.01)	(0.05)	(0.01)	(0.04)
Gender (Male=1)	0.003	0.015	0.053	0.186
	(0.04)	(0.18)	(0.04)	(0.17)
Raven Score	0.028	0.106	0.034*	0.138*
	(0.03)	(0.12)	(0.02)	(0.08)
Malleability (pre)	0.024	0.094	-0.001	0.000
	(0.02)	(0.10)	(0.02)	(0.08)
Perseverance (pre)	0.022	0.082	-0.010	-0.051
	(0.03)	(0.12)	(0.02)	(0.09)
Math Score	0.001	0.005	0.004***	0.018***
	(0.00)	(0.00)	(0.00)	(0.00)
Risk Tolerance	-0.010	-0.041	0.022*	0.101*
	(0.02)	(0.06)	(0.01)	(0.05)
Control Mean	0.39	1.54	0.72	2.87
N	425	425	468	468

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Randomization Balance

	Mean [SD]	Treatment	Control	Difference
Malleability (pre)	0.00	-0.01	0.01	-0.02
	[1.00]			(0.90)
Perseverance (pre)	0.00	0.00	0.00	0.00
	[1.00]			(0.97)
Confidence (pre)	0.00	0.00	0.01	-0.01
	[1.00]			(0.87)
Gender (Male=1)	0.52	0.51	0.53	-0.01
	[0.50]			(0.49)
Raven	0.00	0.02	-0.02	-0.03
	[1.00]			(0.81)
Task Ability	5.07	5.00	5.14	-0.14
	[2.22]			(0.45)
Risk Tolerance	2.52	2.49	2.56	-0.07
	[1.49]			(0.60)
Wealth	2.84	2.80	2.89	-0.08
	[0.97]			(0.58)
Math	67.14	66.44	67.94	-1.50
	[23.84]			(0.68)
Turkish	70.42	69.59	71.37	-1.78
	[20.00]			(0.63)
Social Sc./Science	77.23	76.26	78.35	-2.09
	[17.40]			(0.50)

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Evaluation Design

		Grit & Fwd-Looking Behavior (IT)	Fwd-Looking Behavior (CT)	Pure Control (PC)
Phase 1	Training	-	-	-
	Measurement	March 2013: Baseline Data Collection		
Phase 2	Training	Spring 2013 (Fwd-L)	-	-
Phase 3	Training	Fall 2013 (Grit)	Fall 2013 (Fwd-L)	-
Phase 4	Training	-	-	-
	Measurement	May 2014: Follow-up Data Collection (Grit)		

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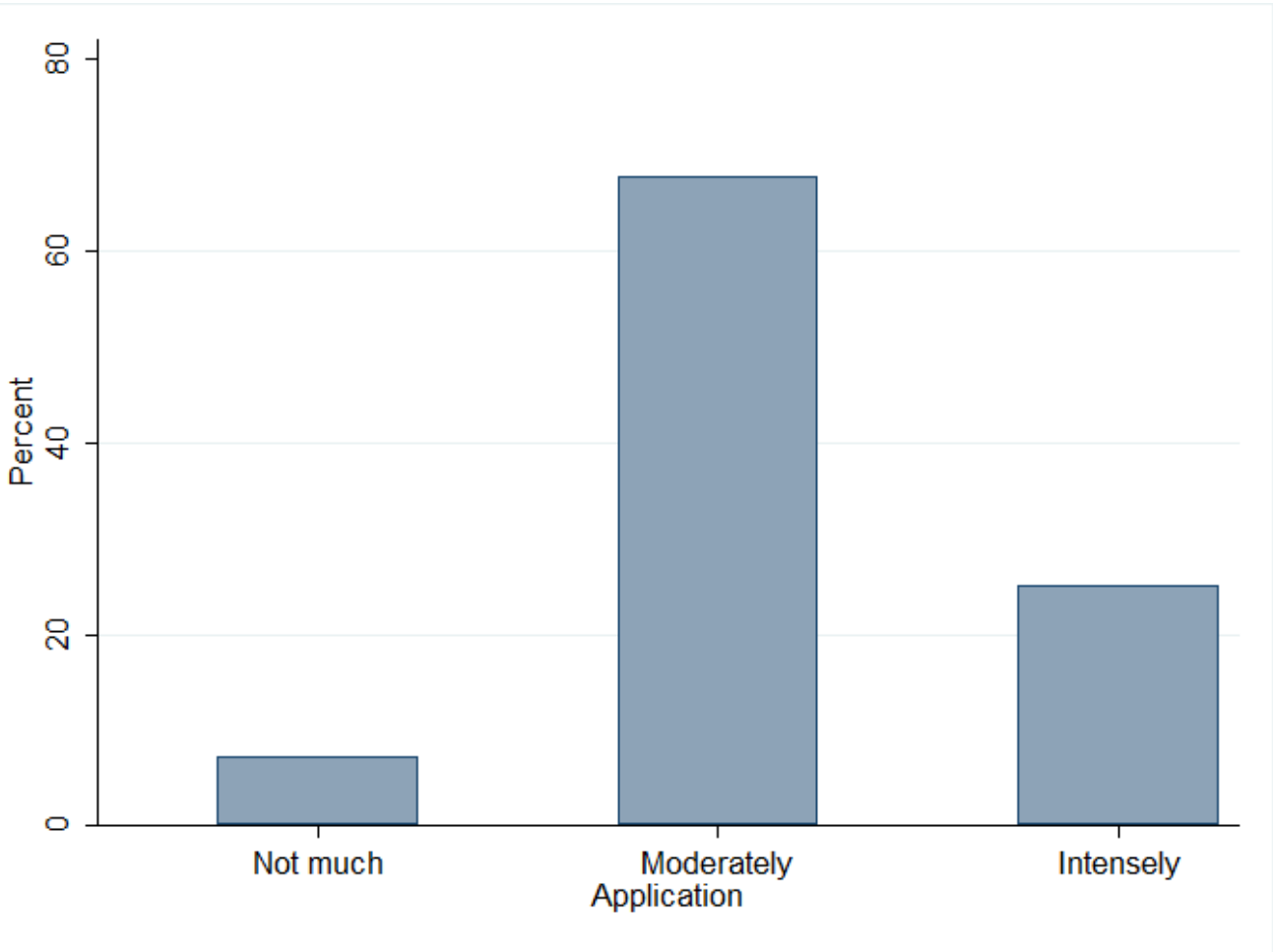
Application Intensity



Teacher Agreement