

What Motivates Health Behavior: Preferences, Constraints, or Beliefs? Evidence from Psychological Interventions in Kenya

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Introduction

- Broad evidence that people forgo profitable investments
 - ▶ Health: demand for bednets, chlorinating water, deworming pills, using improved cookstoves

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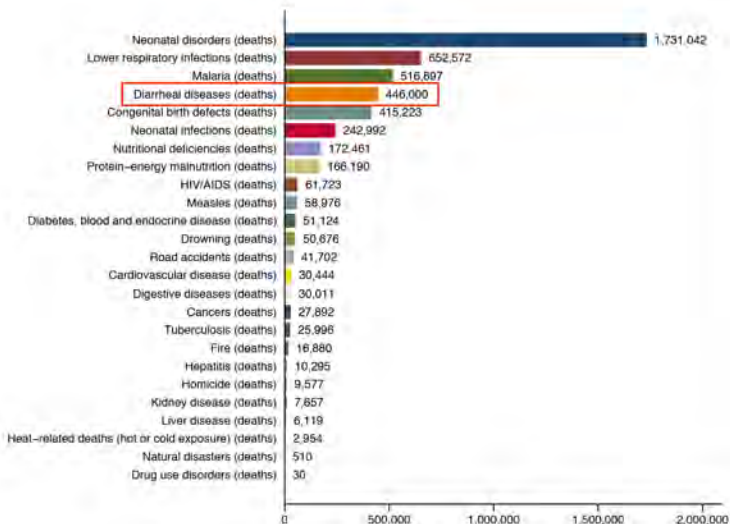
- Broad evidence that people forgo profitable investments
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-even when standard barriers have been removed or minimized
 - ▶ Little or no effect of information and marketing
 - ★ Kremer et al 2011, Dupas 2009
 - ▶ Even tiny fees dramatically reduce take-up for bednets, chlorine, soap
 - ★ reviewed in Kremer and Glennerster 2011, Dupas and Miguel 2017
 - ▶ Our setting: Chlorine cheap or free, info provided, minimal hassle
 - ★ Null et al 2018: Adherence: 23 percent after two years

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 - ★ Null et al 2018: Adherence: 23 percent after two years
- Role of psychological factors?
- This paper: Psychological workshops to separately target preferences, beliefs, cognitive constraints

Under-5 mortality

Diarrheal diseases are the fourth largest cause of under 5 mortality worldwide



The Targeted Behaviour: Treating Water with Chlorine



- Chlorine for drinking water is cheap and readily available
 - ▶ USD 0.20 per bottle (= 1 month) (average monthly earnings: \$90)
- Taste is virtually unaltered by chlorination (if used correctly)
- Null et al (2018): Dispensers at water points + community health promoters: usage 23% (control: 3%)
 - ▶ Fails to replicate Kremer et al (2011)'s 60% (dispensers + incentivized promoters) ▶ Kremer et al 2011

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This study:

- Distinguish between these mechanisms using a randomized controlled trial, $N=3750$, in Western Kenya. Use light-touch psychological interventions to induce exogenous variation in each target.
- Test whether psychological and material barriers interact

Literature: Interventions targeting...

- Bundled psychotherapy interventions
 - ▶ CBT-style interventions improve patience, self-esteem, economic outcomes (Blattman et al 2017, Baranov et al 2018) and reduce delinquency (Heller et al 2017)
- Time Preferences
 - ▶ Alan & Ertac (2018) increase patience in Turkish primary schools
 - ▶ [via commitment: Schilbach (2018), Gine et al (2010), Royer et al (2015)]
- Constraints: memory, planning, executive function
 - ▶ Milkman et al., 2011, 2013 (planning prompts), Karlan et al. 2016 (SMS reminders)
- Beliefs about the world
 - ▶ Jensen 2010, Dinkelman & Martinez 2014 and many others
- Beliefs about the self
 - ▶ Bernard et al 2018, Ghosal et al (2016), McKelway (2018)

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- Cross-cut: “WASH Benefits” study in rural Kenya (ran 2013-2016)
 - ▶ Half of our sample villages received chlorine dispensers

Interventions

PREFERENCES	CONSTRAINTS	BELIEFS	
Baseline	Baseline	Baseline	

Interventions

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<p>Baseline</p> <p>Intervention: "Time preferences" (N=992)</p> <ol style="list-style-type: none"> 1. Connect present behavior to future outcomes 2. Visualize alternative realizations of the future depending on current behavior 3. Put yourself in the shoes of your future selves, imagine how they feel, and 'talk' to them. 	<p>Baseline</p>	<p>Baseline</p>	

Time Preferences: Participant drawing

Name: _____ Date: _____

What my future will look like (draw):

How I will behave now (write, or draw):

1. Save money as much as possible to take care of my future family
2. Work hard to get a stable job which will enable me to save more money to buy a car.
3. Invest to buy a plot and build my own house
4. Invest to start my own business

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Executive Function: Planning Exercises

Name:

Date:

Exercise 1

List some **routine** activities here, eg. Cleaning the house, cooking a meal

List some **pleasantable** activities here, eg. Going out with friends and family

List some **necessary** activities here, eg. Paying school fees, dealing with difficult situations

Exercise 2

Put your list in order of difficulty, ranking up the **difficultest** routine, pleasantable and necessary activities:

<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	The most difficult
---	--------------------

<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	Medium difficulty
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<hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/> <hr/>	The easiest
---	-------------

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Morning	What							
	Where							
	When							
Afternoon	Who							
	What							
	Where							
Evening	When							
	Who							
	What							

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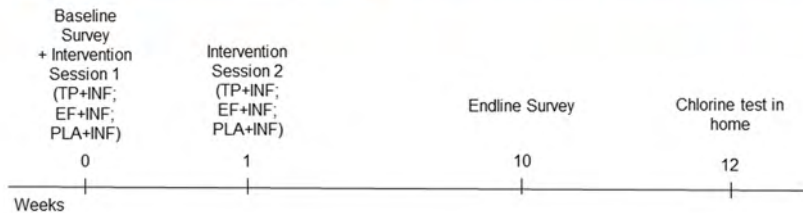
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Timeline



Outcomes of Interest: Psychological Mechanisms

PREFERENCES	CONSTRAINTS	BELIEFS
<p>Intervention: “Time preferences” (N=992)</p> <ol style="list-style-type: none"> Preferences: Do I value the future? Time preferences (impatience, present bias) Beliefs: Can I influence the future? Self-efficacy (Generalized Self-Efficacy Scale) Beliefs: Is chlorination beneficial? Survey question 	<p>Intervention: “Executive Function” (N=991)</p> <ol style="list-style-type: none"> Constraints: Ability to plan and execute Executive function (Tower of London, Behavioral Activation Scale) Beliefs: Will my actions influence outcomes? Self-efficacy (Generalized Self-Efficacy Scale) Beliefs: Is chlorination beneficial? Survey question 	<p>Intervention: “Information Control” (N=992)</p> <p>Beliefs: Is chlorination beneficial? Survey question</p>

Outcomes of Interest: Behaviour

HEALTH	SAVING	LABOR
<p>1. Chlorination: Has the participant added chlorine to her stored drinking water? Has she added the correct amount of chlorine? Objective chlorine test</p> <p>2. Diarrhea incidences: How many diarrhea incidences have her children experienced? Survey question</p> <p>3. Preventive healthcare: How many of her children have been taken for healthcare check-ups? How many have been vaccinated? How many ANC visits has she attended if pregnant? Survey question</p>	<p>1. Saving behavior: Does the participant save regularly? Does she save for productive investments? Survey question</p> <p>2. ROSCA participation: Has the participant joined any new ROSCAs? Survey question</p> <p>3. Saving quantities: How much does the participant save each week? Survey question</p>	<p>1. Labor Supply: How many hours has the participant worked in the last 3 months? How many days of work? Survey question</p> <p>2. Earnings: how much has the participant earned on average in the last 3 months? Survey question</p>

Specification

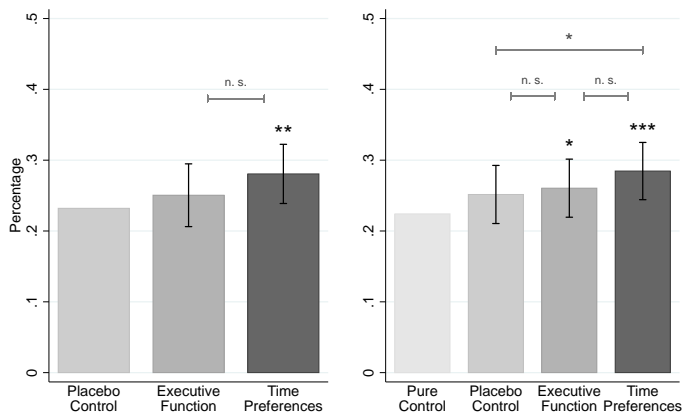
$$y_{i1} = \alpha + \beta_1 T_{1i} + \beta_2 T_{2i} + \delta y_{i0} + \Phi \mathbf{X}_i + \gamma_v + \theta_w + \varepsilon_i \quad (1)$$

- β_j = treatment effects
- y_{i0} = baseline outcome measure
- $\Phi \mathbf{X}_i$ = time invariant individual controls: age, education, marital status, employment status
- γ_v = village of residence fixed effect
- θ_w = indicator for above median wealth
- Standard errors clustered by intervention group
- Specification above is for comparison to placebo group, and restricted to compliers ($N = 2175$)
- For comparison to pure control, we add a third treatment indicator T_{3i} for the placebo group, and include non-compliers
- FDR q -value correction across groups of main outcomes (Anderson, 2008)

► Balance, Non-Compliance, Attrition

Health: Chlorination

Water has been chlorinated (TCR present)



* above bars denotes significance of treatment coefficients.

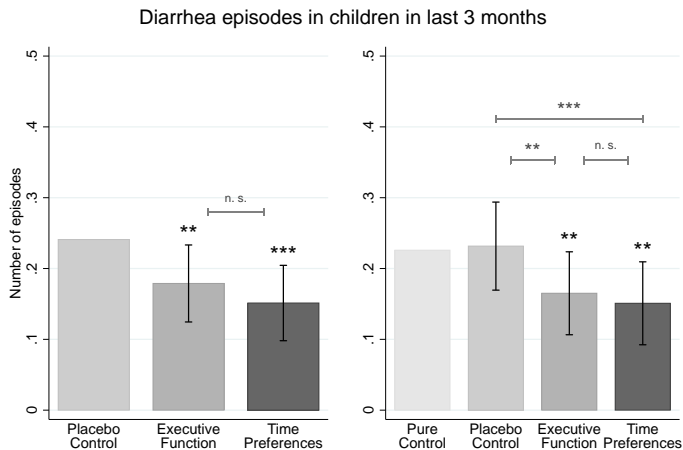
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Share of households who chlorinate increases by 18% (EF) and 27% (TP)

FCR

Health: Diarrhea



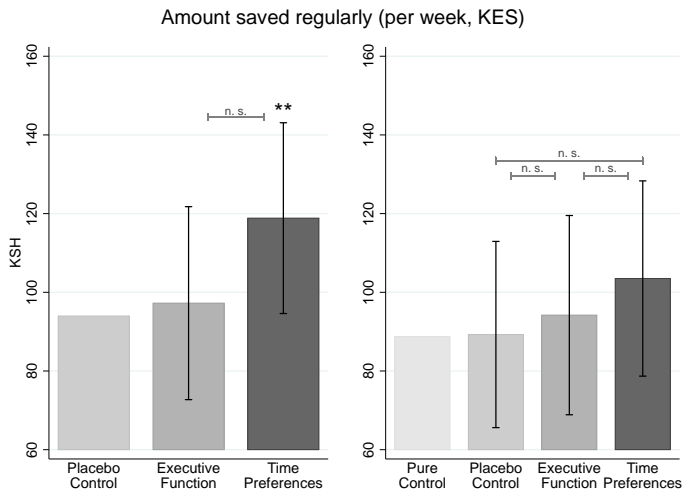
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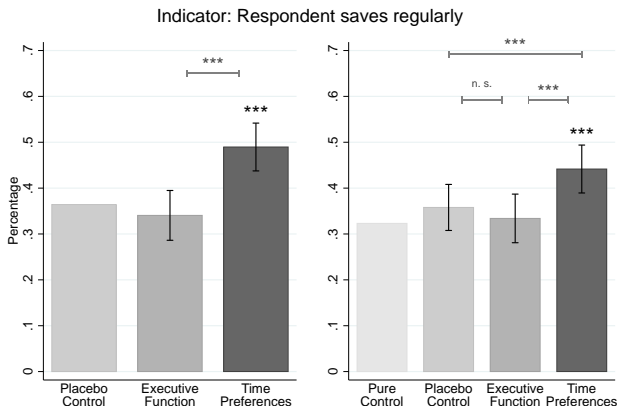
Diarrhea episodes in children are reduced by 26% (EF) and 35% (TP)

Saving: Amount saved regularly



Savings per week increased by 26 percent (TP).

Saving: Regular saving (external margin)



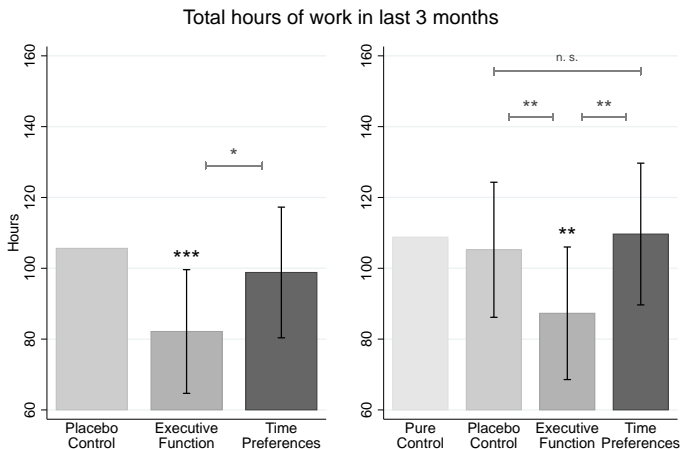
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External margin of savings (positive amount saved per week) increased by 36% (13pp) for TP. Other results: More likely to save for productive investment, more likely to have joined ROSCA.

Labor supply (hours of work)



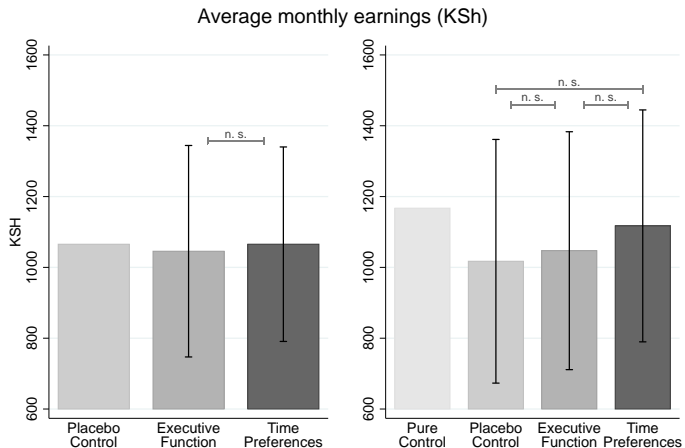
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Hours worked decrease by 20% in EF...

Labor: Income



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... but no effect on earnings.

Summary: Behavioral outcomes

HEALTH	SAVING	LABOR
<p>1. Chlorination: Has the participant added chlorine to her stored drinking water? Has she added the correct amount of chlorine? Objective chlorine test INCREASE for both EF & TP</p>	<p>1. Saving behavior: Does the participant save regularly? Does she save for productive investments? Survey question INCREASE for TP</p>	<p>1. Labor Supply: How many hours has the participant worked in the last 3 months? How many days of work? Survey question DECREASE FOR EF</p>
<p>2. Diarrhea incidences: How many diarrhea incidences have her children experienced? Survey question DECREASE for both EF & TP</p>	<p>2. ROSCA participation: Has the participant joined any new ROSCAs? Survey question INCREASE for TP</p>	<p>2. Earnings: How much has the participant earned on average in the last 3 months? Survey question NO EFFECT for both</p>
<p>3. Preventive healthcare: How many of her children have been taken for healthcare check-ups? How many have been vaccinated? How many ANC visits has she attended if pregnant? Survey question NO EFFECT for both</p>	<p>3. Saving quantities: How much does the participant save each week? Survey question INCREASE for TP</p>	

Time Preferences over Effort: Measurement

Based on Augenblick (2017):

- “How many tasks do you want to do at time X , at piece rate Y ?”
 - ▶ where $X = \{\text{same evening, tomorrow, 7 days, 8 days}\}$
and $Y = \{2, 6, 10\}$ Kenyan shillings
- One question randomly selected to “count”

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Effort task in Kenya: SMS Data entry task (30 digits ≈ 2 min)

Task 1	SMS1- 969 228 853 496 963 294 743 281 619 446
Task 2	SMS2- 151 575 320 519 150 525 175 694 371 897

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Structural estimation:

- Variation in Y allows estimation of convex cost of effort γ , variation in X estimates $\beta\delta$ —discount function

Time Preferences over Effort: Structural Estimation

- Follows Augenblick (2017) and DellaVigna and Pope (2017):
 - ▶ Power cost of effort function γ , quasi-linear utility
 - ▶ Quasi-hyperbolic discounting ($\beta\delta$)
 - ▶ Non-monetary reward s (\approx intrinsic motivation)
 - ▶ We add weekday dummies d_w for different opportunity cost of time
- The optimal level of effort is then given by

$$e^* = \operatorname{argmax} (s + D_m(14) \cdot \phi \cdot w) \cdot e - \beta^{I(t>0)} \cdot \delta^t \cdot \left(\frac{1}{\gamma} e^\gamma + d_w \cdot e\right)$$

where $w = \{2, 6, 10\}$ is the piece rate,

$D_m(14)$ is monetary discounting of the payment in 14 days

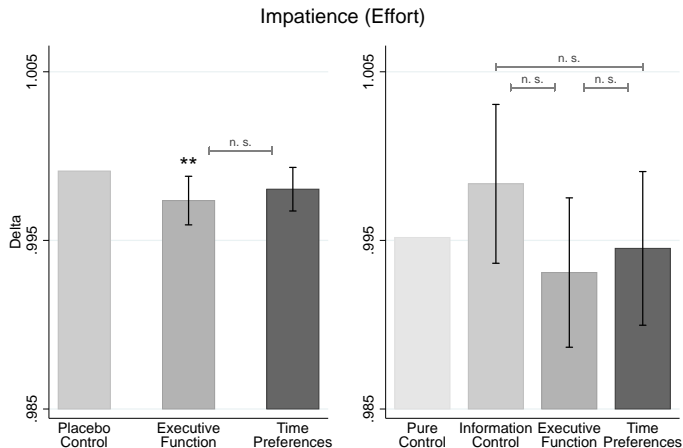
t is the time of effort provision

$\gamma > 1$ captures convex costs of effort,

ϕ is a slope parameter, and d_w are weekday indicators

- We estimate additive treatment effects of TP, EF, and PLA on the parameters β , δ , s , and γ .

Time Preferences over Effort: Impatience (δ)



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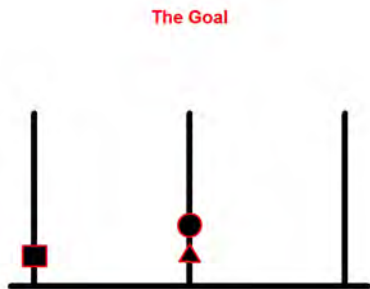
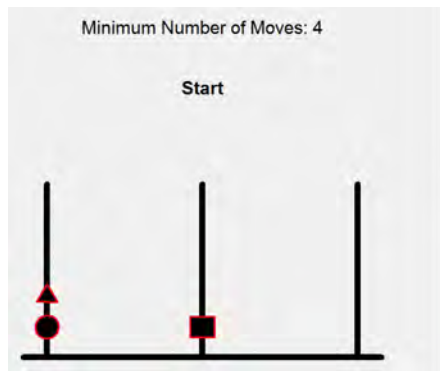
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- Time Preferences over money (MPLs): No effect on β or δ .

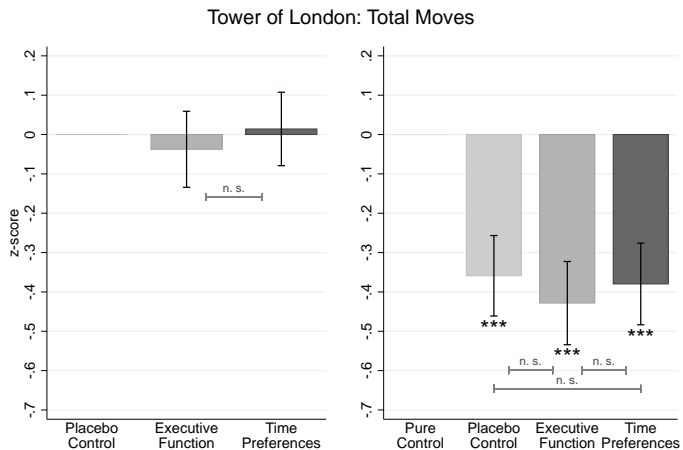
▶ TP over Money

Cognitive Constraints: Measurement

- Executive Function measured with the *Tower of London task* (Shallice, 1982; Phillips et al. 2001)
 - ▶ measures a participant's ability to plan ahead in sequential strategies
 - ▶ Selected based on a separate validation study (*SOBC1*)



Cognitive Constraints: Executive Function



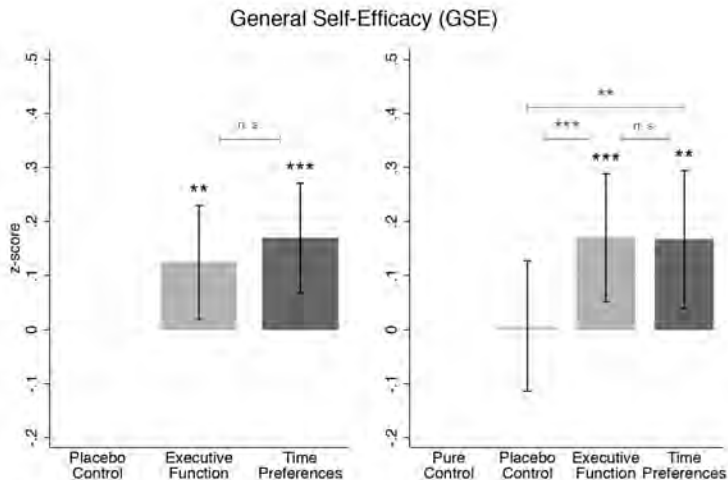
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Beliefs About the Self: Measurement

- General Self-Efficacy Scale (GSE) following Schwarzer/Jerusalem (1995)
 - ▶ Validated and widely recognized in psych literature
 - ▶ Cronberg's alpha (internal reliability)= 0.8, Test-Retest $\rho = 0.62$
 - ▶ Selected based on a separate validation study (SOBC1)

1	<i>I can always manage to solve difficult problems if I try hard enough.</i>
2	<i>If someone opposes me, I can find the means and ways to get what I want.</i>
3	<i>It is easy for me to stick to my aims and accomplish my goals.</i>
4	<i>I am confident that I could deal efficiently with unexpected events.</i>
5	<i>Thanks to my resourcefulness, I know how to handle unforeseen situations.</i>
6	<i>I can solve most problems if I invest the necessary effort.</i>
7	<i>When I am confronted with a problem, I can usually find several solutions.</i>
8	<i>If I am in trouble, I can usually think of a solution.</i>
9	<i>I can usually handle whatever comes my way.</i>

Beliefs about the self: Can I influence outcomes/the future?



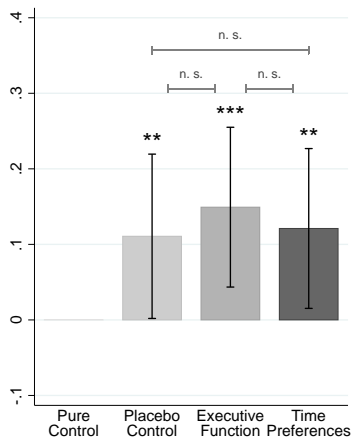
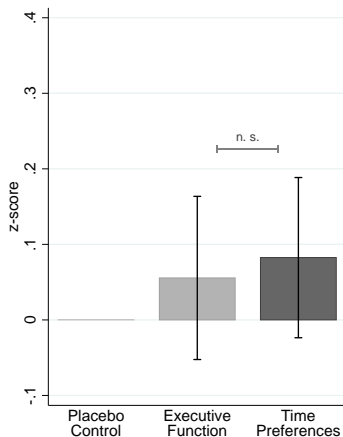
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Beliefs about the world: Is chlorination beneficial?

Beliefs about the efficacy of chlorine



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Summary of Treatment Effects

- Psychological targets
 - ▶ Our Executive Function intervention did not affect lab measures of planning
 - ▶ Our Time Preferences intervention did not affect lab measures of effort discounting
 - ▶ Both TP and EF increased self-efficacy
 - ▶ TP, EF and the Placebo intervention all increased beliefs in efficacy of chlorine
- Behaviour
 - ▶ Health: More chlorination & less diarrhea in EF and TP
 - ★ No effect on other health behaviours: Vaccinations, ANC/PNC, check-ups
 - ▶ Savings measures increase in TP
 - ▶ Labor supply decreases in EF, but without a decrease in income

Mechanisms

- **Self-Efficacy**

- ▶ Can explain most, though not TP-only effect on savings

- **Information**

- ▶ Unlikely: Beliefs about chlorine efficacy increased also in Placebo, but no effect on chlorine/diarrhea
- ▶ Does not explain effects outside health

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- **“Time Preferences” as Forecasting Skills (Gabaix & Laibson 2017)**

- ▶ TP intervention made future in one year more vivid & tangible
 - ★ Previously abstract → increase savings & chlorination
- ▶ Effort task: Work now for payment in two weeks
 - ★ Clear and tangible from the start → no effect

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- **Salience**

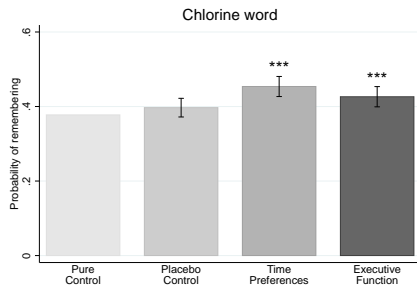
- ▶ Our psych interventions may have differentially increased the salience of water chlorination

Salience

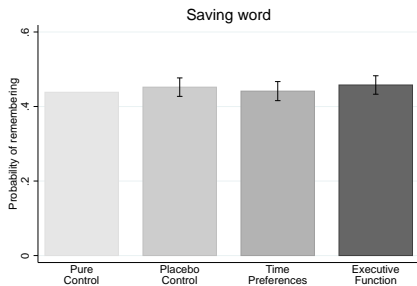
- Our psych interventions may have differentially increased the salience of water chlorination
 - ▶ TP and EF scripts domain general, but chlorine used as example
- We measure salience of three future-oriented behaviors (chlorination, savings, and farm investment) compared to filler words
- Salience of chlorine increases in EF and TP, salience of savings and farm investment does not
- Thus, salience could explain chlorine result, but does not provide a consistent explanation across our findings (esp. savings)
- Possibility of reverse causality: More chlorination → more salience

Salience effects: Chlorine more salient, but not savings

- Salience test:
 - ▶ Enumerators read out 3 lists of 9 words. Each list contained one word relating to chlorine, savings, farm investment, plus six filler words
- Test for differential recall of future-oriented words, controlling for #total words remembered



* denotes significance at 10 pct., ** at 5 pct., *** at 1 pct. level



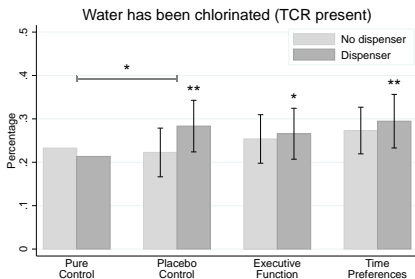
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The Relative Role of Cost and Psychological Constraints

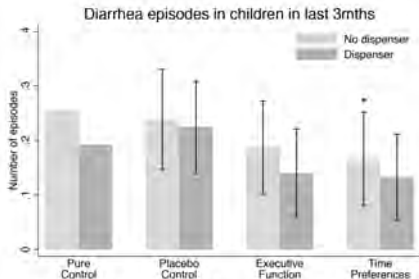
- Interventions were cross-randomized with previous dispenser RCT (Null et al 2018)
 - ▶ 115 control villages, 90 dispenser villages, ran 2013–2016
 - ▶ 23% chlorinate water after 2 years (control: 3%)
- Allows us to test whether psychological interventions are substitutes or complements to reductions in standard barriers

The Relative Role of Cost and Psychological Constraints

- No strong evidence for differential effectiveness of psychological interventions when dispensers are present vs. absent
- But: effects on chlorination and diarrhea are significant with dispensers, but not without



* denotes significance of interaction between treatment group and living in a village with a dispenser at 10 pct., ** at 5 pct., *** at 1 pct. level



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Conclusion

- ① **Light-touch psychological interventions can improve clinical outcomes, incl. water chlorination and diarrhea**
- ② Targeting beliefs about the effectiveness of chlorination has limited effectiveness
- ③ Targeting time preferences and executive function is effective, but through surprising mechanisms: Both interventions do not affect their intended targets as measured in the lab, but do strongly affect beliefs about one's ability to affect outcomes
- ④ **Beliefs about oneself (as opposed to beliefs about the world) may facilitate (or constrain!) health behavior**

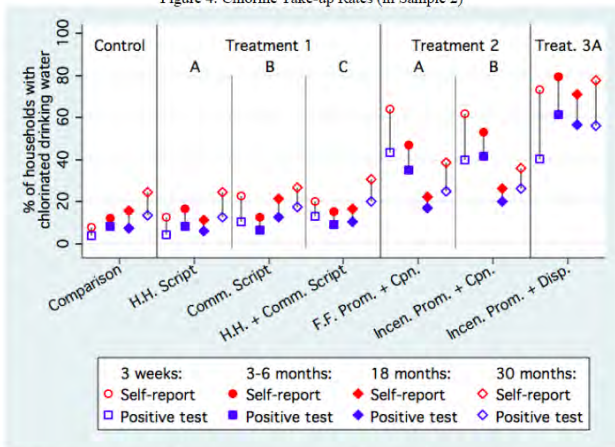
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- 4 **Beliefs about oneself (as opposed to beliefs about the world) may facilitate (or constrain!) health behavior**

... Thank You for Your Attention!

Kremer et al (2011): Chlorine dispensers in Kenya

Figure 4: Chlorine Take-up Rates (in Sample 2)



Notes: Bands depicted in graph above are not confidence intervals, but rather reflect an upper and lower bound measure of take-up (self-reported chlorination and positive chlorine tests, respectively). A positive chlorine test result is defined conservatively as sodium hypochlorite of at least 0.1 mg/L with pink color or 0.2 mg/L or greater regardless of color. See section 2.3 for a full description of the treatment arms: 0=Comparison (no intervention), 1A=Household persuasion script, 1B=Community persuasion script, 1C=Both household and community persuasion scripts, 2A=Flat-fee promoter plus one coupon for free WaterGuard per surveyed household, 2B=Incentivized promoter plus one coupon for free WaterGuard per surveyed household, 3=Incentivized promoter plus unlimited supply of free chlorine via a point-of-collection dispenser.

The Setting

- Eligibility: Women aged 18-35, $N = 3750$ in 205 villages

Baseline Data

- Mean age = 26
- Mean #children = 2.7 [93% have children, 73% of 18-19yo's]
- Occupations:
 - ▶ 60% subsistence farming, 19% no work, self-employed 16%, employed 3%
- Education: 64% Primary, 28% Secondary. Daily wage 150-400 Ksh.
- Water Source
 - ▶ 32% stream, 23% public tap, 20% private well, 16% public well
- Water treatment
 - ▶ 66% report having used chlorine at some point last month
 - ▶ but only 17% always chlorinate (5% always boil)
- 2014 Census: 15% of under-5's in Kenya had diarrhea in last two weeks, 26% are stunted

Balance, Non-Compliance and Attrition

- Balanced on demographic characteristics at baseline
- Non-compliance of 22% of treated individuals, balanced across treatment groups
- Attrition between baseline and endline is moderate (8%) in the complier sample, and balanced between treatment arms
 - ▶ Much larger attrition (24%) in full sample, balanced between active arms
 - ▶ Small imbalance ($\sim 4\%$) between treatment groups and pure control
- Attrition is predicted by demographics, but the same types of people (young & unmarried) attrite in each treatment group and in pure control group

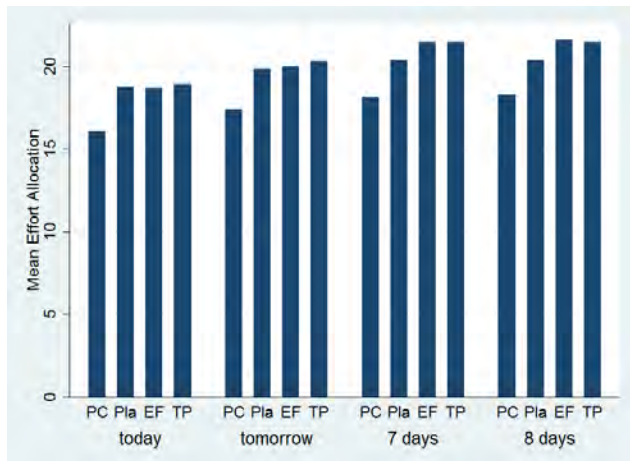
Balance, Non-Compliance and Attrition

	Comparison with active control (PLA+INF)					Comparison with pure control (PC)				
	(1) Active Control Group Mean (SD)	(2) Time Preferences Treatment Effect	(3) Executive Function Treatment Effect	(4) Column 2 vs. Column 3 p-value	(5) N	(6) Pure Control Mean (SD)	(7) TP+INF Treatment Effect	(8) EF+INF Treatment Effect	(9) PLA+INF Treatment Effect	(10) N
<i>Baseline balance</i>										
Age	26.37 (4.56)	-0.10 (0.20)	0.01 (0.20)	0.60	2975	26.62 (4.69)	-0.42 (0.22)*	-0.36 (0.22)	-0.31 (0.22)	3750
Married or cohabiting	0.89 (0.32)	-0.00 (0.02)	0.01 (0.01)	0.28	2975	0.90 (0.30)	-0.02 (0.02)	-0.01 (0.01)	-0.02 (0.02)	3750
Education level	5.87 (1.23)	-0.02 (0.05)	0.06 (0.05)	0.11	2975	5.93 (1.08)	-0.08 (0.05)	0.00 (0.05)	-0.05 (0.05)	3750
High wealth index	0.54 (0.50)	-0.02 (0.02)	-0.03 (0.02)	0.61	2975	0.52 (0.50)	0.00 (0.02)	-0.01 (0.02)	0.02 (0.02)	3750
Village of residence	83.26 (54.89)	0.84 (4.96)	-0.20 (4.90)	0.84	2975	83.31 (56.43)	0.80 (4.18)	-0.24 (4.14)	-0.07 (3.97)	3750
<i>Delay variables</i>										
Days between endline and baseline	68.92 (21.52)	0.59 (0.98)	0.88 (0.93)	0.76	2396	68.73 (24.07)	1.82 (1.06)*	2.12 (1.01)**	1.23 (1.00)	2984
Days between chlorine test and baseline	79.33 (26.71)	0.45 (1.32)	1.46 (1.26)	0.46	2203	81.20 (27.41)	0.60 (1.26)	1.55 (1.20)	0.09 (1.17)	2758
<i>Attrition</i>										
Attrited from endline	0.08 (0.27)	0.02 (0.02)	0.03 (0.02)*	0.39	2337	0.24 (0.43)	-0.06 (0.02)***	-0.04 (0.02)*	-0.06 (0.02)***	3750
Attrited from chlorine test	0.12 (0.33)	0.01 (0.02)	0.03 (0.02)	0.33	2337	0.26 (0.44)	-0.04 (0.02)*	-0.02 (0.02)	-0.04 (0.02)**	3750
<i>Compliance</i>										
Completed both first and second intervention	0.74 (0.44)	0.01 (0.02)	-0.02 (0.02)	0.35	2975	-	-	-	-	-
Completed first intervention	0.78 (0.41)	0.01 (0.02)	0.01 (0.02)	0.85	2975	-	-	-	-	-
Completed no intervention	0.22 (0.41)	-0.01 (0.02)	-0.01 (0.02)	0.85	2975	-	-	-	-	-

Predicting Attrition

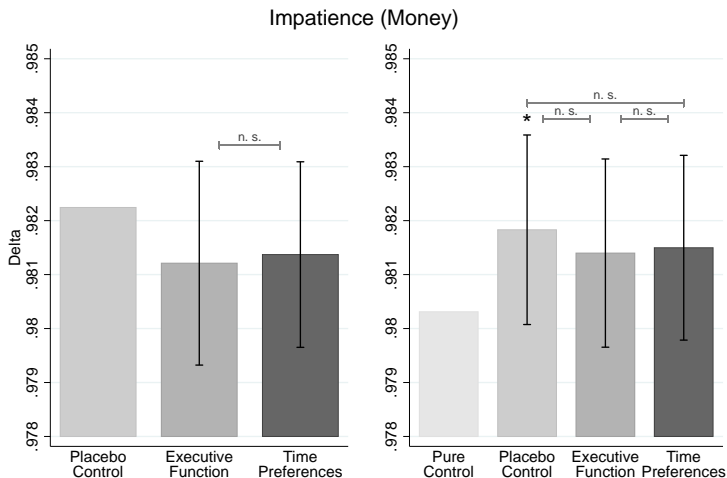
	(1)	(2)	(3)	(4)	(5)	(6)
	Attrited from endline	Attrited from chlorine test	Attrited from endline	Attrited from chlorine test	Attrited from endline	Attrited from chlorine test
TP+INF	-0.05 (0.02)***	-0.04 (0.02)*	-0.06 (0.02)***	-0.04 (0.02)*	-0.02 (0.16)	0.01 (0.17)
EF+INF	-0.04 (0.02)*	-0.02 (0.02)	-0.04 (0.02)**	-0.02 (0.02)	-0.04 (0.18)	0.01 (0.18)
PLA+INF	-0.06 (0.02)***	-0.04 (0.02)*	-0.06 (0.02)***	-0.04 (0.02)**	-0.16 (0.17)	-0.09 (0.17)
Age			-0.01 (0.00)***	-0.01 (0.00)***	-0.01 (0.00)**	-0.01 (0.00)*
Married or cohabiting			-0.08 (0.02)***	-0.08 (0.02)***	-0.10 (0.06)*	-0.13 (0.06)**
Education level			-0.01 (0.01)**	-0.01 (0.01)**	-0.01 (0.01)	-0.01 (0.01)
TP+INF x Age Interaction					-0.00 (0.00)	-0.00 (0.00)
EF+INF x Age Interaction					0.00 (0.00)	0.00 (0.00)
PLA+INF x Age Interaction					0.00 (0.00)	-0.00 (0.00)
TP+INF x Married Interaction					0.01 (0.07)	0.03 (0.08)
EF+INF x Married Interaction					0.04 (0.08)	0.08 (0.08)
PLA+INF x Married Interaction					-0.05 (0.07)	0.09 (0.08)
TP+INF x Education Interaction					0.00 (0.02)	-0.01 (0.02)
EF+INF x Education Interaction					-0.01 (0.02)	-0.02 (0.02)
PLA+INF x Education Interaction					0.00 (0.02)	-0.00 (0.02)
TP+INF x Wealth Interaction					0.00 (0.04)	-0.00 (0.04)
EF+INF x Wealth Interaction					-0.02 (0.04)	-0.02 (0.04)
PLA+INF x Wealth Interaction					0.02 (0.04)	0.00 (0.04)
Constant	0.26 (0.02)***	0.29 (0.02)***	0.59 (0.06)***	0.62 (0.06)***	0.61 (0.13)***	0.61 (0.14)***

Time Preferences: Raw Effort Responses



- Same effort across Pla - EF - TP for 0 and 1 days
- Significantly higher effort in EF and TP at 7 and 8 days
- Pure control always supplies less effort (they haven't done the task before)

Time Preferences over Money: Impatience (δ)

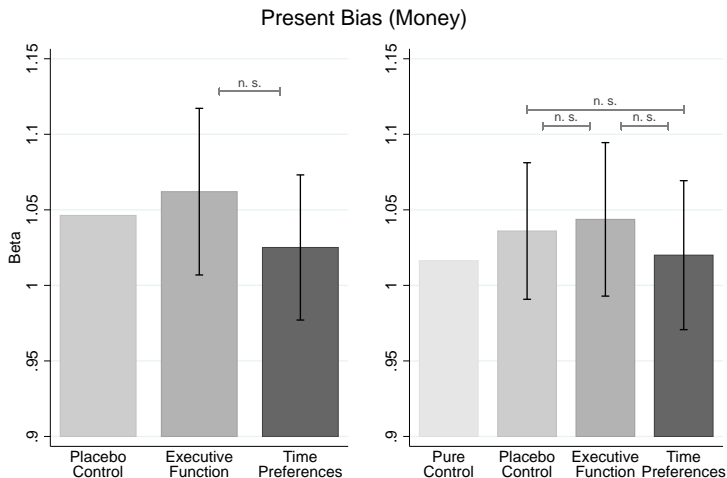


* above bars denotes significance of treatment coefficients.

* between bars denotes significance of a test of coefficient equality between treatment groups.

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Time Preferences over Money: Present Bias (β)



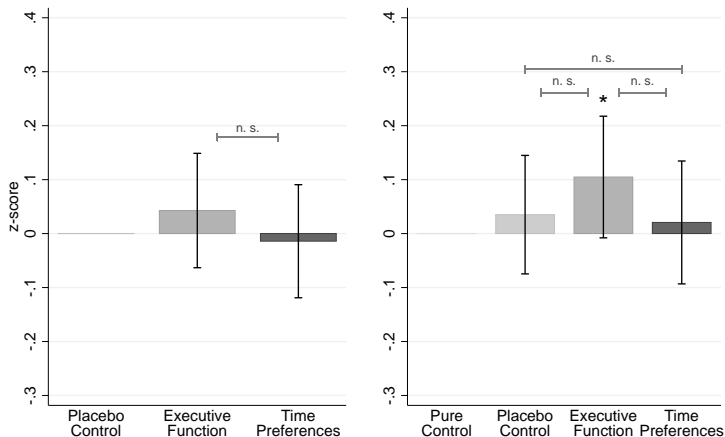
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Cognitive Constraints: Behavioral Activation

Behavioral Activation (BADS)



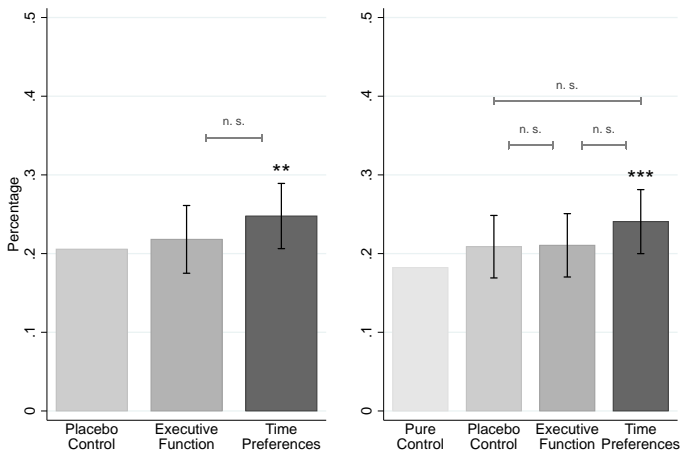
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Health: Chlorination (FCR)

Water is safe to drink (FCR present)



Gabaix and Laibson (2017): Simulating Future Utility

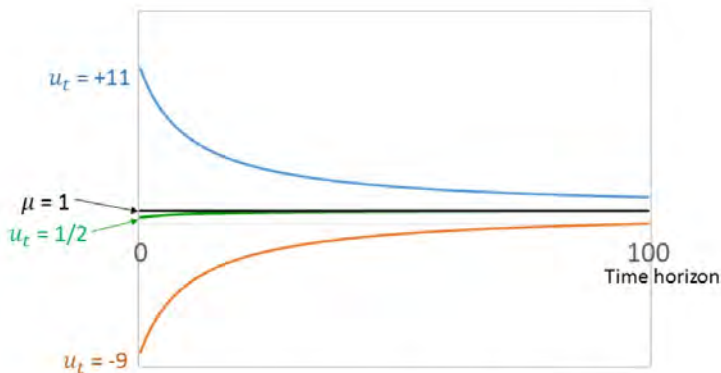


Figure 1: Plot of the average perceived value \bar{u}_t , given for three different true utilities u_t ($u_t \in \{-9, 1/2, 11\}$), as a function of the time horizon t . This average perceived value is: $\bar{u}_t = \mu + \frac{u_t - \mu}{1 + \frac{\sigma_s^2}{\sigma_u^2} t}$. The figure uses $\sigma_s^2 / \sigma_u^2 = 0.1$.