The Effects of Stress on Economic Decision-Making

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Motivation: Behavioral poverty trap?

Motivation

- This paper focuses on the link between psychological outcomes and economic decision-making

- Specifically, focus on channel of stress

(Stress is defined as the response when environmental demands exceed an organism's ability to cope)

Motivation: Why stress?

- Extensive evidence that stress may mediate relationship between poverty and decision-making
  - Evidence that cash transfers, rainfall shocks, and health insurance affect self-reported stress and cortisol (Haushofer and Shapiro, 2016; Haushofer et al., 2017; Chemin et al., 2013)
  - Poverty is highly correlated with stress (Haushofer et al., 2013)
  - Extensive evidence that stress affects decision-making: memory, cognitive ability, tasks (anagrams, analogies, proof-reading)

Focus on temporal discounting

- Temporal discounting captures the decrease in the subjective value of a reward when the reward is delayed
- Affects economic decision-making, for example whether households undertake long-term investments (health, education, etc.)
- Evidence that it is a relevant factor of decision-making as individuals exhibit a demand for commitment (Ashraf et al., 2006; Duflo et al., 2009)

Our contribution

- Mixed evidence regarding the effects of stress on time preferences
  (Koppel et al., 2017; Riis-Vestergaard et al., 2018; Haushofer et al., 2015; Delaney et al., 2014; Haushofer et al., 2013)
- Similarly for risk preferences, social preferences, and competitiveness
  (Kandasamy et al., 2014; Cahlikova and Cingl, 2017; Porcelli and Delgado, 2009; Koppel et al., 2017; Delaney et al., 2014; Buser et al., 2017; Taylor et al., 2000; Preston, 2013; Bendahan et al., 2016)
- We contribute by:
  - Examining the effects of stress in a low-income population in Kenya
  - Using multiple methods of stress induction in the same setting
  - Examining multiple outcomes related to economic decision-making: risk preferences, time preferences, self-efficacy, and executive control
  - Differentiating between acute and ``chronic'' stress

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Methodology: Laboratory Experiment at the Busara Center for Behavioral Economics

Design

- Randomize stress induction
    - Implement stressors (or control) for 7 days consecutively
        - Day 1: acute stress
        - Day 1: "chronic" stress

- Measure economic decision-making on a variety of outcomes

- Focus on temporal discounting:
    - Individuals choose between amounts on a sooner and later date

        (today versus 2 weeks from today; today versus 4 weeks from today; 2 weeks versus 4 weeks from today)

    - Over different domains:
        - Gains: Endowment of 1600 KSH, 400 KSH earlier versus amounts ranging between 340-1600 KSH later

        - Losses: Endowment of 1600 KSH, loss of 400 KSH versus losses ranging between 340-1600 KSH later

        - Effort: 2 phone calls earlier versus amount between 1-12 phone calls later for 500 KSH in one month

Psychosocial Stressor: Trier Social Stress Test (TSST)

- Treatment: mock job interview, difficult mental arithmetic task
- Control: describe self, easy and forgiving mental arithmetic task

  (treatment varies across sessions)
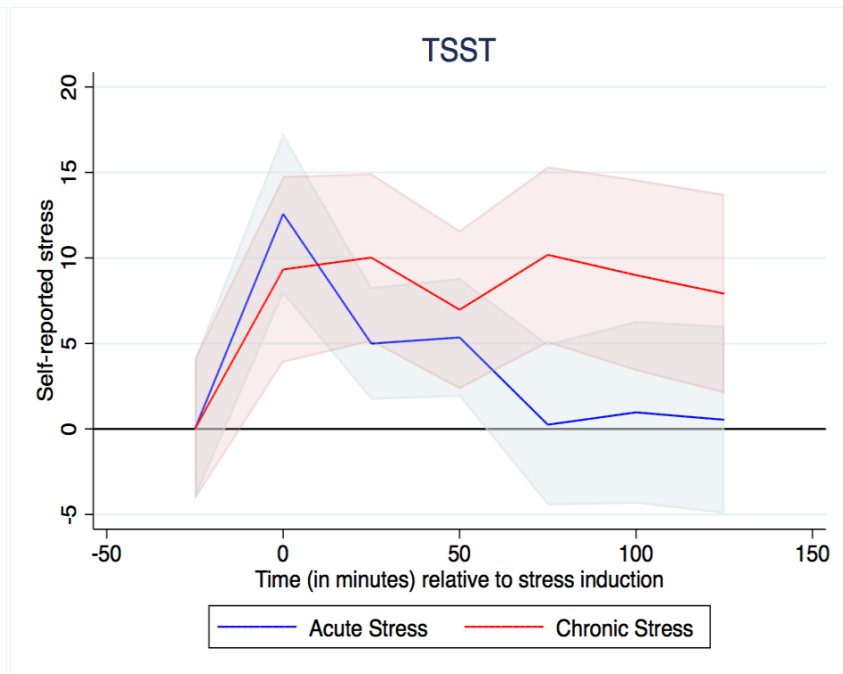- Sample: 268 participants from informal settlements in Nairobi

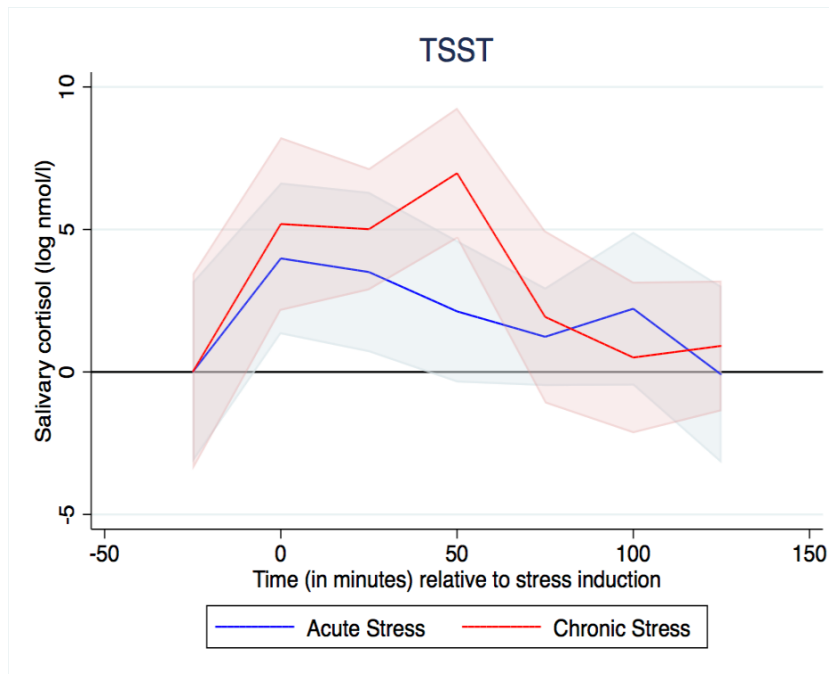# Neurobiological Stressor: Hydrocortisone

- Treatment: 20mg of hydrocortisone

- Control: placebo

    (treatment varies within a session)

- Sample: 317 participants from informal settlements in Nairobi

Manipulation Check: Effects of TSST on Self-Reported Stress and Salivary Cortisol

- TSST has short-lived effects on salivary cortisol and self-reported stress in both the acute and "chronic" conditions

Manipulation Check: Effects of Hydrocortisone on Self-Reported Stress and Salivary Cortisol
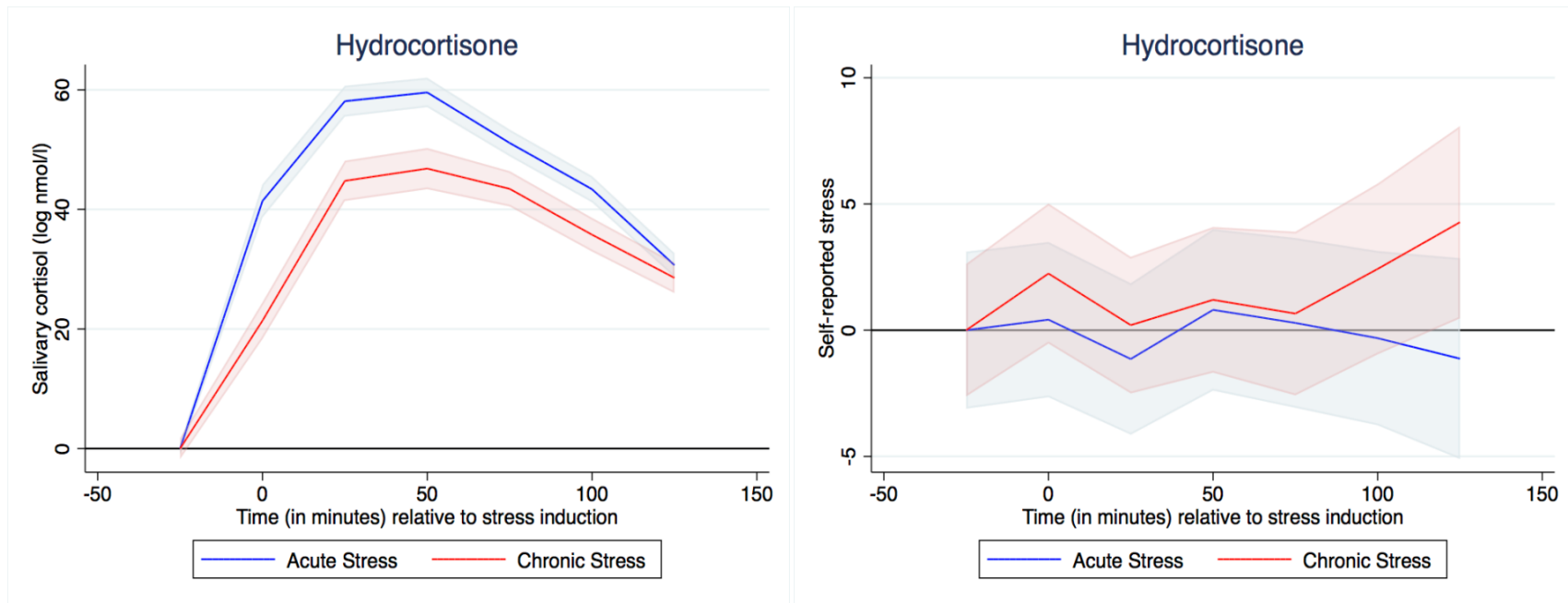
- Hydrocortisone significantly increases salivary cortisol; the effect is larger in the "chronic" condition
- Hydrocortisone does not have significant effects on self-reported stress

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Empirical Specification

$$y_{it} = \beta_0 + \beta_1 T_i \cdot Day1_t + \beta_2 Day7_t + \beta_3 T_i \cdot Day7_t + \epsilon_{it}$$

- y_{it} is the outcome of interest for respondent *i* on day *t*
- T_i indicates whether the respondent *i* received treatment
- $Day1_t$ indicates whether the data are from day 1 of the study
- $Day7_t$ indicates whether the data are from day 7 of the study
  ("chronic")

  β_1 β_3
     and   are the coefficients of interest

Effects of Hydrocortisone on the Likelihood of a Later Choice

	Probit		
	(1) $\text{LateChoice}_{\text{Gains}}$	(2) $\text{LateChoice}_{\text{Losses}}$	(3) $\text{LateChoice}_{\text{Effort}}$
Hydrocortisone			
Day 1	−0.13	−0.00	−0.08
	(0.01)***	(0.01)	(0.01)***
Day 7	−0.11	−0.05	−0.13
	(0.01)***	(0.01)***	(0.01)***
Difference *p*-value	0.62	0.38	0.31
Control mean	0.53	0.32	0.34
	(0.50)	(0.47)	(0.47)
N	13196	13196	9466

Notes: Due to the level of randomization, standard errors are clustered at the session level for the TSST study and at the individual level for the Hydrocortisone study. These probit regressions are carried out on the participant-set level and include set-fixed effects. Standard errors are bootstrapped.

Effects of TSST on the Likelihood of a Later Choice

| | Probit | | |
	(1) LateChoice$_{\text{Gains}}$	(2) LateChoice$_{\text{Losses}}$	(3) LateChoice$_{\text{Effort}}$
Trier Social Stress Test			
Day 1	-0.09	-0.06	-0.13
	$(0.01)^{***}$	$(0.01)^{***}$	$(0.01)^{***}$
Day 7	-0.11	-0.21	0.08
	$(0.01)^{***}$	$(0.01)^{***}$	$(0.01)^{***}$
Difference p-value	0.80	0.00^{***}	0.00^{***}
Control mean	0.54	0.32	0.33
	(0.50)	(0.47)	(0.47)
N	12264	12264	20877

Notes: Due to the level of randomization, standard errors are clustered at the session level for the TSST study and at the individual level for the Hydrocortisone study. These probit regressions are carried out on the participant-set level and include set-fixed effects. Standard errors are bootstrapped.

Temporal Discounting

- Distinguish between present bias (β) and intertemporal discounting (δ) as in Laibson et al. (1997)
    - $\beta < 1$ indicates that the individual is present-biased
    - $\delta < 1$ indicates that the individual discounts the future exponentially
- Take into account curvature (σ) and loss aversion (λ) parameters from risk preferences task with choices over mixed lotteries as in Tanaka et al. (2010)
- Estimate using two-step maximum likelihood

Effects of Hydrocortisone on Time Preferences

	(1) $\beta_{\text{Gains}}^{\text{2-Step}}$	(2) $\delta_{\text{Gains}}^{\text{2-Step}}$	(3) $\beta_{\text{Losses}}^{\text{2-Step}}$	(4) $\delta_{\text{Losses}}^{\text{2-Step}}$	(5) $\sigma^{\text{2-Step}}$	(6) $\lambda^{\text{2-Step}}$
Hydrocortisone						
Day 1	0.12	−0.03	−0.07	0.05	0.03	0.00
	(0.09)	(0.03)	(0.07)	(0.05)	(0.04)	(0.33)
Day 7	−0.04	0.01	−0.08	0.02	0.10	0.32
	(0.10)	(0.03)	(0.08)	(0.05)	(0.05)**	(0.33)
Difference *p*-value	0.24	0.43	0.98	0.63	0.21	0.50
Control mean Day 1	1.22	1.02	1.16	1.04	0.42	1.87
	(0.70)	(0.30)	(0.66)	(0.41)	(0.31)	(2.99)
Control mean Day 7	1.40	1.00	1.13	1.09	0.34	1.64
	(0.83)	(0.25)	(0.70)	(0.42)	(0.34)	(2.27)
N	550	550	550	550	550	550

Notes: Due to the level of randomization, standard errors are clustered at the individual level.

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Effects of TSST on Time Preferences

	(1) $\beta^{\text{2-Step}}_{\text{Gains}}$	(2) $\delta^{\text{2-Step}}_{\text{Gains}}$	(3) $\beta^{\text{2-Step}}_{\text{Losses}}$	(4) $\delta^{\text{2-Step}}_{\text{Losses}}$	(5) $\sigma^{\text{2-Step}}$	(6) $\lambda^{\text{2-Step}}$
Trier Social Stress Test						
Day 1	0.13	−0.02	−0.08	0.00	0.05	−0.49
	(0.08)	(0.03)	(0.09)	(0.06)	(0.04)	(0.33)
Day 7	−0.20	−0.04	0.05	0.05	0.00	0.05
	(0.11)*	(0.03)	(0.07)	(0.05)	(0.05)	(0.29)
Difference *p*-value	0.01**	0.75	0.24	0.56	0.45	0.23
Control mean Day 1	1.20	1.01	1.13	1.07	0.43	1.95
	(0.74)	(0.24)	(0.63)	(0.43)	(0.33)	(2.99)
Control mean Day 7	1.38	0.99	1.07	1.03	0.44	1.58
	(0.77)	(0.14)	(0.56)	(0.36)	(0.36)	(2.45)
N	511	511	511	511	511	511

Notes: Due to the level of randomization, standard errors are clustered at the session level.

Conclusion

- Both the TSST and hydrocortisone increase discounting (*less* likely to choose money on later date)

- Taking risk preferences into account, we find that chronic stress, induced using the TSST, increases present-bias when monetary payoffs are framed as gains (consistent with Cornelisse et al., 2013)

- Results suggest that stress can contribute towards the persistence of poverty through its effects on temporal discounting

- Additional results:

  - No significant effects on other behavioral outcomes: self-efficacy and executive control

 - Other stressors (centipede game and cold pressor task) do not affect stress in our sample

Thank you for your time! I can be reached at
prachi.jain@lmu.edu with any questions or comments.

Executive Control

- Executive function refers to a set of inter-related higher-order cognitive abilities involved in self-regulatory functions (Roth et al., 2013)

- We use a 3 minute spatial version of the Stroop task, using congruent and incongruent arrows

- Participants are incentivized for speed and accuracy

- The Stroop effect refers to the difference in performance (speed and accuracy) between incongruent and congruent arrows

- We use a subset of the Behavior Rating Inventory of Executive Function Scale - Adult Version (BRIEF-A) that measures
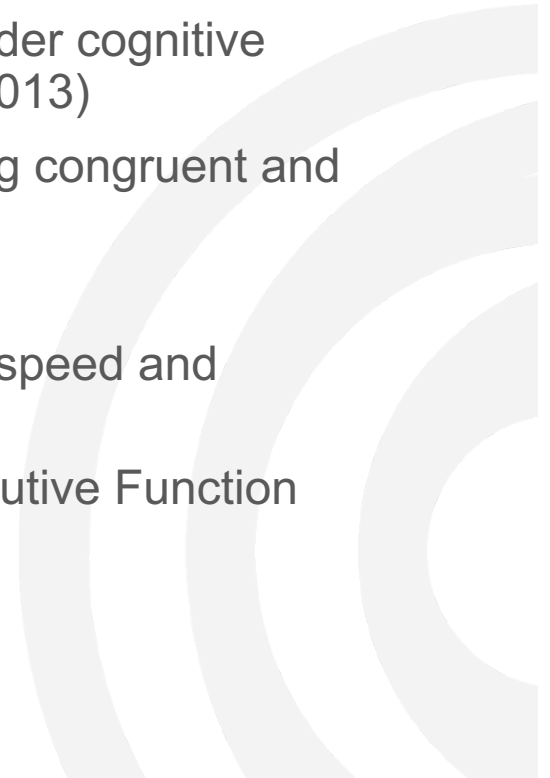
Effects of Hydrocortisone on Executive Control

	(1) Overall Performance Stroop	(2) Total Stroop time	(3) Stroop correct answers	(4) Stroop effect time	(5) Stroop effect answer	(6) BRIEF-A Scale
Day 1	0.00	−0.25	0.18	0.70	0.35	−3.93
	(0.02)	(1.97)	(0.76)	(1.19)	(0.40)	(2.72)
Day 7	−0.01	0.87	−0.17	0.84	0.54	−4.64
	(0.02)	(1.57)	(0.73)	(1.16)	(0.52)	(2.74)*
Difference p-value	0.58	0.66	0.74	0.93	0.77	0.85
Control mean Day 1	0.47	60.15	26.33	0.87	0.33	164.23
	(0.16)	(16.81)	(6.61)	(9.91)	(3.49)	(21.21)
Control mean Day 7	0.54	53.49	27.69	−4.66	−1.56	169.40
	(0.16)	(13.21)	(5.74)	(8.70)	(4.25)	(19.46)
N	547	547	547	547	547	550

Notes: Due to the level of randomization, standard errors are clustered at the individual level.

Effects of TSST on Executive Control

	(1) Overall Performance Stroop	(2) Total Stroop time	(3) Stroop correct answers	(4) Stroop effect time	(5) Stroop effect answer	(6) BRIEF-A Scale
Day 1	0.00	−0.25	0.18	0.70	0.35	−3.93
	(0.02)	(1.97)	(0.76)	(1.19)	(0.40)	(2.72)
Day 7	−0.01	0.87	−0.17	0.84	0.54	−4.64
	(0.02)	(1.57)	(0.73)	(1.16)	(0.52)	(2.74)*
Difference p-value	0.58	0.66	0.74	0.93	0.77	0.85
Control mean Day 1	0.47	60.15	26.33	0.87	0.33	164.23
	(0.16)	(16.81)	(6.61)	(9.91)	(3.49)	(21.21)
Control mean Day 7	0.54	53.49	27.69	−4.66	−1.56	169.40
	(0.16)	(13.21)	(5.74)	(8.70)	(4.25)	(19.46)
N	547	547	547	547	547	550

Notes: Due to the level of randomization, standard errors are clustered at the individual level.

Self Efficacy

- Self-efficacy is defined as the belief that one can perform well in a specific situation (Bandura, 1982)

- We develop a behavioral (slider) task to capture self-efficacy (SE), in which participants are incentivized based on both on their performance in absolute terms (y) and relative to a goal set (y_a)

$$SE = \frac{y_a}{1+ |\, y_a - y \,|}$$

- The Pearlin Mastery Scale measures the extent to which one regards one's life-chances as being under one's own control (Pearlin and Schooler, 1978)

Effects of Hydrocortisone on Self-Efficacy

	(1) Round 1 Performance	(2) Belief Performance Round 1	(3) Goal Set Round 2	(4) Compound Self Efficacy Measure	(5) Pearlin Mastery Scale
Day 1	0.39	−0.71	0.60	0.63	−0.44
	(1.24)	(1.31)	(0.94)	(0.33)*	(0.55)
Day 7	1.02	0.51	0.76	−0.01	−1.10
	(1.34)	(1.40)	(1.18)	(0.43)	(0.68)
Difference p-value	0.73	0.53	0.92	0.25	0.45
Control mean Day 1	25.86	14.45	13.29	1.27	23.93
	(11.75)	(12.84)	(7.94)	(1.70)	(4.62)
Control mean Day 7	29.69	19.15	16.35	1.92	25.60
	(11.13)	(11.07)	(8.53)	(3.98)	(5.09)
N	566	566	566	566	550

Notes: Due to the level of randomization, standard errors are clustered at the individual level. The Self-Efficacy Measure is a compound measure derived from the sliders goal and actual performance in Round 2.

Effects of TSST on Self Efficacy

	(1)	(2)	(3)	(4)	(5)
	Round 1 Performance	Belief Performance Round 1	Goal Set Round 2	Compound Self Efficacy Measure	Pearlin Mastery Scale
Day 1	−0.53	1.22	0.28	−0.09	−1.61
	(1.96)	(1.98)	(1.51)	(0.41)	(0.67)**
Day 7	2.31	1.58	−0.55	−0.11	−0.65
	(2.10)	(2.58)	(2.03)	(0.43)	(0.78)
Difference p-value	0.33	0.91	0.74	0.97	0.35
Control mean Day 1	30.27	18.88	16.68	2.00	25.74
	(12.38)	(14.17)	(10.04)	(3.49)	(5.31)
Control mean Day 7	35.92	25.08	21.18	2.31	27.43
	(10.74)	(18.73)	(13.47)	(3.23)	(5.98)
N	511	511	511	511	511

Notes: Due to the level of randomization, standard errors are clustered at the session level. The Self-Efficacy Measure is a compound measure derived from the sliders goal and actual performance in Round 2.