

# Destructive Behavior, Judgement and Economic Decision-making Under Thermal Stress

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# Motivation

- Large literature ties extreme climate to adverse economic and political outcomes
- Many plausible channels for temperature effects:
  - Individual productivity (Mackworth 1946, '47; Parsons 2002; Ye et al. 2010)
  - Other economic factors, e.g., agriculture (Miguel et al., 2004; Burke et al., 2015)
  - Effects may be situational (e.g., more people outside on hot days → crime)
- Temperature has also been hypothesized to have behavioral effects:
  - Standard economic preferences (e.g., impatience), social preferences
  - Emotional and other psychological responses
- Reduced-form work critiqued for not identifying **mechanisms** (Dell et al. 2014)
  - >> Address this directly in a lab setting

## This study

- Estimate causal effect of high temperature on individual decision-making in experimental labs in **Nairobi**, Kenya and **California**, USA
- Focus on plausible channels linking temperature to important outcomes:
  - Standard economic preferences (e.g., time preferences, risk)
  - Social preferences, including destructive anti-social acts
  - Emotions and affect
- Contribute to a nascent literature on how environmental factors and neurobiology influence economic choices, including work on poverty, hunger, noise, sleep, and stress (Mani et al., 2013; Bushman et al., 2014; Haushofer and Fehr, 2014; Dean, 2018; Rao, Schilbach and Schofield 2018)

# Timeline and Sample

- Experimental timeline
  - Nov. 2016 and January 2017: Pre-pilots
  - Sept. 18-20, 2017: Pilot sessions for main experiment
  - **Sept. 25, 2017 to Feb. 15, 2018:** Main experiments conducted in both California and Nairobi
- Large samples: California N=903, Nairobi N=1,015
  - Samples of university students, young adults

# Lab Setup

## Temperature Treatment

- **Control Room:** Target 22 °C (71.6 °F)
- **Hot Room:** Target 30 °C (86 °F)
- 6 participants in each room, randomized
- Individuals “heat up” for 20 minutes in room before experiments, then experiments last for 35-55 minutes
  
- Rooms have hidden temperature monitors, other sensors
- Participants cannot see heaters
- Complete 12 experimental tasks, then a brief survey

## Berkeley Hot Room (30 °C)



## Berkeley Control Room (22 °C)



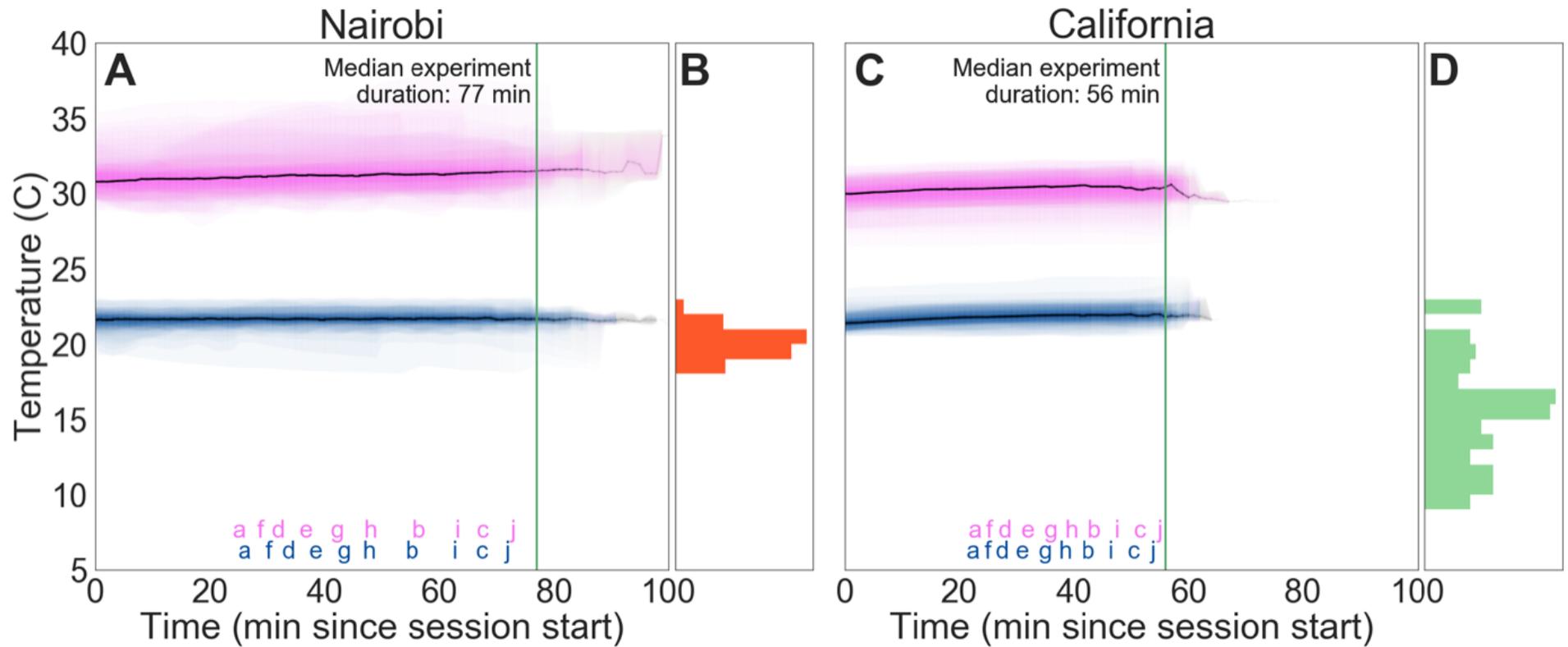
## Kenya Hot Room (30 °C)



## Kenya Control Room (22 °C)



# Observed Temperature by Location and Treatment



## Participants Complete Tasks

<b>Group</b>	<b>Label</b>	<b>Measurement</b>	<b>Description</b>
Individual Cognitive Performance	a	Precision task	Slider task (Gill & Prowse 2012)
	b	Fluid intelligence	Raven's Matrices (Penrose & Raven 1936)
	c	Cognitive reflection	Ability to override gut response (Frederick 2005)
Standard Economic Preferences	d	Risk-taking	Choice across risky lotteries (Eckel and Grossman 2008)
	d	Rational choice violation I	When coin toss A is preferred to coin toss B, and coin toss B is preferred to coin toss C, but coin toss A is not preferred to coin toss C (Eckel and Grossman 2008)
	e	Patience	Time discounting (Andreoni et al. 2015)
	e	Time inconsistency	Present bias (Andreoni et al. 2015)
Social Preferences	f	Fairness	Real Effort Dictator Game (Almas et al. 2010)
	g	Trust	Trust game (Johnson & Mislin 2001)
	h	Public contribution	Public Goods game (Fischbacher et al. 2001)
	i	Joy of Destruction	Share of partner's vouchers or gift cards voluntarily and anonymously destroyed, as a measure of ill-will (Abbink & Sadrieh 2009)
	j	Charitable donation	Amount of tokens donated to charity (Andreoni 2006)
Emotions and Affect	c	Happiness	Self-expressed degree of happiness (Russell & Barrett 1999)
	c	Alertness	Self-expressed degree of alertness (Russell & Barrett 1999)

## 10. Joy of Destruction

- Measures if temperature affects **anti-social behavior**
- Participants informed everyone won different amounts of \$1 Amazon gift cards // 50 Ksh air time vouchers in the Raven's Matrices task
- Participants then randomly and anonymously matched in pairs, told how much their partner has won, X; they do not know their own earnings
- To demonstrate "destruction", lab assistants publicly rip up actual gift cards // air time vouchers in example scenarios

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- To demonstrate "destruction", lab assistants publicly rip up actual gift cards // air time vouchers in example scenarios
- Participants can **choose to destroy** between 0 and  $X$ ; informed the computer may also destroy some of the remaining vouchers
- Partner never finds out their original earnings, or amount destroyed, or cause of any destruction (i.e., their partner or the computer)
  - >> Primary outcome is the proportion of gift cards // vouchers destroyed by the participant

## Differences across sites

- Plausibly meaningful differences between the **California**, **Nairobi** sites:
- Heightened political and ethnic tensions in Nairobi vs. calm in California
  - >> Might lead to somewhat different impacts in Nairobi
- On average, labs are somewhat longer (and slightly hotter) in Nairobi
  - >> Might generate somewhat larger impacts in Nairobi
- Outdoor weather conditions differ, e.g., 5 °C warmer in Nairobi on average
  - >> Results robust to controlling for daily weather conditions
- More females participated in California (59%) than Nairobi (35%)
  - >> Results robust to controlling for session gender composition
- Share of participants suspecting (in ex post survey) that heat is a treatment
  - >> More awareness in California, participants might overcompensate?

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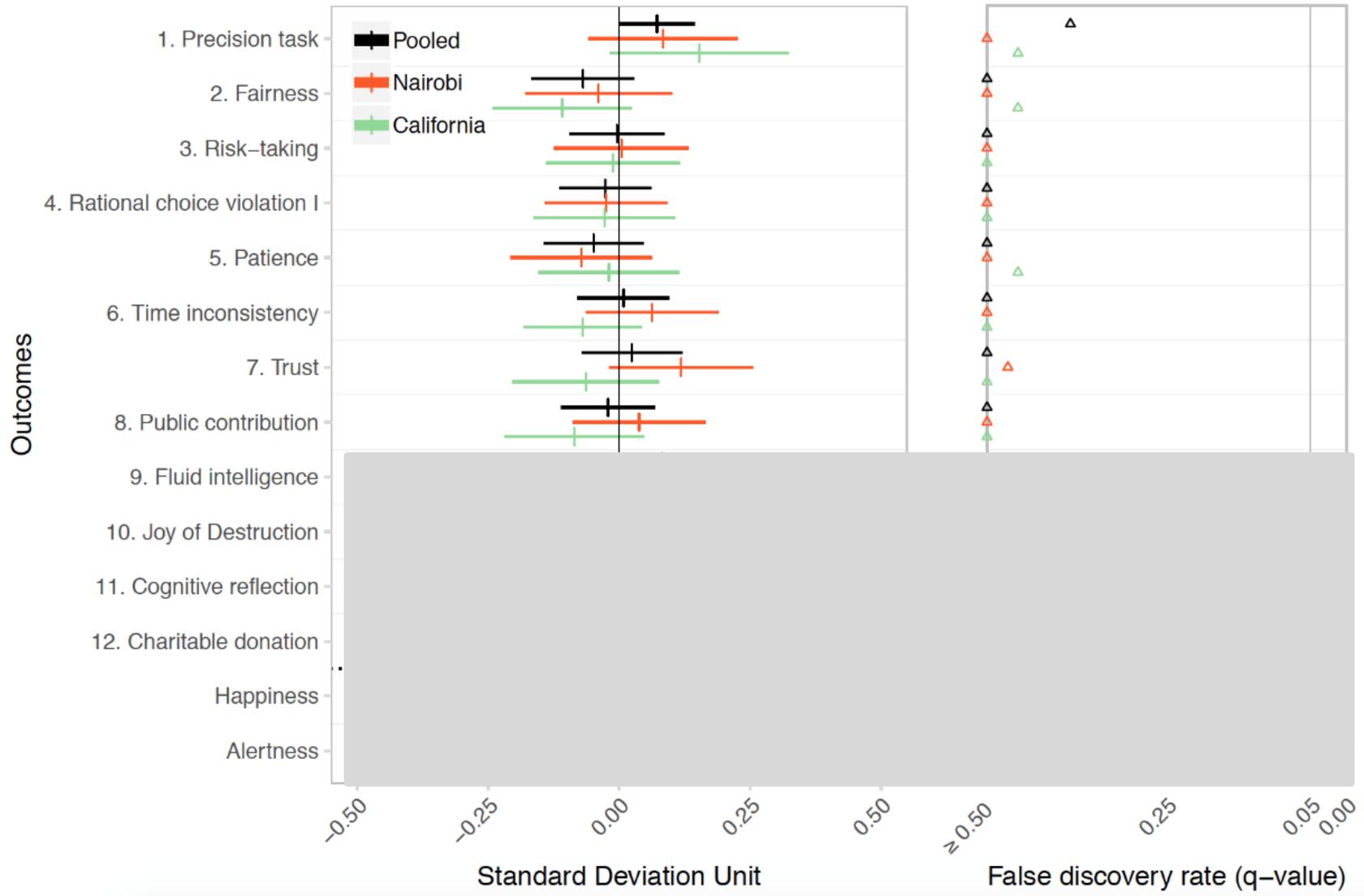
## Kenyan political setting

- Political setting in Kenya: contested 2017 national general elections
  - Aug. 8: National presidential and parliamentary elections held. Incumbent Uhuru Kenyatta (ethnic Kikuyu) declared winner (54% vs. 45%) over Raila Odinga (ethnic Luo), followed by protests
  - Sept. 1: Supreme Court nullifies result due to irregularities, schedules new polls for October 26
  - Oct. 10: Odinga announces election boycott, protests banned
  - Oct. 30: Kenyatta declared winner (98%), low 39% turn out
  - Nov. 20: Supreme Court upholds, Odinga declares illegitimate
  - Feb. 2, 2018: Protests over arrest of opposition lawyer
- Many observers believe Odinga also lost two earlier Presidential elections (in 2007 and 2013) due to irregularities and fraud.

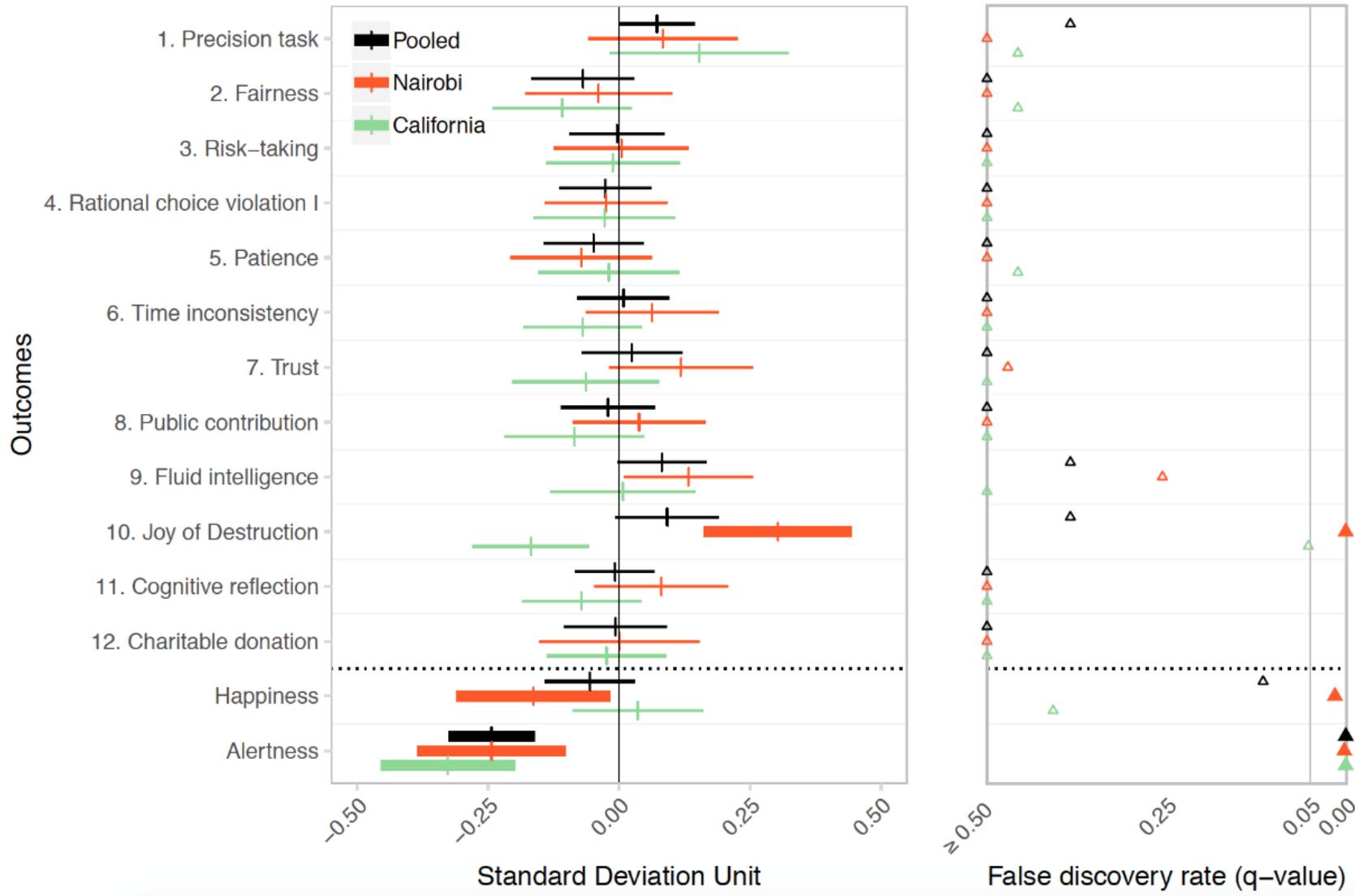
## Pre-analysis Plan

- AEA Registry #0001361 (registered June 20, 2016)
    - Pre-analysis plan uploaded Sept. 13, 2017, before any data collection
  - 12 main outcomes; plus affect measures (alertness, happiness)
  - Multiple testing adjustment (False discovery rate q-values)
  - Pre-specified key dimensions of heterogeneity:
    - Site (California, Nairobi); Gender
- >> I will note when we present additional exploratory analysis

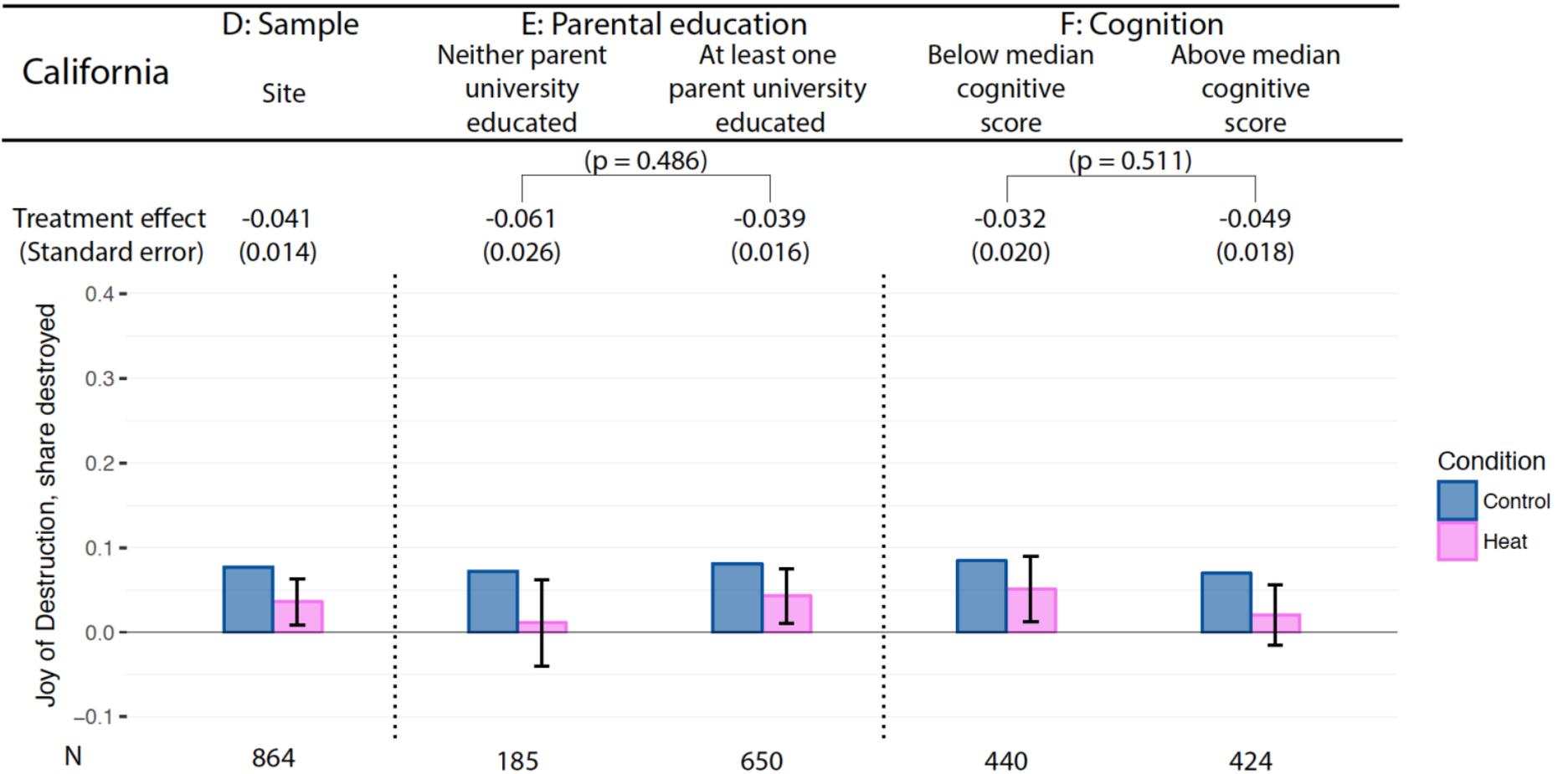
# Main Results



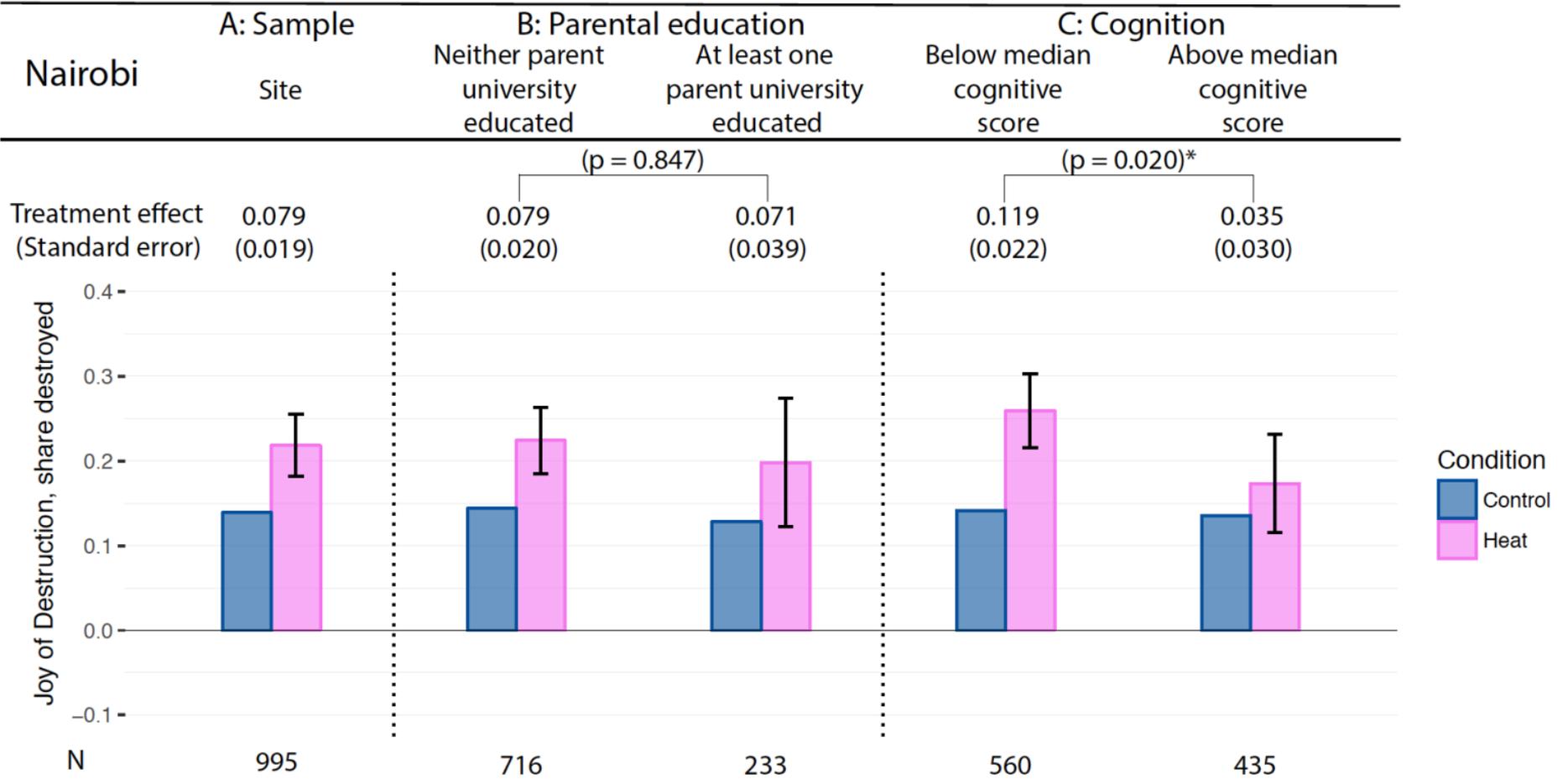
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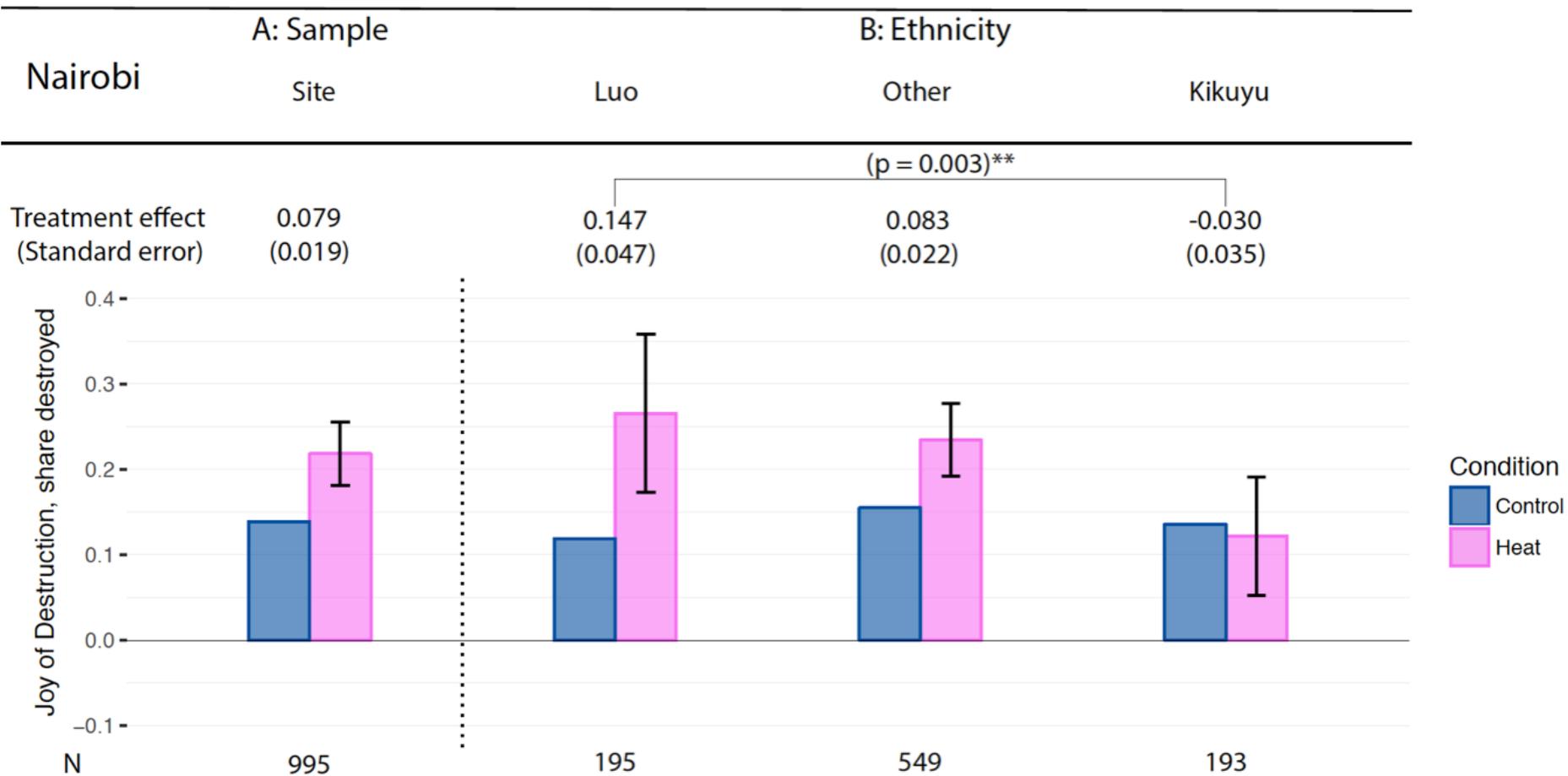
# Joy of Destruction in California



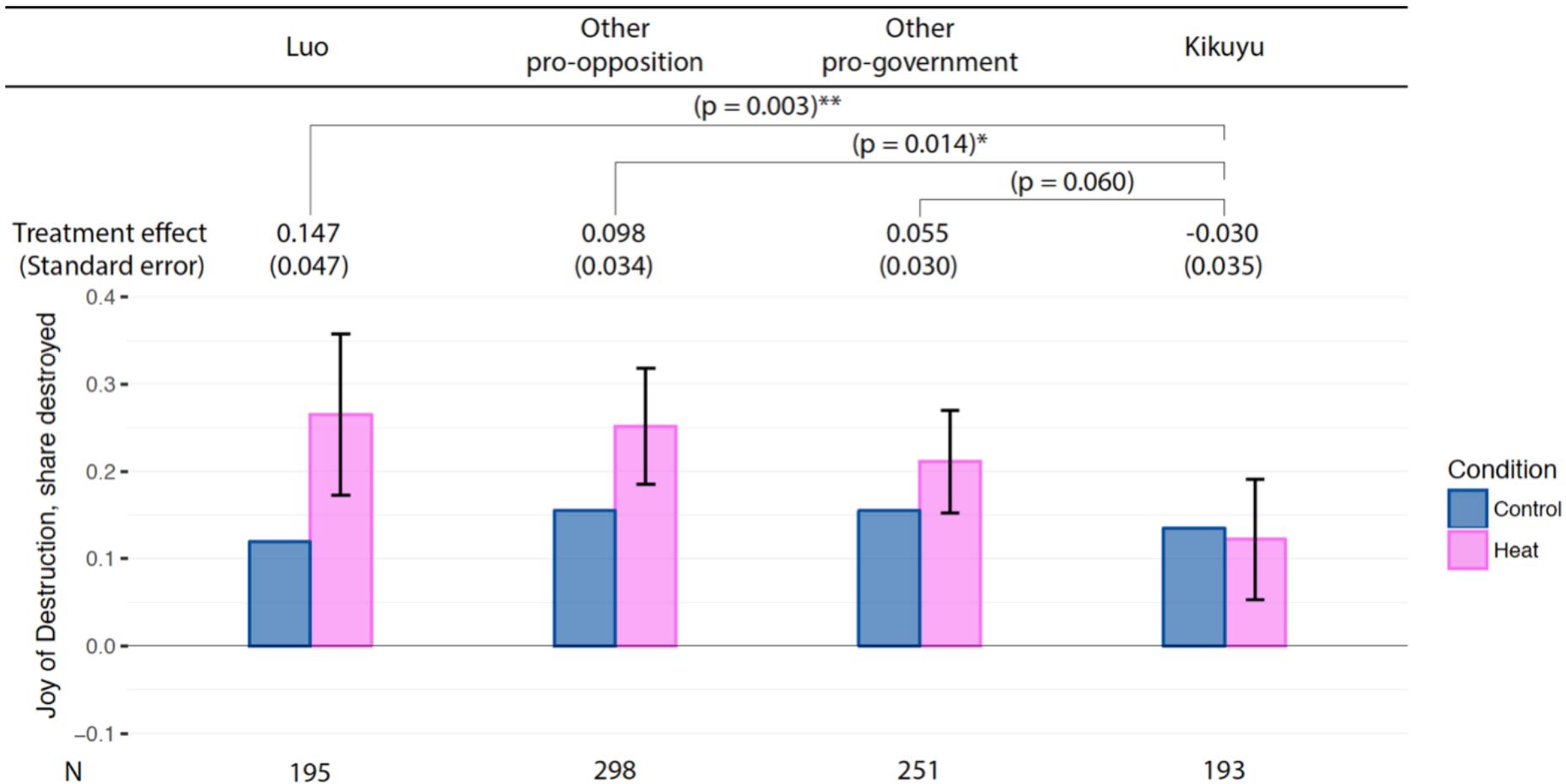
# Joy of Destruction in Nairobi (1)



# Joy of Destruction in Nairobi (2)



# Joy of Destruction in Nairobi (detailed ethnic breakdown)



## Joy of Destruction in Nairobi: Interpretation

- Effects are most pronounced among members of a politically marginalized ethnic group (Luo), perhaps in part due to the heightened political tension in Kenya during study period
  - Consistent with the frustration-aggression hypothesis
- Opposition-aligned ethnic groups also show effects
- Questions:
  - Do **socially marginalized** groups respond more to heat?
  - Are election periods particularly fraught?
  - Would results in Nairobi be different in a non-election period?

## Discussion (1)

- Experiments with 1,900 participants in Nairobi, California show:
- Result 1: No evidence that thermal stress leads to measurable changes in standard economic preferences, or pro-social behavior
- Result 2: High temperature increases anti-social “destruction” in the Nairobi sample
  - Survives the multiple testing adjustment
  - Appears concentrated among politically marginalized groups

## Discussion (2)

- Implications: aggressive emotional reactions at high temperature are a plausible mechanism for some existing aggregate findings linking extreme temperature to increased violence
- Next research steps: longer timeframe for treatments; higher temperatures (if logistically feasible and ethical); biomarker data
- Extreme climate seems to nudge some people towards destructive behavior; how can policy nudge them away from conflict?

>> Policy interventions that target “external” factors such as economic conditions may **not** be sufficient if internal mental impacts matter.

# Extra Slides

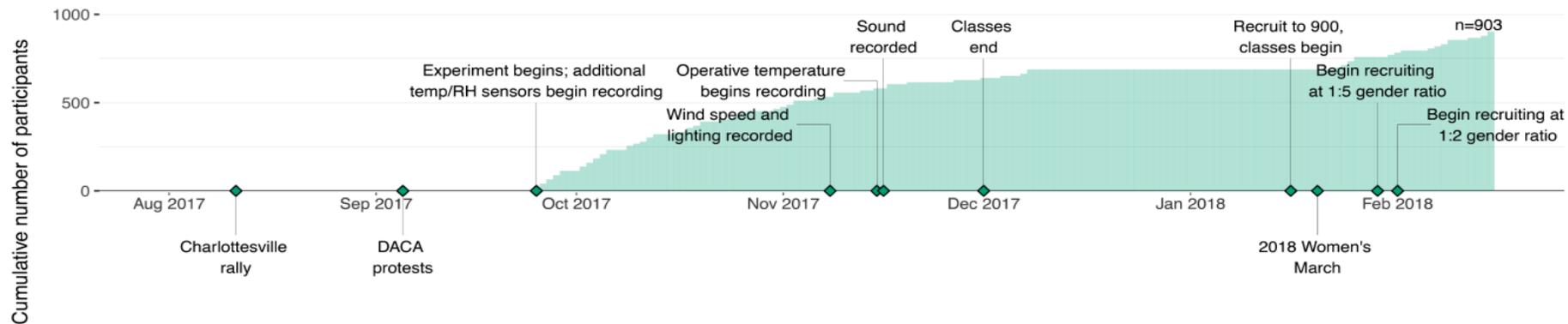
## Differences in perception of heat

	California			Nairobi		
	Control	Heat	diff	Control	Heat	diff
<b>How was room temperature?</b>						
Comfortable	0.79 (0.41)	0.09 (0.29)	**	0.57 (0.50)	0.47 (0.50)	*
Too cold	0.20 (0.40)	0 (0)	**	0.43 (0.50)	0.01 (0.10)	**
Too hot	0.01 (0.11)	0.91 (0.29)	**	0 (0)	0.52 (0.50)	**
<b>Was the experiment about...</b>						
room temperature?	0.09 (0.29)	0.46 (0.50)	**	0.09 (0.29)	0.11 (0.31)	
generosity?	0.74 (0.44)	0.75 (0.44)		0.64 (0.48)	0.59 (0.49)	
gender discrimination?	0.06 (0.23)	0.07 (0.25)		0.03 (0.17)	0.02 (0.13)	

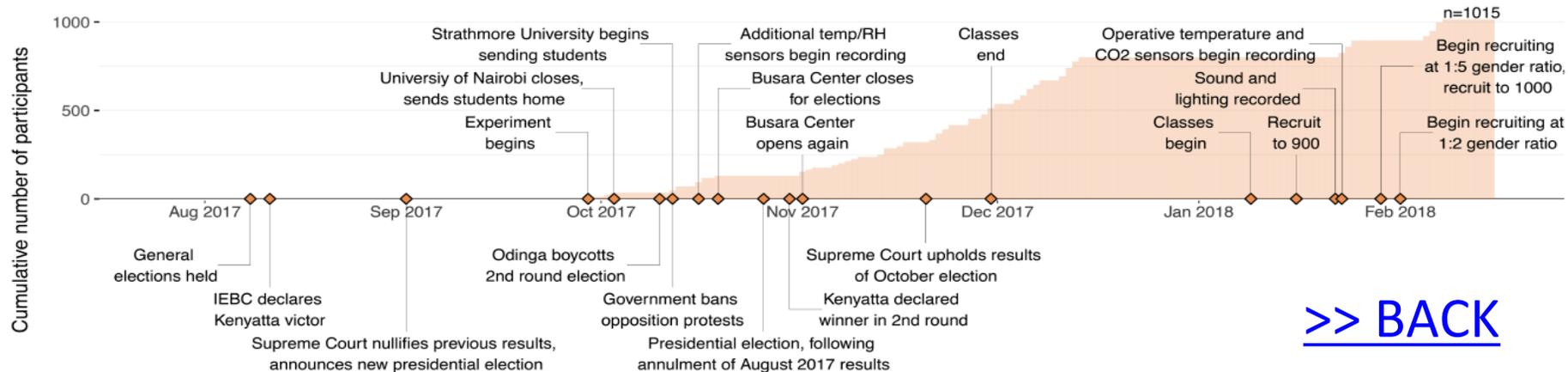
Note: standard deviation in parentheses. \*  $p < .05$ , \*\*  $p < .01$

Figure D.8.1: Experimental timeline

### A: California



### B: Nairobi

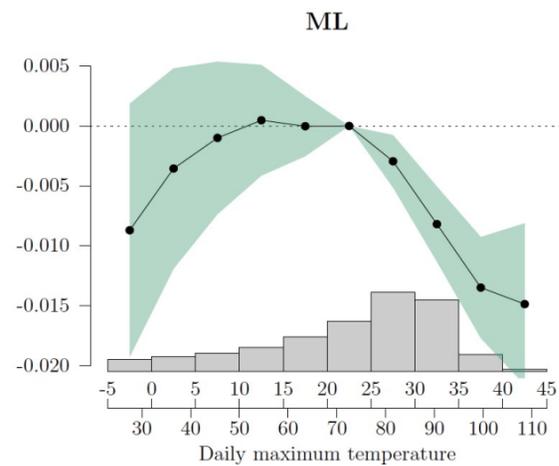
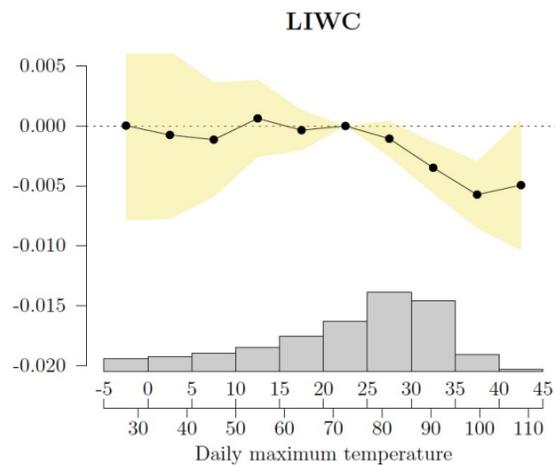
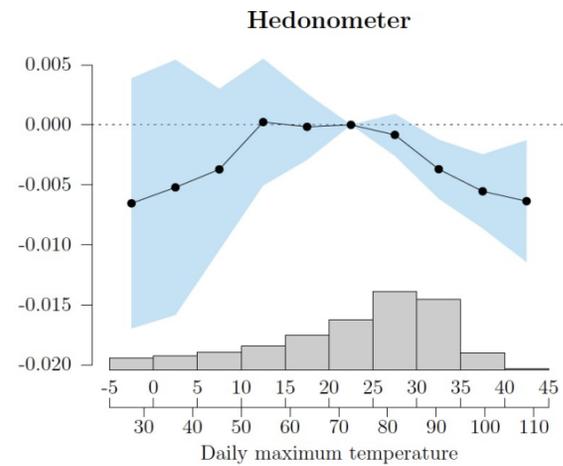
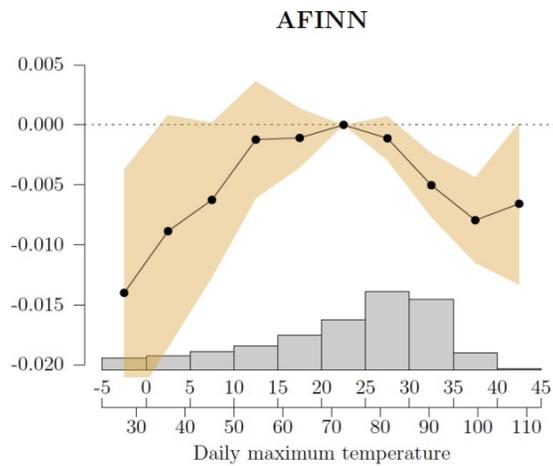


[>>> BACK](#)

# Results

Module		Treatment effect	Standard error	p-value	q-value	Control Mean (SD)
1. Precision task	Pooled	0.516	0.261	0.049	0.384	17.9 (7.1)
	Nairobi	0.451	0.391	0.253	0.722	13.0 (5.4)
	California	0.590	0.336	0.083	0.457	23.6 (3.9)
2. Fairness		-0.017	0.012	0.170	0.618	0.32 (0.24)
		-0.010	0.018	0.586	1.000	0.33 (0.26)
		-0.025	0.015	0.114	0.457	0.31 (0.23)
3. Risk-taking		-1.835	20.643	0.929	1.000	366.3 (449.8)
		1.926	27.568	0.944	1.000	329.1 (421.5)
		-5.553	30.951	0.858	0.850	409.0 (477.2)
4. Rational choice violation I		-0.004	0.007	0.561	1.000	0.03 (0.16)
		-0.004	0.010	0.678	1.000	0.03 (0.16)
		-0.005	0.011	0.687	0.846	0.03 (0.16)
5. Patience		-0.000033	0.000181	0.854	1.000	0.996 (0.007)
		0.000551	0.000509	0.279	0.722	0.997 (0.015)
		-0.000349	0.000208	0.093	0.457	0.996 (0.006)
6. Time inconsistency		0.000953	0.008517	0.911	1.000	0.947 (0.356)
		0.008398	0.023585	0.722	1.000	0.997 (0.718)
		-0.003109	0.010737	0.772	0.850	0.934 (0.303)
7. Trust		0.008	0.016	0.617	1.000	0.42 (0.32)
		0.033	0.020	0.096	0.471	0.35 (0.28)
		-0.022	0.024	0.377	0.759	0.50 (0.34)
8. Public contribution		-8.923	19.444	0.647	1.000	529.7 (426.2)
		15.316	25.846	0.555	1.000	442.5 (401.1)
		-36.881	29.359	0.213	0.520	629.6 (432.6)
9. Fluid intelligence		0.015	0.008	0.061	0.384	0.86 (0.18)
		0.027	0.013	0.037	0.256	0.80 (0.21)
		0.001	0.008	0.919	0.850	0.94 (0.12)
10. Joy of Destruction		0.023	0.013	0.069	0.384	0.11 (0.25)
		0.071	0.019	<0.001	0.001**	0.14 (0.26)
		-0.041	0.014	0.004	0.053	0.08 (0.24)
11. Cognitive reflection		-0.002	0.011	0.837	1.000	0.33 (0.29)
		0.016	0.013	0.218	0.722	0.21 (0.20)
		-0.023	0.018	0.217	0.520	0.46 (0.32)
12. Charitable donation		-4.443	31.228	0.887	1.000	410.4 (628.0)
		0.412	52.675	0.994	1.000	561.8 (675.3)
		-12.673	30.512	0.679	0.846	245.0 (524.9)
Happiness		-0.079	0.062	0.208	0.116	5.31 (1.42)
		-0.190	0.087	0.031	0.016*	5.91 (1.16)
		0.049	0.088	0.579	0.408	4.62 (1.39)
Alertness		-0.420	0.073	<0.001	0.001**	5.25 (1.42)
		-0.322	0.096	0.001	0.003**	6.09 (1.32)
		-0.307	0.061	<0.001	0.001**	4.28 (1.62)

# Temperature and Expressed Sentiment (on Twitter)



Source: Baylis, 2017

# Balance Across Treatment and Control

	California			Nairobi		
	Control	Heat	diff	Control	Heat	diff
<b>Panel A: Demographic variables</b>						
Age	19.8 (2.75)	20.1 (2.68)		21.9 (2.73)	22.1 (2.12)	
Female	0.59 (0.49)	0.60 (0.49)		0.35 (0.48)	0.35 (0.48)	
Weight (kg)	64.1 (12.97)	63.6 (12.36)		61.3 (7.84)	63.0 (9.27)	**
Height (cm)	169.2 (11.19)	168.7 (10.58)		166.4 (18.06)	166.9 (17.79)	
Mother's education (university)	0.66 (0.47)	0.69 (0.46)		0.12 (0.32)	0.16 (0.37)	
Father's education (university)	0.72 (0.45)	0.71 (0.45)		0.22 (0.41)	0.22 (0.41)	
Mother employed (self or wage)	0.78 (0.41)	0.76 (0.43)		0.65 (0.48)	0.67 (0.47)	
Father employed (self or wage)	0.95 (0.22)	0.93 (0.26)		0.77 (0.42)	0.76 (0.43)	
Parent income (> \$24k, PPP)	0.88 (0.33)	0.90 (0.30)		0.09 (0.28)	0.08 (0.27)	
In-state status ( $\geq 5$ years)	0.69 (0.46)	0.67 (0.48)				
Kikuyu ethnicity				0.24 (0.42)	0.18 (0.38)	*
Luo ethnicity				0.19 (0.39)	0.23 (0.42)	

Note: standard deviation in parentheses. \*  $p < .05$ , \*\*  $p < .01$

## Participants Complete 12 Tasks (ordered)

- [1] Precision task (Gill & Prowse 2012)
  - [2] Fairness [Real Effort Dictator Game] (Almas et al. 2010)
  - [3] Risk taking (Eckel & Grossman 2008)
  - [4] Rational choice violation (Eckel & Grossman 2008)
  - [5] Patience (Andreoni et al. 2015)
  - [6] Time inconsistency (Andreoni et al. 2015)
  - [7] Trust [Trust Game] (Johnson & Mislin 2011)
  - [8] Public contribution [Public Good Game] (Fischbacher et al. 2001)
  - [9] Fluid intelligence (Penrose & Raven 1936)
  - [10] Joy of Destruction (Abbink & Sadrieh 2009)
  - [11] Cognitive reflection (Frederick 2005)
  - [12] Charitable donation (Andreoni 2006)
- >> Short survey, including affect questions (Russell & Barrett 1999)

## No Effect on A) Patience or B) Time Inconsistency

<b>A) Patience</b>	(1) Pooled	(2) California	(3) Nairobi
Heat	-0.00023305 (0.277) [0.995]	-0.00040615 (0.078) [0.438]	0.00002915 (0.963) [1.000]
Outcome mean	0.9965259	0.9962787	0.9969872
Observations	7512	3496	4016
<b>B) Time inconsistency</b>	(1) Pooled	(2) California	(3) Nairobi
Heat	0.00496274 (0.581) [1.000]	0.00014919 (0.988) [0.977]	0.01868129 (0.490) [1.000]
Outcome mean	0.9475111	0.9332354	1.000915
Observations	7512	3496	4016

Note:  $p$ -values in parentheses, multiple hypothesis testing FDR  $q$ -values in brackets

## 1. Precision task

- Participants are engaged with a slider task, where they place a slider on an assigned number from 1 - 100 using the touchscreen (or mouse)
- Participants receive a point if the number is correct, 0 otherwise
- Final earnings from precision phase are either “high” (weakly above median) or “low” (below median) precision
- Provides the work needed to create real effort stakes in Dictator Game

>> Primary outcome of interest is total points earned

## 2. Fairness [Real Effort Dictator Game]

- Use precision phase to establish clear individual entitlements
- Match participants with roughly equal precision (high or low), give information about what each of them have earned in the precision phase
- Participants asked how much of joint earnings to transfer to other participant
- Participants know there is 50% chance their decision will be implemented

>> Primary outcome is the share of the total allocated to the other participant

### 3. & 4. Risk taking and rational choice violation

- Examine effect of temperature on risk preferences, as well as measuring the quality of decision-making
- Elicit risk preferences using choice over lotteries with equal probability
- There are two menus to choose from, each tracing out a different budget line with different slopes

>> Primary outcomes are the degree of risk taking, and the existence of a rational choice violation, namely, selecting a bundle that is dominated

## 5. & 6. Patience and Time Inconsistency

- Use an established protocol for eliciting “beta-delta” preferences, namely a choice over temporal budgets (CTB) design
- Each person is shown 2 budget lines for today vs. 3 weeks, and 2 budgets for 3 vs. 7 weeks

>> Primary outcomes are the aggregate estimate (across all participants) of delta (patience) and beta (time inconsistency)

## 7. Trust [Trust Game]

- Participants are matched in pairs. They play the game twice, each time with a different partner.
- Participant A is given an amount  $X$ . Participant B has no endowment
- Participant A chooses tokens,  $Y$ , to pass on to Participant B. This amount is multiplied by 3. Participant B then decides how much of  $3*Y$  to send back to Participant A; this amount is called  $Z$ .

>> Primary outcome is share of tokens sent to Participant B, often referred to as “trust”. (A secondary outcome is share of tokens sent back to Participant A, often referred to as “trustworthiness”.)

## 8. Public contribution [Public Goods Game]

- Participants are randomly matched with two other participants
  - Endowment of 1200 tokens each and decide how much of one's endowment to put into a shared fund
  - Choices are made simultaneously, and each token put into the fund is multiplied by 2. The shared fund is split equally among the three participants
  - Participants also asked what they believe another player has put into fund
- >> Primary outcome of interest is the amount put into the fund
- (An exploratory outcome is individual beliefs about other's contributions, namely, an indicator variable that marks as 1 if the individual guesses correctly about another's contribution, and 0 otherwise.)

## 9. Fluid Intelligence

- Use Raven's matrices puzzles to measure cognitive ability
- Performance on this task also creates individual earnings for the Joy of Destruction task
- Measure cognitive ability, and specifically fluid intelligence
- The participants are not told how many puzzles they have completed correctly, nor are they given their payment
- The payout could be anywhere between 0 to 6 vouchers depending on the number of puzzles answered correctly

>> Primary outcome of interest is the share of puzzles chosen correctly

## 10. Joy of Destruction

- Measures if temperature affects **anti-social behavior**
  - Participants informed everyone won different amounts of \$1 Amazon gift cards // 50 Ksh air time vouchers in the Raven's Matrices task
  - Participants then randomly and anonymously matched in pairs, told how much their partner has won, X; they do not know their own earnings
  - To demonstrate "destruction", lab assistants publicly rip up actual gift cards // air time vouchers in example scenarios
  - Participants can **choose to destroy** between 0 and X; informed the computer may also destroy some of the remaining vouchers
  - Partner never finds out their original earnings, or amount destroyed, or cause of any destruction (i.e., their partner or the computer)
- >> Primary outcome is the proportion of gift cards // vouchers destroyed<sup>42</sup>

## 11. Cognitive Reflection

- Use a Cognitive Reflection Test (CRT) that constitutes five survey questions to elicit potential treatment effects on cognitive reflection
- Participants may answer a question incorrectly because 1) the questions may cognitively be difficult to work through, or 2) the questions are designed to be somewhat misleading

>> Primary outcome of interest is share of questions answered correctly

## 12. Charitable Donation

- At the very end of the experiment, after the survey, participants are informed of their earnings (which is the sum across all games, and not just from a random subset of games) and we then offer them the opportunity to donate part of it to a charity
- Participants are randomly assigned a charity on a list (of 7 in Nairobi and 6 in California) and can donate a percentage up to 40% of their total earnings

>> Primary outcome of interest is the amount chosen to donate

## Affect

- Consists of two Likert style scales, in this order:
- Happiness: “On a scale of 1-7, with 1 being sad and 7 being happy, how do you feel right now?”
- Alertness: “On a scale of 1-7, with 1 being tired and 7 being alert, how do you feel right now?”

