How does stress affect social interactions? *

PRELIMINARY AND INCOMPLETE

Laura Ralston, MIT

November 2012

Abstract

This paper studies the impact of stress on social behavior by exogenously stimulating the two biological systems associated with stress: the hypothalamus-pituitary-adrenal axis (HPA) and noradrenergic (NA) system and measuring behavior in interactive tasks in a laboratory experiment. Our preliminary findings suggest that the concurrent stimulation of both systems, through the administration of 60mg of hydrocortisone and 20mg of yohimbine, did not lead to statistically detectable changes to behavior in any of the social tasks. It did, however, manifest in lower opinions of the trustworthiness and fairness of other people, as well as a decrease in the value associated with helping other people, as measured through a visual analog scale survey. Given these initial results, we find preliminary evidence for a relationship between stress and anti-social behavior as revealed through lower beliefs on social standards, and we plan to extend the number of participants in the study to further investigate these results.

JEL codes: C91, C92, D7

Introduction

Conflict is an inherently unproductive activity and its occurrence is not fully understood. Why do some individuals choose to fight, while others abstain? This question is central to understanding why violence prevails in many social

This research is ongoing as we plan to extend the number of participants in the study. This preliminary paper serves the purpose of demonstrating the innovate methodology we implemented to identify the impacts of stress on social behavior. The laboratory experiments were planned and carried out by myself, Laura Ralston, and Johannes Haushofer. This version of the paper represents the initial analysis carried out by myself. I thank Catherine Ricciardi, the clinical nurse who assisted in this study, as well as her staff at the MIT Clinical Research Center. This project was made possible through financial support from the NIH and the Obie Schultz Fund. All errors are my own. Appendix available on request. Email: lralston@mit.edu

and economic settings. For example, what triggers civilians to participate in violent uprisings or to take up arms during civil wars, and what motivates criminals to offend or resort to violence? Recent work has found that both poverty [17] [8] [5] and previous exposure to violence or hostile behavior [18] [25] [19] can increase the probability that an individual will participate in violence or conflict. While little is known about the mechanism through which both these factors influence antisocial behavior, different schools of work have shown a link between poverty and stress [6] [7] [14] [13] [4], and between exposure to violence and stress [3] [20] [1] [16] [15] [11] [21] [10]. This paper aims to shed light on the relationship between stress and social interactions to elucidate whether this particular pathway can help explain violent behavior. Specifically, through the administration of cortisol and yohimbine we exogenously activate the hypothalamus-pituitary-adrenal axis (HPA) and noradrenergic (NA) system, both of which are implicated during a stress response, and then we measure the participants' behavior in a series of social and non-social tasks in a laboratory experiment.

The fight-or-flight response is generally regarded as the prototypic human response to stress. For example, a biological response to stress is an increase in blood sugar levels as well as an increase heart rate and elevated blood pressure. This response would seem to prepare us for an increased tendency towards aggressive or reactionary behavior, at least for instrumental purposes, to ensure that we put priority on our own survival and well being ahead of that of others. While this explanation of the manifestation of aggressive behavior seems plausible, there is actually very little evidence of how stress pervades social interactions particularly from a causal perspective. Put differently, although aggressive behavior is commonly associated with stressful confrontations, it is unclear whether aggression is caused by stress or whether aggressive interactions provoke stress. By exogenously manipulating the stress levels of participants and then having participants play interactive games, we are able to address whether stress does in fact facilitate aggressive or antisocial behavior. Simultaneously, we are also able to address an emerging alternative hypothesis that suggests that stress may instead strengthen social relationships as humans try to improve social networks that may be beneficial in situations of stress [29] [27].

Exposure to stress activates two biological systems: the rapidly acting autonomic sympathetic nervous system (ANS) and the slower hypothalamic-pituitary-adrenal (HPA) axis. The activation of these systems leads, respectively, to a rapid release of the catecholamines adrenaline and noradrenaline by the adrenal medulla, followed by a somewhat slower release of glucocorticoids (cortisol in humans) by the adrenal cortex. Via the release of cortisol and noradrenaline, stress affects many brain areas that are important in cognitive functioning, such as the prefrontal cortex, amygdala and hippocampus. In this study, we activate the NA and HPA systems of healthy male adults with the α2-adrenoceptor antagonist yohimbine and the synthetic glucocorticoid hydrocortisone, respectively, and examine their separate and combined effects on several aspects of behavior: trust, trustworthiness, expectations of trustworthiness, willingness to share, willingness to punish, expectations of willingness to punish, generosity, inequity aversion, risk tolerance and patience. These behavioral outcomes are monitored through the actions the participants choose in standard versions of the Trust, Ultimatum and Dictator Games, as well as a lottery game to measure risk preferences and a task that reveals time preferences. We collect saliva samples, for assaying cortisol and alpha-amylase (a biomarker for the adrenergic system), throughout the experiment to measure the participants response to the oral administration of yohimbine and hydrocortisone and to check for any basal differences among participants.

By stimulating both the NA and HPA systems simultaneously as well as in isolation we are addtionally able to investigate whether any changes in social behavior rely on the co-occurrence of glucocoticoids (mainly cortisol in humans) and noradrenergic activity, or if activation of one system is more important than the other. Previous studies have found that behavioral outcomes can depend on whether both systems are activated, rather than just one. For example, the stress effects on the ability to remember words, pictures and statements (declarative memory) and the shift of instrumental behavior from goal-directed to habitual control necessitate co-activation of both systems [23] [22] [30] [24]. Other work, however, has found that hydrocortisone on its own has a fear-reducing effect [26] [2], while yohimbine is associated with greater panic symptoms that lead to less attention to threats [28]. Either of these latter effects could plausibly lower participants' loss-aversion and this may result in changes to their behavior in the social games. Given this, we test for the effects of stimulating each system in isolation as well as their joint stimulation.

Methods

Participants

Healthy males between the ages of 18-40 years were recruited to participate in the study that took place at the MIT Behavioral Research Lab between the March - May 2012. The participants received a flat fee of $50 and could earn up to an additional $60 in the social games and non-social tasks. Exclusion criteria required that the participants were not a psychology or economics major, weighed no more than 190 lbs, did not smoke more than 5 cigarettes per day on average, nor drink more than 1 bottle of wine or 2 pints of beer per day on average, nor consume cannabis or other drugs, did not take regular medications, did not have a history of psychiatric disorder and had not recently been under severe stress. We also required that participants did not consume alcohol or coffee, or engage in sexual activity for the 24 hours before the study, and we asked participants not to eat or drink anything apart from water and not to engage in strenuous physical activity in the 2 hours before the study. These criteria were made clear when participants signed up for the study and we reminded the participants of the restrictions on food and drink 2 days before they were due to present themselves for the study. This resulted in a sample of 105 healthy male adults, who were randomly assigned to four different conditions: yohimbine only (Y), hydrocortisone only (H), yohimbine and hydrocortisone (Y+H) and placebo (P). Of these participants, 4 have been excluded from analyses because they did not fully understand the games (1 participant), they appeared to be under the influence of recreational drugs (1 participant), they had baseline cortisol above 30 nmol/l (1 participant) or they attended two study sessions (1 participant). The final subsample size of the respective groups was: 25, 25, 25, 26. For the first 9 participants we piloted the study and these participants did not play the Ultimatum or Dictator Games, but did complete all the other tasks.

In general the subsamples showed similar demographic and income measures (see table 1). The characteristics upon which the treatment subsamples varied relative to the placebo subsample were: age, weight, whether they had any siblings, whether they were a student, and their political leaning.[1] The participants in the Y and H subsamples were slightly younger (24.8 and 24.3, respectively, vs. 27.8 in the P subsample), more likely to be a student (68% and 64%, respectively, vs. 35%) and held more liberal views (2.44 and 2.36, respectively, vs. 3.19). Participants in the Y subsample were on average heavier as well (167.4 lb vs. 155.3 lb). We also collected psychometric measures at the start of the experiment for all the participants (see table 2 and appendix table 1). Based on a Visual Analog Scale (VAS), where the participants were asked to mark on a 10 cm horizontal line their level of agreement between total disagreement to complete agreement to a series of reflective statements, we obtained measures of how the participant regarded themself as well as other people. In response to the statement "I am a very trustworthy person" we found that participants in the Y+H subsample had a lower opinion of themselves (78.8 vs. 87.0), and to the statement, "It is more important to think of oneself than others" we found participants in the H subsample

[1] Of these characteristics, only whether they were a student or had any siblings (0.05 significance level), and their political leaning (0.10 significance level), varied across all the subsamples according to an F-test.

disagreed more strongly (39.2 vs 51.8) (see table 2). We also asked the participants to rate their perceived level of negative emotion (distress, upset, guilty, ashamed, hostile, irritable, nervous, jittery, scared, afraid) using a 7-point Positive and Negative Affect Scale (PANAS) and this did not reveal any significant differences between the subsamples at the start of the experiment (see appendix table 1).

Given these variations in demographic characteristics and personal views, we present results that include controls for age, weight, student status, having any siblings, political leaning and each participant's initial VAS scores for "trustworthiness" and "selfishness" based on the statements, "I am a very trustworthy person" and "It is more important to think of oneself than others", respectively.

Social and non-social tasks

The participants were asked to play in 3 social games: the Trust Game, the Ultimatum Game, and the Dictator Game, and to respond to questions during tasks that elicited both their time and risk preferences. All the games and tasks were carried out on computers using the zTree software. [9]

The **Trust Game** asked the participants whether or not they would like to send $4 to another player. If they chose to send $4, they were informed that the other player would receive triple the amount they sent, that is $12. This other player could choose to send any integer amount between $0-$12 back to them. We used this game to obtain a measure of trust for the sending player and a measure of trustworthiness for the receiving player. The response for the receiving player was elicited using the strategy method so we asked all receiving players what they would do if they received $12, regardless of whether or not the social interaction led them to this scenario. In addition, we asked the sending players to tell us what they expected their partner to return to provide us with a secondary measure of trust. The participants played the Trust Game twice: once as a sender and once as a receiver. For all the interactive games we told the participants that they would be randomly matched to partners, they would not remain with the same partner for more than one iteration of a game or across games, and we provided no feedback on their performance or their partners' actions until the very end of the experiment. This was to minimize any type of reputation or learning effects on their behavior, and so that their behavior could not be influenced by how their partners were playing.

The **Ultimatum Game** again involved a sender and receiver role, which each participant played once each, but in this case the sender chose how much of $10 they would like to offer to the receiver. For example, they could choose to send $4 and keep $6 for themself.[2] The receiver, however, was able to veto any offer they were unsatisfied with and force both players to receive zero.[3] We used this game to measure the participants willingness to share and to punish as well as their inequity aversion. We also asked the sender what was the minimum amount they thought their partner would accept to measure expectations of the willingness to punish.

The **Dictator Game** involved only one active role, the sender, although the players were randomly matched to receivers for the purpose to calculating payoffs. The sender chose how much of $10 they would like to offer to the receiver, who was not allowed to refuse their offer. For example, if the sender chose to keep $10 for themself there was nothing the receiver could do about this. We used this game to measure generosity and inequity aversion. We also asked the sender how much they thought other players were likely to send to measure expectations of generosity.

In the **Time Preference Task** the participants were asked a series of 18 questions soliciting their preference between two payments at different points in time. In the first six questions the payments could be made on the day of the experiment or in 6 months, in the next six questions the payments could be made on the day of the experiment or in 12 months, and in the last 6 questions the payments were either in 6 months or 12 months. This enabled us to calculate indifference points for each of the participants for payments made at six month intervals and calculate both the rate at which participants discounted future outcomes (δ) and their level of present bias (β), according to Laibson's quasi-hyperbolic discounting model.[4] [12]

In the **Risk Preference Task** we offered the participants a choice between a relatively "safe" lottery, where the possible payments were $2 and $1.75, and a more "risky" lottery, where the possible payments were $4 and $0.25. We offered the choice of lotteries with increasingly better odds (from p=0.1 to p=1) of obtaining the higher payment in each lottery so that we could observe the point at which each participant was willing to take the more risky lottery and calculate their risk index.

Procedure

The experiment sessions lasted between 2-2.5 hours and were scheduled between 12 noon to 8 pm in order to control for diurnal variations in cortisol secretion. Each session included between 4 - 12 participants. On arrival at

[2] We only allowed splits by whole integer amounts.

[3] We elicited this decision through the strategy method, by asking for each possible split ($10/$0, $9/$1,...,$0/$10) whether the receiver would accept an offer.

[4] For example, the value of a income stream x is valued as $U(x) = x + \beta\delta x + \beta\delta^2 x + \beta\delta^3 x + \ldots$

laboratory the participants were seated at separate computer desks with partitions and were not allowed to communicate with each other, use their cell phones or read personal material. Once seated at the desks, the participants were asked to read and sign their consent forms. Individually we called participants to be screened by a clinical nurse before administering any drugs. When all the participants for a session had arrived we took an initial salivary sample. While the participants were waiting to be screened, we had them read instructions and complete a set of practice questions on the social and non-social tasks. We immediately checked all the practice questions and explained mistakes that participants had made to ensure they had a full comprehension of the tasks before they attempted them.

Once all the participants had been screened, at about 30 minutes after their arrival time, we took another saliva sample and had them fill in a short questionnaire on their current level of negative emotions using the 7-point Positive and Negative Affect Scale and their view of themself and others using the visual analogue scale. We then administered the treatment drugs. Each participant received two tablets which either contained: 20mg yohimbine and one placebo, 60mg hydrocortisone and one placebo, 20mg yohimbine and 60mg hydrocortisone, or two placebo. The placebo tablets contained lactose and all the tablets looked identical. We then waited for 50 minutes before starting the tasks so that the drugs could take affect. During this time we handed out neutral reading material (National Geographic, March 2012) and 30 minutes after administering the drugs we took a third saliva sample. At 50 minutes, we took a fourth saliva sample and had them complete a second questionnaire of the same content as the first to assess any changes in those psychometric measures. Then we started them on the social and non-social tasks. The order of tasks was: time preference task, risk preference task, trust game, ultimatum game, dictator game. Once all the tasks were finished, the participants completed the a demographic survey and provided a fifth saliva sample. Participants were then called individually for payment and an exit health screening, before leaving the laboratory.

Endocrine stress responses

Saliva samples, for assaying cortisol and alpha-amylase levels, were collected using a commercially available sampling device (Salivette, Sarstedt, Numbrecht, Germany). Saliva collection took place at five time points: initial (-30 minutes), baseline (-1 minutes), and then at +30, +50 and +70 minutes. After each experimental session, samples were stored at -20 C until they were biochemically analysed.

Psychological stress responses and psychometric measures

To measure subjectively perceived levels of stress, we gave participants a visual analogue scale at baseline (-1 minutes) and just before the social and non-social tasks (+50 minutes). At these time points we also elicited their level of negative emotions using the 7-point Positive and Negative Affect Scale and their view of themself and others using the visual analogue scale (see appendix figures), as was discussed earlier.

Results

First Stage Results

The H and Y+H subsamples experienced a substantial increase (+371 nmol/l, SE=43.5 nmol/l, p<0.01) in their salivary cortisol levels that peaked at +50 minutes, just before they undertook the social and non-social tasks, (see figure 1 and table 4). The Y and Y+H subsamples experienced increases to salivary alpha-amylase by +50 minutes (+52 u/ml, SE=13.3 u/ml, p<0.01), although this biomarker looks to have continued rising between +50 to +70 minutes, while the tasks were being completed (see figure 2 and table 5). Interestingly, baseline alpha-amylase is negatively correlated with changes to cortisol, suggesting that participants with higher baseline noradrenergic activity were slightly less susceptible to increased HPA system activity. The Y subsample had a higher initial level of alpha-amylase (see figure 2), although this difference was not signifcant and did not affect the increase in alpha-amylase induced by exogenous administration of yohimbine.

Figure 3 demonstrates that subjects were not able to correctly guess which drug they had been administered.

Trust Game

The results from the Trust Game indicate that the participants in the Y subsample may have been more willing to trust other people. The participants from this subsample were 25% more likely to send $4 (SE=12 p.p., p<0.05, see table 6) but this result is only significant under the full set of controls. Further sensitivity analysis on this result showed that it depended on controlling for initial levels of trustworthiness as recorded through the visual analog scale, which was itself positively correlated with sending $4, as would be expected. Once this control is included in the regression, we find that participants from the Y subsample were significantly more likely to send $4 to their partners.

There is also weak evidence that the Y+H subsample showed a significantly lower level of trustworthiness (returned \$1.08 less, SE=0.67, $p<0.10$, see figures 4 and 5, and table 6). However, once the control for the initial level of trustworthiness is included the Y+H subsample no longer show any discernible differences in the amount they were willing to return in the Trust Game.

In addition, we find that higher baseline alpha-amylase is significantly negatively correlated with both the measure of trust and trustworthiness ($p<0.05$), while higher baseline cortisol is significantly negatively correlated with the measure of trust ($p<0.05$). These findings are consistent with two threads of previous research. First, that exposure to violence can elevate baseline indicators for stress, such as salivary cortisol, and second, that exposure to violence can increase hostile behavior. Thus, while not helping us unravel the causality of the relationship, these results provide further indications of the correlation between stress and antisocial behavior, as measured through reductions in trust and trustworthiness.

Ultimatum Game

We find very limited evidence for behavioral differences across the drug conditions in the Ultimatum Game. The coefficient estimates from the regression analysis suggest that the H subsample may have been more willing to punish (15-17% more likely to refuse offers below \$5) but these results were not significant (see figures 6 and 7, and table 7). Measures of the time it took participants to make decisions suggest that the Y subsample took less time to decide how much to accept, perhaps suggesting they were less concerned by their outcome which would be consistent with lower attention to threat and reduced loss aversion (see table 9).

Dictator Game

Again, we find limited evidence for behavioral differences across the drug conditions in the Dictator Game. Based on the sign of the coefficient estimates, there is some indication that the Y+H subsample were less generous, expected others to be less generous (gave \$0.69 less, and expected others to give \$0.49 less) and took a longer time to decide how much to give (7.1 seconds, SE=4.2, $p<0.10$), but the results for the actions were not significant (see figure 8, and tables 8 and 9). The H subsample, however, had a higher expectation of the generosity of others when the full set of controls are included (\$1.08, SE=0.61, $p<0.10$).

Risk Preferences

There were no differences in risk preferences between the drug conditions (see figures 9-11 and table 10).

Time Preferences

There were no differences in time preferences between the drug conditions (see figures 12-14 and table 11). There were, however, concerns over the participants internal inconsistency, since their revealed preferences in this specific task were not constant. For example, we started each series of 6 questions by asking whether they would prefer $15 at an earlier time point or $30 at a later time point and re-asked this question at the end of the series. A high proportion of participants (34-45%) gave different responses to these identical questions.

VAS Post surveys

The visual analog scale post survey at +50 minutes revealed that Y+H subsample felt more stressed (6.94, SE=3.67, p<0.10), less trust towards others (-6,57, SE=3.77, p<0.10), less willing to help others (-6.29, SE=2.67, p<0.05), that other people were less fair (-5.18, SE=2.90, p<0.10), and were less likely to return a lost wallet (5.33, SE=3.12, p<0.10). These results were robust to controlling for the participants initial VAS scores and the full set of controls. The VAS score on personal fairness for the H subsample was also lower (-7.18, SE=3.16, p<0.05).

However, in contrast to the findings from the Trust Game, the VAS post survey scores show that trusting others and being trustworthy was postively correlated with baseline cortisol, indicating that when asked to self-report individuals with higher levels of baseline cortisol thought they were more trustworthy and willing to trust others.

Discussion

Our preliminary findings suggest mixed results. There is some indication that the exogenous stimulation of the NA system or the exogneous stimulation of the HPA axis in isolation may encourage more pro-social behavior, as our initial results found that the participants given 20mg yohimbine showed an increase in trustworthiness in the Trust Game, while participants given 60mg of hydrocortisone anticipated greater generosity in the Dictator Game. However, these results were sensitive to the regression specification and are unlikely to be robust if we adjust our p-values to take into consideration the multiple inferences explored in the study. Given this, we are keen to verify these findings by extending the number of participants in the study.

The concurrent stimulation of both systems, our primary method for simulating the biological response to stress, did not reveal any robust changes to behavior in any of the social or non-social tasks. It did, however, manifest in lower opinions of the trustworthiness and fairness of other people, as well as a decrease in the value associated with helping other people, as measured through the VAS post-survey. At the same time, within our sample of participants, those with higher levels of baseline cortisol were less trusting in the Trust Game, although they consider themselves more trusting in the self-reported survey measures, and those with higher levels of alpha-amylase were both less trusting and less trustworthy, in the Trust Game, and did not consider themselves more or less trusting or trustworthy in the self-reported survey measures.

In contrast to our proposed hypothesis, the exogenous stimulation of the two biological systems associated with stress did not lead to any statistically detectable increases in anti-social behavior in the interactive tasks, nor did it affect risk or time preferences. It did, however, lead to lower self-reported opinions of the trustworthiness and fairness of other people, and of the value associated with helping other people. Higher baseline cortisol was also associated with greater distrust in other people in the Trust Game, even though these participants did not self-identify a lower willingness to trust others in the self-reported survey measures. Given these initial results, we wish to further explore the relationship between stress and anti-social behavior, and we plan to extend the number of participants in the study to further investigate these results.

Appendix available on request. Email: lralston@mit.edu

Tables

Table 1: Summary Statistics - Demographic and Income Data

	Y	H	Y+H	Placebo
age	24.8*	24.3**	25.9	27.8
	(1.07)	(1.08)	(1.23)	(1.24)
weight	167.4**	160.3	157.9	155.3
	(3.38)	(3.11)	(4.01)	(4.23)
black	0.12	0.12	0.16	0.23
	(0.07)	(0.07)	(0.07)	(0.08)
disposable income ($ per month after bills)	476.8	390.4	479.2	439.8
	(77.17)	(129.13)	(122.36)	(85.10)
are you currently in debt?	0.40	0.52	0.44	0.54
	(0.10)	(0.10)	(0.10)	(0.10)
how much do you donate per year? ($)	67.5	77.6	134.5	102.5
	(23.16)	(23.89)	(51.74)	(43.66)
do you have any siblings?	0.80	0.96	0.80	1.00
	(0.08)*	(0.04)	(0.08)*	(0.00)
what is your parents' annual income?	218,100	169,100	88,100	103,000
	(117,100)	(45,800)	(10,900)	(21,500)
are you a student?	0.68**	0.64**	0.40	0.35
	(0.10)	(0.10)	(0.10)	(0.10)
how important is religion is your life? (1=not at all, 7=veryimportant)	2.80	3.08	3.12	3.96
	(0.42)	(0.39)	(0.47)	(0.40)
how liberal/conservative are you? (1=very liberal, 7=very conservative)	2.44*	2.36*	3.28	3.19
	(0.26)	(0.29)	(0.32)	(0.36)
smoker	0.20	0.08	0.12	0.23
	(0.08)	(0.06)	(0.07)	(0.08)
N	25	25	25	26

Table 2: Summary Statistics - Pre-Treatment VAS scores

	Y	H	Y+H	Placebo
(0=don't agree at all, 100=completely agree)				
stressed	10.9	11.7	12.6	13.8
	(2.47)	(3.19)	(2.79)	(3.76)
punishment	42.3	45.9	55.0	53.3
	(4.14)	(4.45)	(4.11)	(5.60)
otherstrust	60.5	55.5	56.3	59.5
	(3.35)	(4.16)	(4.25)	(3.97)
metrust	82.2	82.9	78.8*	87.0
	(1.94)	(3.76)	(4.17)	(2.38)
othersgenerous	50.7	48.6	44.8	50.0
	(3.88)	(3.40)	(4.69)	(3.85)
megenerous	64.5	68.7	68.3	71.8
	(5.63)	(4.65)	(4.18)	(4.32)
othersfair	54.0	54.4	54.3	52.0
	(4.68)	(3.72)	(4.97)	(4.89)
mefair	72.8	79.1	79.7	80.0
	(4.42)	(3.14)	(3.61)	(2.78)
help	86.7	86.1	83.2	84.9
	(2.61)	(3.50)	(4.04)	(3.48)
share	73.4	81.6	71.3	78.2
	(4.65)	(3.37)	(5.08)	(3.65)
selfish	46.2	39.2*	50.7	51.8
	(4.96)	(4.18)	(4.13)	(5.82)
wallet_trust	20.0	13.8	29.7	21.6
	(4.57)	(4.42)	(5.99)	(4.10)
N	25	25	25	26

Note: The following questions were asked to obtain measures for each outcome. "stressed" - *In this moment, I feel stressed*; "punishment" - *People who break the rules of society should face severe consequences*; "otherstrust" - *People can generally be trusted*; "metrust" - *I am a trustworthy person*; "othersgenerous" - *Most people are generous*; "megenerous" - *I am a generous person*; "othersfair" - *Most people are fair*; "mefair" - *I am a fair person*; "help" - *It is important to help others who have helped me*; "share" - *It is important to share what we have with others*; "selfish" - *It is more important to think of oneself than others*; "wallet" - *If I find a wallet on the street, it's ok to keep it*.

Table 3: Summary Statistics for Cortisol and Amylase

	Y			H			Y+H			Placebo		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Cortisol t=4	7.0	1.7	17.0	402.6	42.5	982.7	376.6	3.7	1057.2	7.4	1.7	37.3
Cortisol Increase t=2-4	-2.9	-14.2	10.1	376.6	33.0	974.8	366.5	-6.6	1037.4	-1.0	-9.0	35.4
Amylase t=4	171.0	34.3	420.2	109.1	11.6	416.0	143.4	5.7	459.9	118.5	16.2	353.8
Amylase Increase t=2-4	50.9	-100.2	211.0	1.5	-60.5	124.6	57.0	-48.7	296.7	6.4	-112.4	175.8
Observations	25			25			25			26		

Note: cortisol measured in nmol/l and amylase in u/ml.

Table 4: First Stage - Cortisol

	induced cortisol nmol/l				cortisol change nmol/l			
cortisol_group	382.4	371.1			373.5	371.1		
	[41.5]***	[43.5]***			[40.8]***	[43.5]***		
Y+H			369.4	337.9			368.4	337.9
			[51.1]***	[54.5]***			[50.3]***	[54.5]***
H			395.4	403.3			378.5	403.3
			[51.1]***	[53.9]***			[50.3]***	[53.9]***
baseline cortisol nmol/l		0.8		0.7		-0.2		-0.3
		[0.6]		[0.6]		[0.6]		[0.6]
baseline amylase u/ml		-0.4		-0.4		-0.4		-0.4
		[0.2]*		[0.2]*		[0.2]*		[0.2]*
Constant	7.2	504.9	7.2	532.5	-1.9	504.9	-1.9	532.5
	[29.2]	[273.2]*	[29.3]	[274.5]*	[28.7]	[273.2]*	[28.9]	[274.5]*
R^2	0.46	0.58	0.46	0.58	0.46	0.56	0.46	0.57
N	101	92	101	92	101	92	101	92
Controls		X		X		X		X

Note: Y+H and H indicate treatment group and cortisol group indicates subject was in either Y+H or H treatment groups. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish.

Table 5: First Stage - Amylase

	induced amylase u/ml				amylase change u/ml			
amylase_group	43.6	51.9			49.9	51.9		
	[19.6]**	[13.3]***			[12.4]***	[13.3]***		
Y+H			29.5	62.1			53.0	62.1
			[24.3]	[16.7]***			[15.4]***	[16.7]***
Y			57.1	42.1			46.9	42.1
			[23.9]**	[16.4]**			[15.2]***	[16.4]**
baseline cortisol nmol/l		0.1		0.1		0.1		0.1
		[0.2]		[0.2]		[0.2]		[0.2]
baseline amylase u/ml		0.9		0.9		-0.1		-0.1
		[0.1]***		[0.1]***		[0.1]		[0.1]
Constant	113.9	-29.9	113.9	-47.5	4.0	-29.9	4.0	-47.5
	[13.7]***	[80.0]	[13.7]***	[81.8]	[8.7]	[80.0]	[8.7]	[81.8]
R^2	0.05	0.68	0.06	0.68	0.14	0.24	0.14	0.25
N	100	91	100	91	100	91	100	91
Controls		X		X		X		X

Note: Y+H and Y indicate treatment group and amylase group indicates subject was in either Y+H or Y treatment groups. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish.

Table 6: Reduced Form - Trust Game

	Sent $4		Amount Returned		Return Belief	
Y+H	-0.01	0.11	-1.13	-0.42	-0.55	-0.18
	[0.12]	[0.11]	[0.65]*	[0.59]	[0.66]	[0.67]
Y	0.11	0.25	-0.33	0.45	0.44	0.55
	[0.12]	[0.12]**	[0.65]	[0.61]	[0.67]	[0.69]
H	0.07	0.13	-0.17	0.15	0.10	0.40
	[0.12]	[0.11]	[0.65]	[0.60]	[0.66]	[0.67]
baseline cortisol nmol/l		-0.00		-0.00		-0.02
		[0.00]**		[0.01]		[0.01]**
baseline amylase u/ml		-0.00		-0.01		-0.01
		[0.00]***		[0.00]***		[0.00]**
Constant	0.73	-0.01	4.69	-2.22	4.38	1.02
	[0.08]***	[0.50]	[0.45]***	[2.66]	[0.46]***	[2.98]
R^2	0.01	0.32	0.04	0.33	0.02	0.22
N	101	92	101	92	92	92
Controls		X		X		X

Note: Y+H, Y and H indicate treatment group. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish. Liberal/conservative index has a significant negative coefficient, while trustworthiness has a significant positive coefficient for all outcomes.

Table 7: Reduced Form - Ultimatum Game

	Offer at least $5		Only accept at least $5		Accept Belief	
Y+H	0.03	0.08	0.05	0.07	-0.36	-0.26
	[0.13]	[0.15]	[0.13]	[0.12]	[0.42]	[0.44]
Y	0.03	0.10	0.01	-0.05	-0.38	-0.18
	[0.13]	[0.15]	[0.13]	[0.13]	[0.42]	[0.45]
H	0.11	0.15	0.17	0.15	-0.57	-0.49
	[0.13]	[0.15]	[0.13]	[0.12]	[0.42]	[0.44]
baseline cortisol nmol/l		0.00		0.00		0.00
		[0.00]		[0.00]		[0.00]
baseline amylase u/ml		-0.00		-0.00		-0.00
		[0.00]		[0.00]		[0.00]
Constant	0.65	0.98	0.23	-0.66	3.79	1.48
	[0.09]***	[0.66]	[0.09]**	[0.55]	[0.29]***	[1.96]
R^2	0.01	0.14	0.02	0.20	0.02	0.15
N	101	92	101	92	92	92
Controls		X		X		X

Note: Y+H, Y and H indicate treatment group. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish. Trustworthiness has a significant positive coefficient for all outcomes.

Table 8: Reduced Form - Dictator Game

	Dictate		Give at least $5		Dictate Belief	
Y+H	-1.10	-0.69	-0.10	-0.09	-0.78	-0.49
	[0.73]	[0.75]	[0.14]	[0.15]	[0.58]	[0.61]
Y	0.75	1.21	0.06	0.07	0.24	0.77
	[0.73]	[0.77]	[0.14]	[0.15]	[0.59]	[0.63]
H	0.08	0.29	0.14	0.14	0.53	1.08
	[0.73]	[0.76]	[0.14]	[0.15]	[0.58]	[0.61]*
baseline cortisol nmol/l		0.00		0.00		-0.01
		[0.01]		[0.00]		[0.01]
baseline amylase u/ml		-0.00		-0.00		0.00
		[0.00]		[0.00]		[0.00]
Constant	2.75	-2.90	0.38	-0.19	2.17	-1.09
	[0.51]***	[3.36]	[0.10]***	[0.67]	[0.41]***	[2.73]
R^2	0.07	0.22	0.03	0.13	0.06	0.19
N	92	92	101	92	92	92
Controls		X		X		X

Note: Y+H, Y and H indicate treatment group. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish. Trustworthiness has a significant positive coefficient for the "Dictate" outcomes.

Table 9: Reduced Form - Contemplation Times during Social Games

	Trust decisions				Ultimatum decisions				Dictator decision	
	send		return		offer		accept		give	
Y+H	2.21	2.38	-0.80	-2.18	-0.45	-0.88	-1.08	-1.44	8.19	7.13
	[2.11]	[2.49]	[2.23]	[2.52]	[1.50]	[1.60]	[1.06]	[1.10]	[4.00]**	[4.29]
Y	2.85	2.75	-1.76	-3.87	3.20	1.50	-2.53	-3.52	2.86	0.20
	[2.11]	[2.56]	[2.23]	[2.59]	[1.52]**	[1.64]	[1.07]**	[1.13]***	[4.05]	[4.41]
H	3.49	4.11	1.36	-0.31	2.55	1.40	-0.90	-1.66	7.67	6.01
	[2.11]	[2.51]	[2.23]	[2.54]	[1.50]*	[1.61]	[1.06]	[1.11]	[4.00]*	[4.31]
baseline cortisol nmol/l		-0.04		-0.01		0.00		0.01		0.01
		[0.02]		[0.02]		[0.01]		[0.01]		[0.04]
baseline amylase u/ml		0.01		-0.00		-0.01		-0.00		-0.02
		[0.01]		[0.01]		[0.01]		[0.00]		[0.02]
Constant	49.27	46.93	45.88	43.01	51.75	45.12	58.21	48.03	45.42	31.30
	[1.48]***	[11.15]***	[1.56]***	[11.28]***	[1.05]***	[7.14]***	[0.74]***	[4.92]***	[2.80]***	[19.19]
R^2	0.03	0.08	0.02	0.15	0.09	0.19	0.06	0.20	0.06	0.15
N	101	92	101	92	92	92	92	92	92	92
Controls		X		X		X		X		X

Note: Y+H, Y and H indicate treatment group. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish.

Table 10: Reduced Form - Risk Preferences

	Risk Averse Indicator		Risk Averse Index	
Y+H	-0.02	0.18	-0.18	-0.02
	[0.14]	[0.16]	[0.20]	[0.23]
Y	-0.10	0.07	-0.05	-0.08
	[0.14]	[0.16]	[0.20]	[0.22]
H	0.02	0.19	0.00	0.12
	[0.14]	[0.16]	[0.20]	[0.21]
baseline cortisol nmol/l		-0.00		-0.00
		[0.00]		[0.00]
baseline amylase u/ml		0.00		0.00
		[0.00]		[0.00]
Constant	0.50	0.16	0.43	-0.32
	[0.10]***	[0.71]	[0.14]***	[0.94]
R^2	0.01	0.10	0.01	0.09
N	101	92	83	77
Consistent		X		X

Note: Y+H, Y and H indicate treatment group. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish.

Table 11: Reduced Form - Time Preferences

	Beta		Delta	
Y+H	0.09	0.14	-0.05	-0.13
	[0.13]	[0.15]	[0.09]	[0.09]
Y	-0.08	-0.06	-0.01	-0.01
	[0.13]	[0.16]	[0.09]	[0.10]
H	0.14	0.19	-0.11	-0.14
	[0.13]	[0.15]	[0.09]	[0.09]
baseline cortisol nmol/l		0.00		-0.00
		[0.00]		[0.00]
baseline amylase u/ml		0.00		-0.00
		[0.00]		[0.00]
Constant	0.69	-0.01	0.67	1.39
	[0.09]***	[0.68]	[0.06]***	[0.42]***
R^2	0.03	0.06	0.02	0.15
N	101	92	101	92
Consistent		X		X

Note: Y+H, Y and H indicate treatment group. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish.

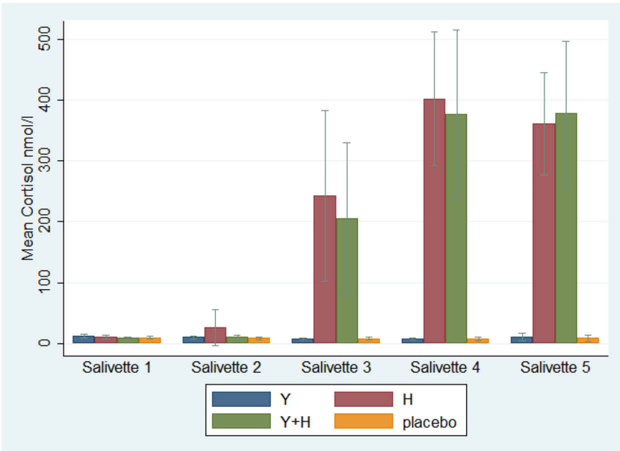
Table 12: Reduced Form - VAS post surveys

	Stressed		Trust Others		Trustworthy		Others Fair		Fair		Help		Wallet	
Y+H	6.94	6.31	-6.57	-7.07	-1.94	-1.66	-5.77	-6.40	-5.18	-5.15	-6.29	-4.89	5.33	5.07
	[3.67]*	[4.29]	[3.77]*	[4.01]*	[2.79]	[3.02]	[3.21]*	[3.47]*	[2.90]*	[3.26]	[2.67]**	[2.92]*	[3.12]*	[3.36]
Y	2.70	1.82	-0.52	0.61	-0.54	-0.84	0.32	0.83	-2.96	-1.98	1.38	3.93	1.25	1.31
	[3.67]	[4.33]	[3.80]	[4.07]	[2.79]	[3.05]	[3.24]	[3.52]	[2.97]	[3.23]	[2.71]	[2.95]	[3.13]	[3.38]
H	4.63	4.27	-0.78	-1.22	-3.69	-4.77	-3.40	-3.43	-7.44	-7.18	-1.23	0.26	2.21	2.11
	[3.67]	[4.22]	[3.77]	[3.93]	[2.75]	[2.98]	[3.21]	[3.43]	[2.90]**	[3.16]**	[2.67]	[2.86]	[3.12]	[3.34]
baseline cortisol nmol/l		-0.02		0.09		0.05		0.04		0.04		0.01		0.00
		[0.04]		[0.04]**		[0.03]*		[0.03]		[0.03]		[0.03]		[0.03]
baseline amylase u/ml		0.01		0.01		0.01		0.01		-0.00		0.02		-0.02
		[0.02]		[0.02]		[0.01]		[0.01]		[0.01]		[0.01]*		[0.01]
Constant	0.97	27.70	10.27	26.70	20.79	13.59	13.68	20.90	15.16	11.54	12.05	6.00	-1.55	9.36
	[2.87]	[19.41]	[5.05]**	[17.84]	[5.99]***	[13.50]	[3.72]***	[15.43]	[5.41]***	[14.30]	[5.27]**	[12.91]	[2.42]	[15.45]
R^2	0.49	0.53	0.63	0.68	0.63	0.65	0.73	0.76	0.70	0.72	0.73	0.76	0.84	0.85
N	99	91	91	91	91	91	91	91	91	91	91	91	91	91
Controls		X		X		X		X		X		X		

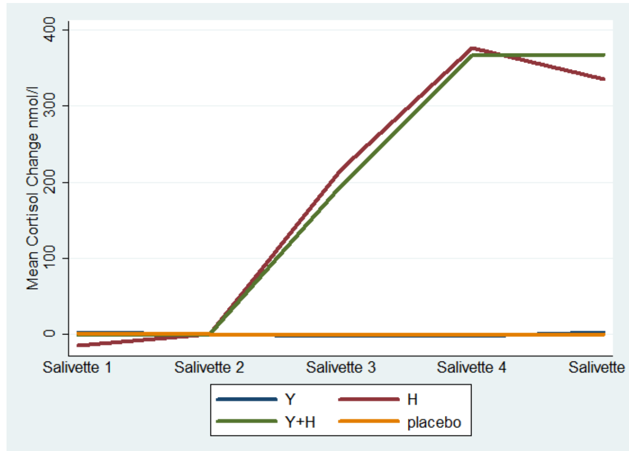
Note: Y+H, Y and H indicate treatment group. Controls include: age, weight, student, having siblings, liberal/conservative index and the VAS scores for trustworthiness and selfish. The corresponding pre-VAS score is always included. Only the results on outcomes that had significant (or close to significant) estimates have been shown.

Figures

Salivette Analysis

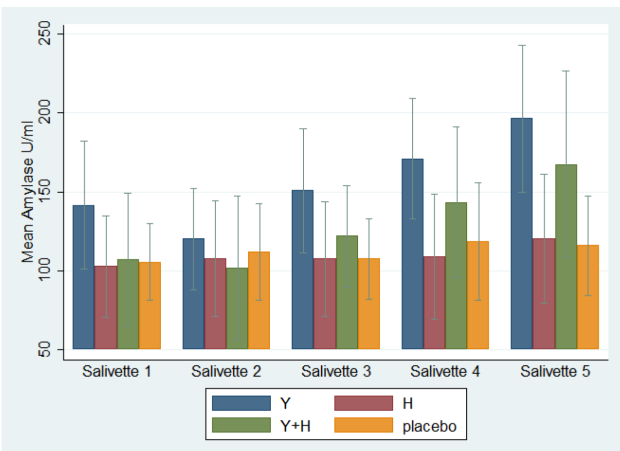


(a) Levels

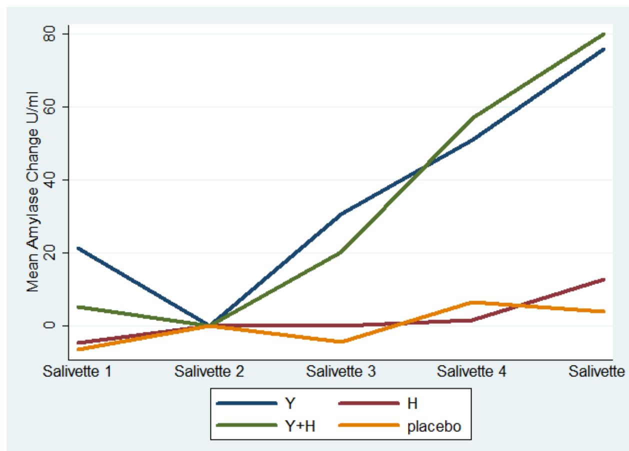


(b) Changes

Figure 1: Cortisol Levels and Changes



(a) Levels



(b) Changes

Figure 2: Amylase Levels and Changes

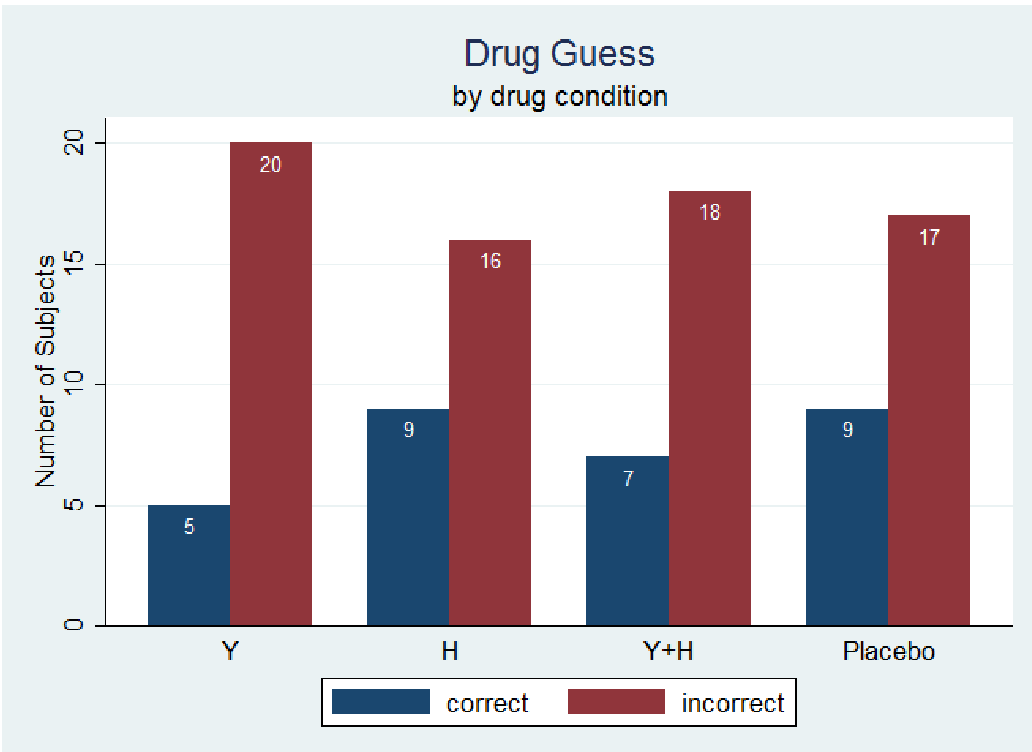
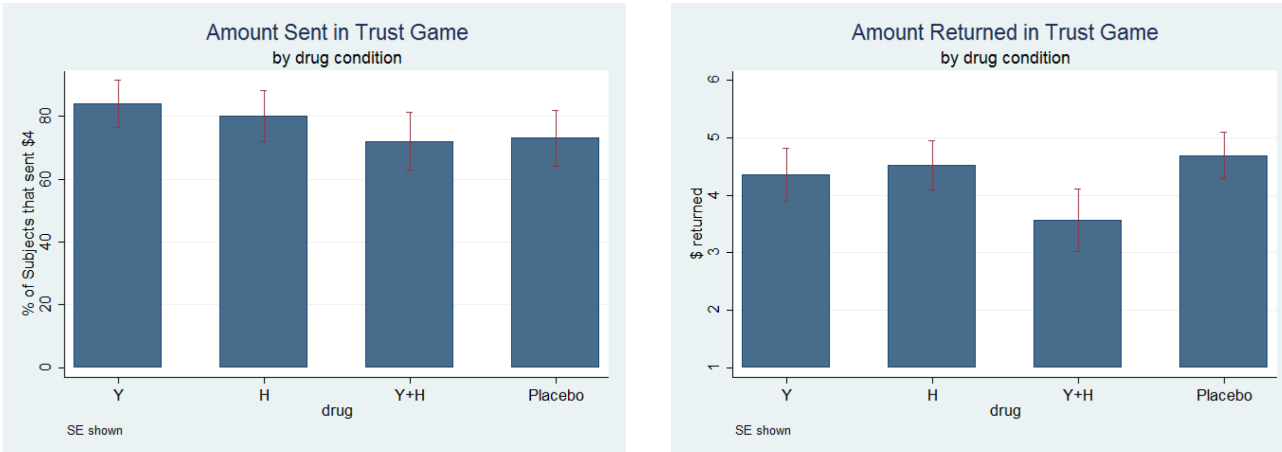


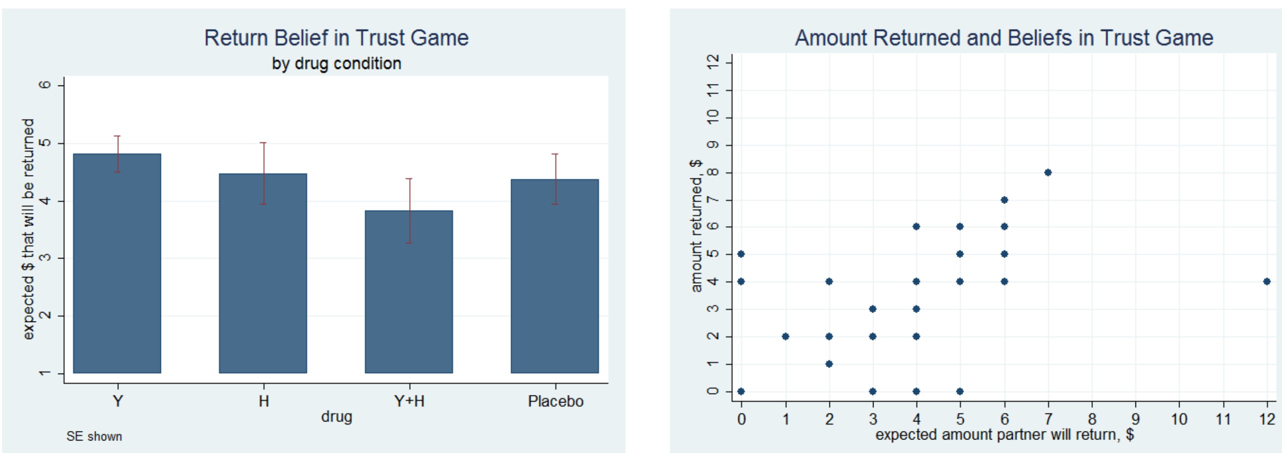
Figure 3: Drug Guess

Social Games Analysis



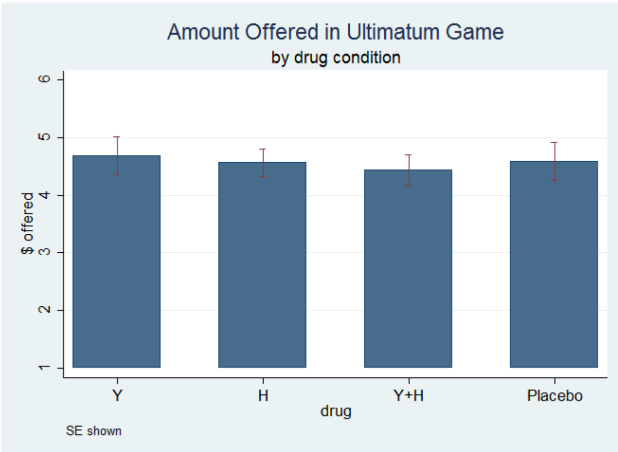
(a) (b)

Figure 4: Trust Game - Amount Sent and Returned

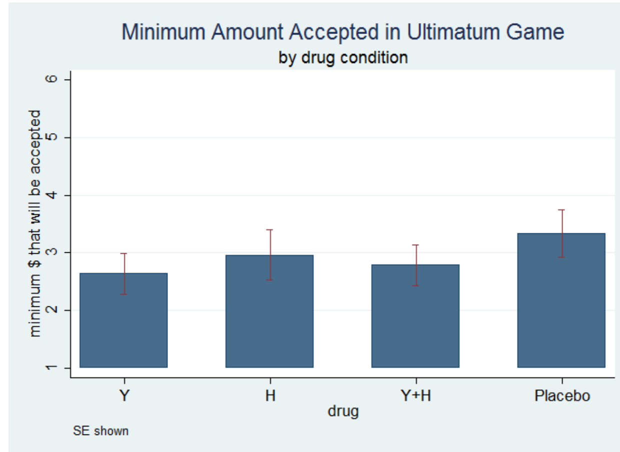


(a) (b)

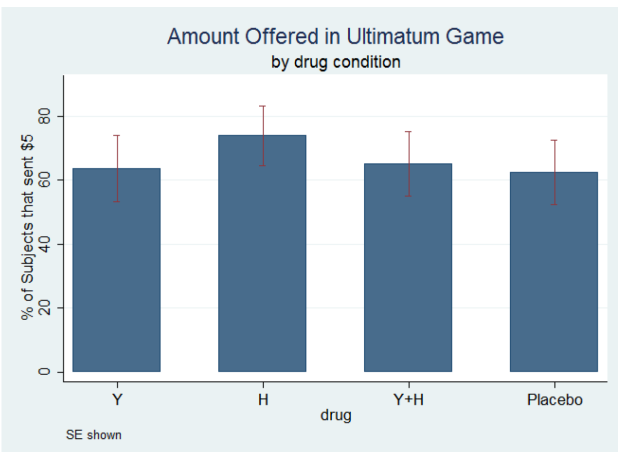
Figure 5: Trust Game - Beliefs



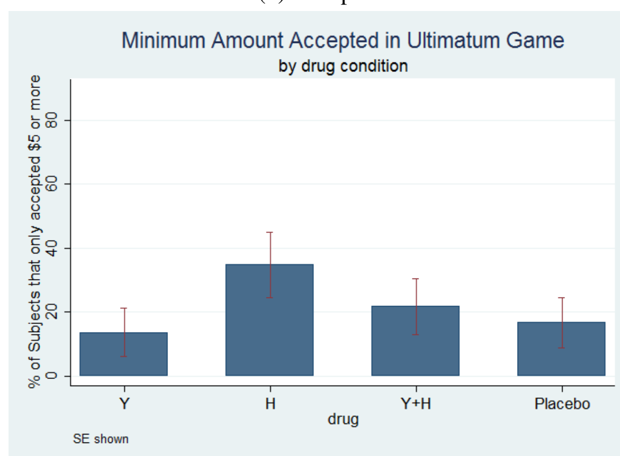
(a) Offered



(b) Accepted

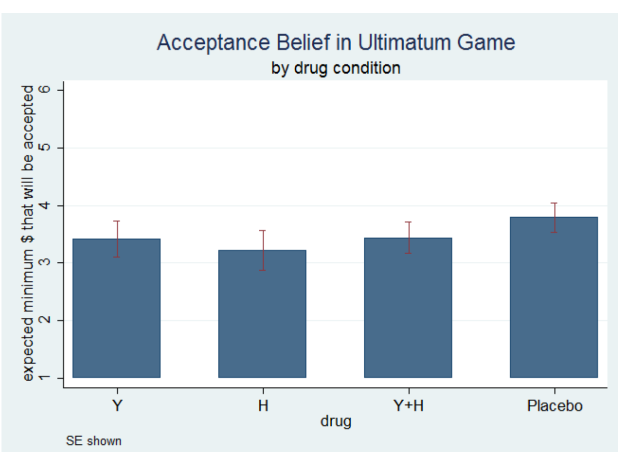


(c) Offered

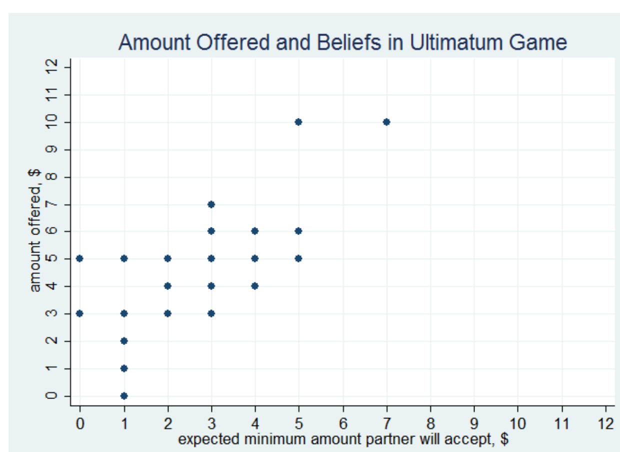


(d) Accepted

Figure 6: Ultimatum Game - Amount Offered and Accepted

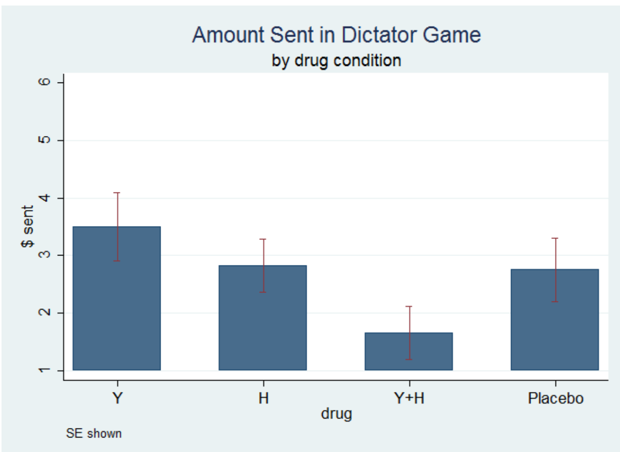


(a)

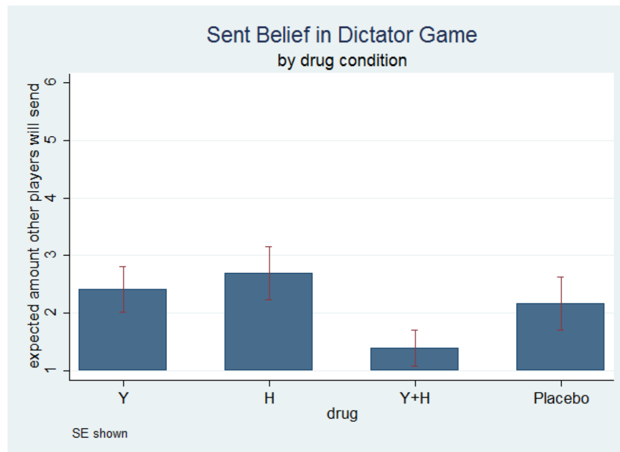


(b)

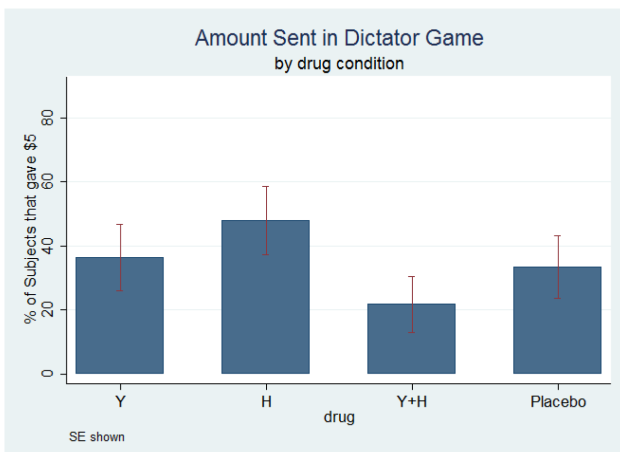
Figure 7: Ultimatum Game - Beliefs



(a)



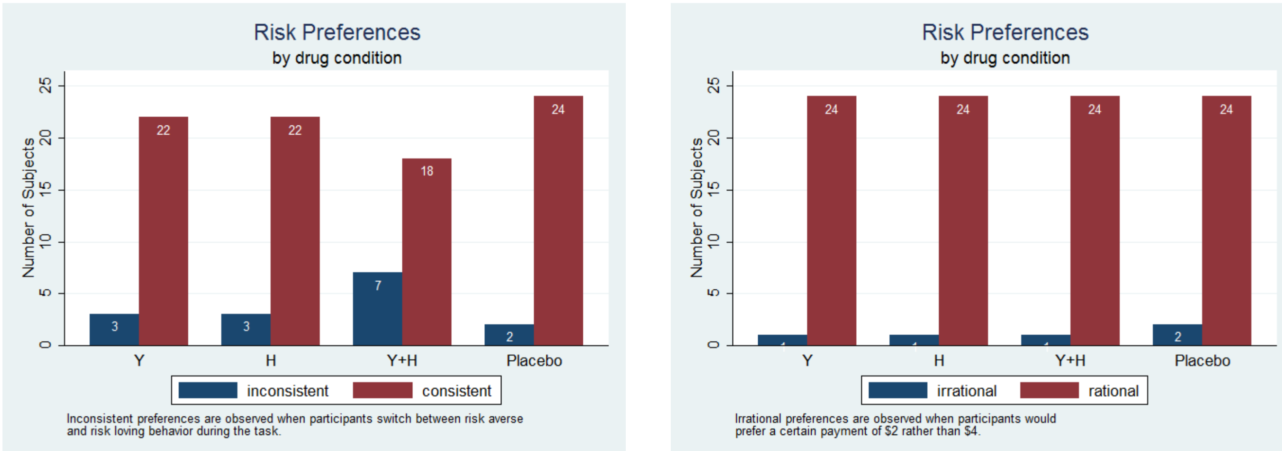
(b)



(c)

Figure 8: Dictator Game - Beliefs

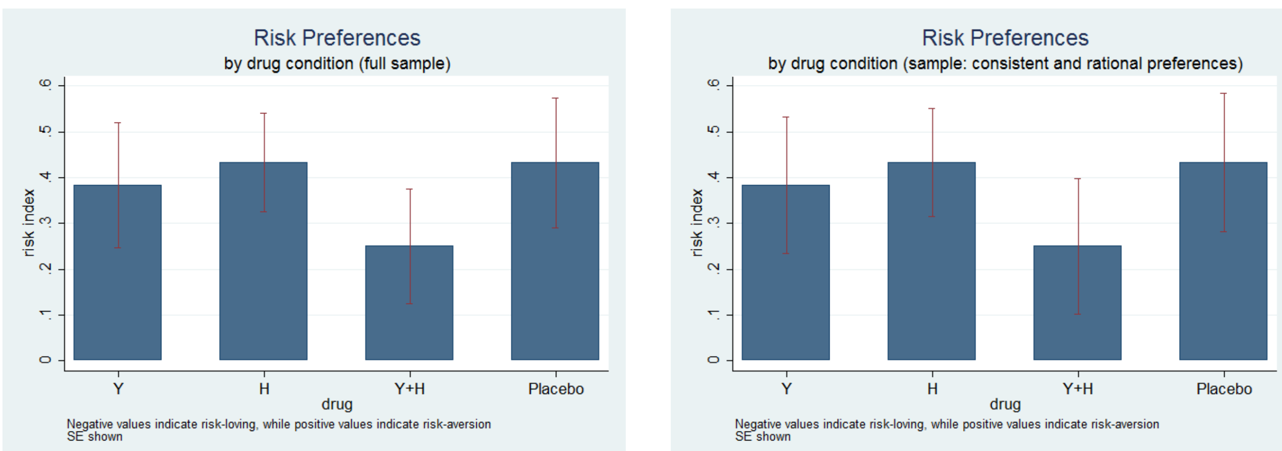
Non-Social Games Analysis



(a) Consistency

(b) Rationality

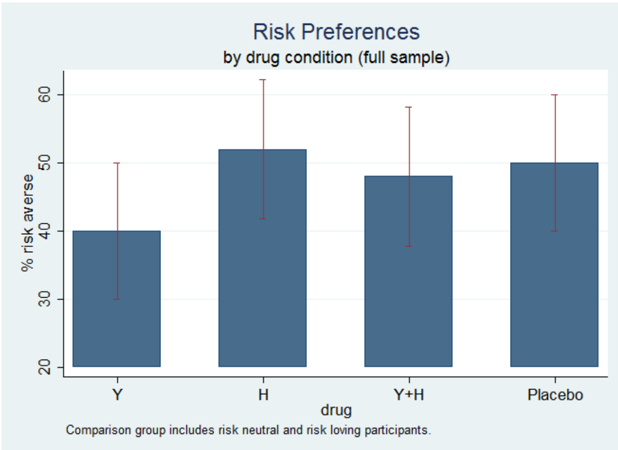
Figure 9: Risk Preference Task - Behavior Consistency and Rationality



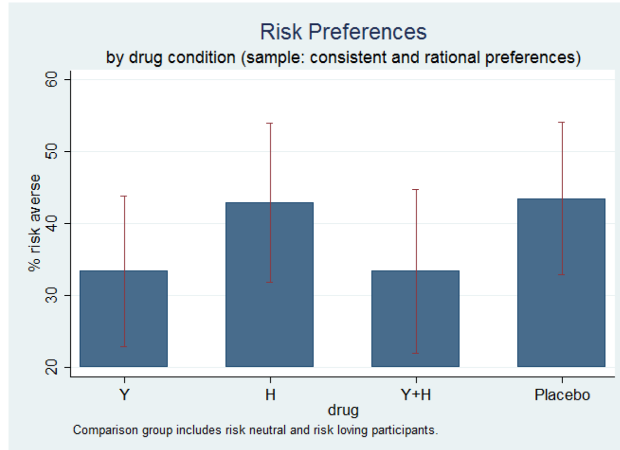
(a) Full sample

(b) Consistent and rational participants

Figure 10: Risk Preference Task - Risk Aversion Index

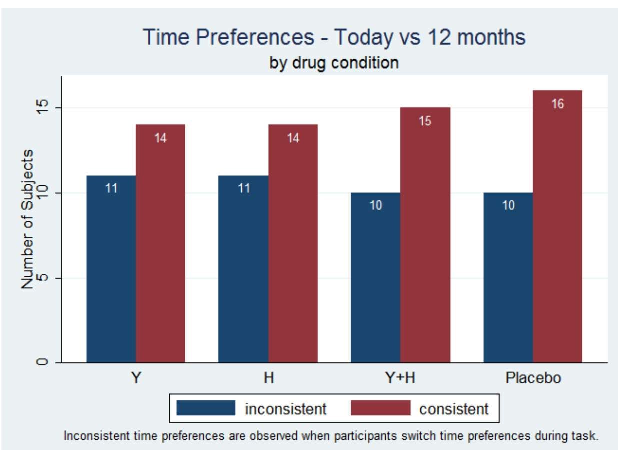


(a) Full sample

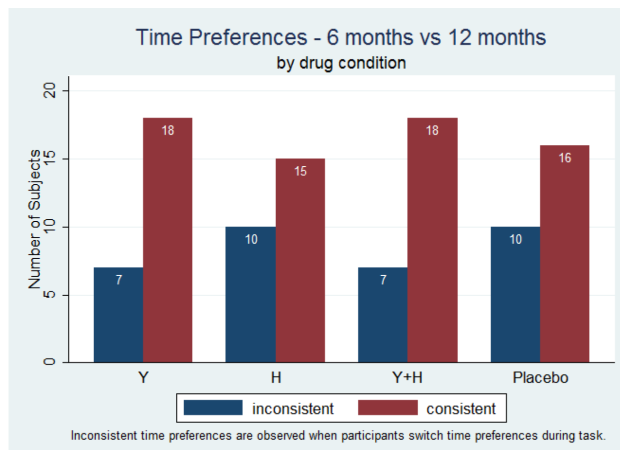


(b) Consistent and rational participants

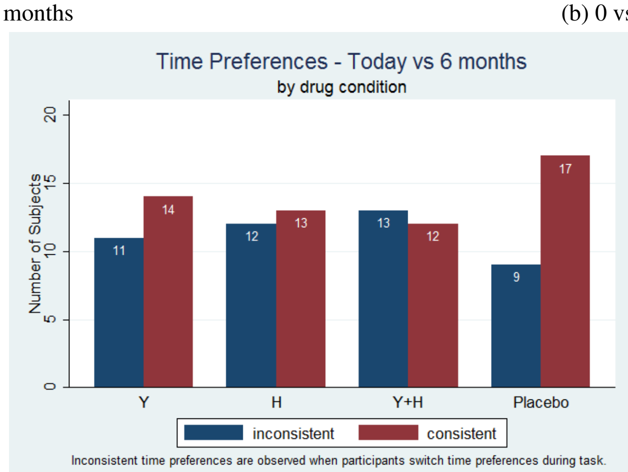
Figure 11: Risk Preference Task - Risk Aversion Indicator



(a) 0 vs. 6 months

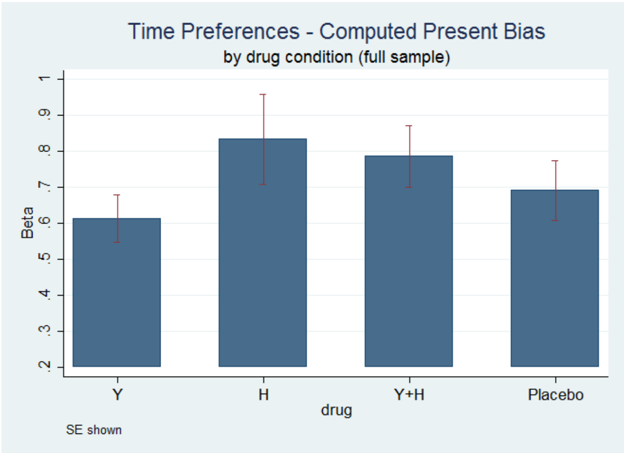


(b) 0 vs. 12 months

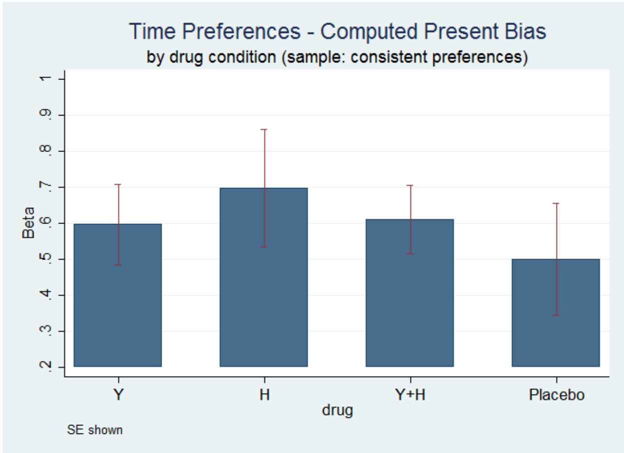


(c) 6 vs. 12 months

Figure 12: Time Preference Task - Behavior Consistency

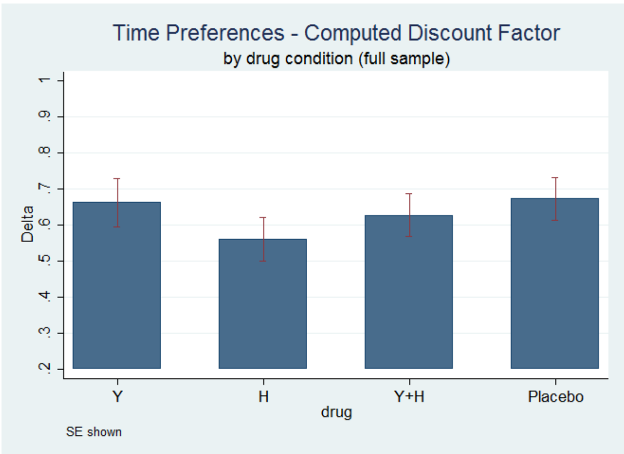


(a) Full sample

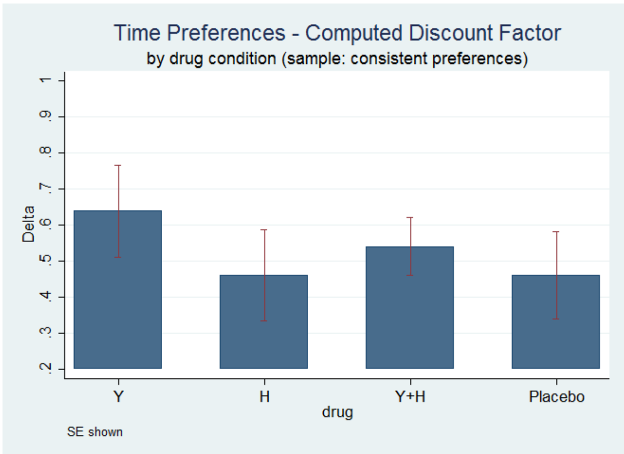


(b) Consistent participants

Figure 13: Time Preference Task - Computed β



(a) Full sample



(b) Consistent participants

Figure 14: Time Preference Task - Computed δ

References

[1] K. Bevans, A.B. Cerbone, and S. Overstreet. Advances and future directions in the study of children's neurobiological responses to trauma and violence exposure. *Journal of Interpersonal Violence*, 20(4):418–425, 2005.

[2] T.W. Buchanan, A. Brechtel, J.J. Sollers, and W.R. Lovallo. Exogenous cortisol exerts effects on the startle reflex independent of emotional modulation. *Pharmacology Biochemistry and Behavior*, 68(2):203–210, 2001.

[3] S.L. Buka, T.L. Stichick, I. Birdthistle, and F.J. Earls. Youth exposure to violence: Prevalence, risks, and consequences. *American Journal of Orthopsychiatry*, 71(3):298–310, 2001.

[4] S. Cohen, J.E. Schwartz, E. Epel, C. Kirschbaum, S. Sidney, and T. Seeman. Socioeconomic status, race, and diurnal cortisol decline in the coronary artery risk development in young adults (cardia) study. *Psychosomatic Medicine*, 68(1):41–50, 2006.

[5] P. Collier and A. Hoeffler. On economic causes of civil war. *Oxford economic papers*, 50(4):563–573, 1998.

[6] G.W. Evans and K. English. The environment of poverty: Multiple stressor exposure, psychophysiological stress, and socioemotional adjustment. *Child development*, 73(4):1238–1248, 2002.

[7] G.W. Evans and P. Kim. Childhood poverty and health cumulative risk exposure and stress dysregulation. *Psychological Science*, 18(11):953–957, 2007.

[8] J.D. Fearon and D.D. Laitin. Ethnicity, insurgency, and civil war. *American Political Science Review*, 97(1):75–90, 2003.

[9] U. Fischbacher. z-tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, 10(2):171–178, 2007.

[10] S.S. Inslicht, C.R. Marmar, T.C. Neylan, T.J. Metzler, S.L. Hart, C. Otte, S.E. McCaslin, G.L. Larkin, K.B. Hyman, and A. Baum. Increased cortisol in women with intimate partner violence-related posttraumatic stress disorder. *Psychoneuroendocrinology*, 31(7):825–838, 2006.

[11] W. Kliewer. Violence exposure and cortisol responses in urban youth. *International journal of behavioral medicine*, 13(2):109–120, 2006.

[12] D. Laibson. Golden eggs and hyperbolic discounting. *The Quarterly Journal of Economics*, 112(2):443–478, 1997.

[13] L. Li, C. Power, S. Kelly, C. Kirschbaum, and C. Hertzman. Life-time socio-economic position and cortisol patterns in mid-life. *Psychoneuroendocrinology*, 32(7):824–833, 2007.

[14] S.J. Lupien, S. King, M.J. Meaney, and B.S. McEwen. Child's stress hormone levels correlate with mother's socioeconomic status and depressive state. *Biological psychiatry*, 48(10):976–980, 2000.

[15] M. Lynch. Consequences of children's exposure to community violence. *Clinical Child and Family Psychology Review*, 6(4):265–274, 2003.

[16] G. Margolin and E.B. Gordis. Children's exposure to violence in the family and community. *Current Directions in Psychological Science*, 13(4):152–155, 2004.

[17] E. Miguel. Poverty and witch killing. *Review of Economic Studies*, 72(4):1153–1172, 2005.

[18] E. Miguel, S.M. Saiegh, and S. Satyanath. Civil war exposure and violence. *Economics & Politics*, 23(1):59–73, 2011.

[19] T.E. Moffitt. Adolescence-limited and life-course-persistent antisocial behavior: a developmental taxonomy. *Psychological Review; Psychological Review*, 100(4):674, 1993.

[20] R. Murali and E. Chen. Exposure to violence and cardiovascular and neuroendocrine measures in adolescents. *Annals of Behavioral Medicine*, 30(2):155–163, 2005.

[21] M.A. Pico-Alfonso, M.I. Garcia-Linares, N. Celda-Navarro, J. Herbert, and M. Martinez. Changes in cortisol and dehydroepiandrosterone in women victims of physical and psychological intimate partner violence. *Biological Psychiatry*, 56(4):233–240, 2004.

[22] B. Roozendaal, B.S. McEwen, and S. Chattarji. Stress, memory and the amygdala. *Nature Reviews Neuroscience*, 10(6):423–433, 2009.

[23] B. Roozendaal, S. Okuda, D.J.F. De Quervain, and JL McGaugh. Glucocorticoids interact with emotion-induced noradrenergic activation in influencing different memory functions. *Neuroscience*, 138(3):901–910, 2006.

[24] L. Schwabe, M. Tegenthoff, O. Höffken, and O.T. Wolf. Concurrent glucocorticoid and noradrenergic activity shifts instrumental behavior from goal-directed to habitual control. *The Journal of Neuroscience*, 30(24):8190–8196, 2010.

[25] A. Shahinfar, J.B. Kupersmidt, and L.S. Matza. The relation between exposure to violence and social information processing among incarcerated adolescents. *Journal of Abnormal Psychology*, 110(1):136, 2001.

[26] L.M. Soravia, M. Heinrichs, A. Aerni, C. Maroni, G. Schelling, U. Ehlert, B. Roozendaal, and J.F. Dominique. Glucocorticoids reduce phobic fear in humans. *Proceedings of the National Academy of Sciences*, 103(14):5585–5590, 2006.

[27] S.E. Taylor, L.C. Klein, B.P. Lewis, T.L. Gruenewald, R.A.R. Gurung, and J.A. Updegraff. Biobehavioral responses to stress in females: tend-and-befriend, not fight-or-flight. *Psychological review*, 107(3):411, 2000.

[28] R.A. Vasa, D.S. Pine, C.L. Masten, M. Vythilingam, C. Collin, D.S. Charney, A. Neumeister, K. Mogg, B.P. Bradley, M. Bruck, et al. Effects of yohimbine and hydrocortisone on panic symptoms, autonomic responses, and attention to threat in healthy adults. *Psychopharmacology*, 204(3):445–455, 2009.

[29] B. von Dawans, U. Fischbacher, C. Kirschbaum, E. Fehr, and M. Heinrichs. The social dimension of stress reactivity acute stress increases prosocial behavior in humans. *Psychological science*, 23(6):651–660, 2012.

[30] O.T. Wolf. Stress and memory in humans: Twelve years of progress? *Brain research*, 1293:142–154, 2009.