The Effects of Bright Light Exposure on Reciprocity*

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1 Introduction

Many individual decisions often have (beneficial or harmful) consequences to others. Humans reciprocate kindness and retaliate against unkind actions. Social interactions thrive under mutually beneficial cooperative behavior and deteriorate without cooperation. In fact, social preferences have emerged as a subtopic of interest in economics, with recent emphasis on the choice processes to better understand the underlying motivations behind pro-social (and anti-social) behavior as a way of predicting the outcomes of strategic interactions (Fiedler et al., 2013; Barrafrem & Hausfeld, 2020; Fischbacher et al., 2022). We investigate exposure to bright light and its influence on social interactions involving reciprocity in four domains: fairness, cooperation, trust, and gift-exchange. We focus on bright light exposure because it is known to affect physiological processes related to emotion regulation (Bedrosian & Nelson, 2017). More specifically, bright light is associated with improving mood because it releases serotonin (aan het Rot et al., 2008; Al-Karawi & Jubair, 2016). Both mood (Capra, 2004; Kirchsteiger et al., 2006; Drouvelis & Grosskopf, 2016; Lane, 2017) and serotonin (Crockett

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et al., 2008) have been linked to changes in economic behavior related to social preferences. Building from these disconnected strands of previous findings, we investigate whether bright light can directly affect social preferences in domains characterized by reciprocal interactions. This question is of economic relevance because manipulating the release of hormones is naturally unfeasible, while light brightness can be exogenously (and easily) manipulated in many environments.

The brain is sensitive to external factors in the surrounding environment through neuromodulators (Crockett & Fehr, 2014). Specifically, light brightness has a direct effect on neurotransmitters and hormones, regulating emotions and other important biological processes (Bedrosian & Nelson, 2017). Neurotransmitters and hormones such as serotonin, oxytocin, and dopamine are also implicated in social behaviors.[1] Though studies have largely been conducted on other species —predominantly rats and mice (Matsumura et al., 2015)— there is strong evidence for light brightness as a mechanism regulating serotonin levels in humans (Bedrosian & Nelson, 2017; Young, 2007). Some evidence even points to changes in eating behavior and glucose homeostasis under different lighting conditions both in animal studies and in humans (Stemer et al., 2015; Liu et al., 2024), possibly due to the effect of light on serotonin levels (Scheibehenne et al., 2010; Biswas et al., 2017; Liu et al., 2022; He et al., 2021). Bright light therapy is gaining popularity to treat mood disorders, anxiety, and depression with evidence from a meta-analysis that its effect sizes are equivalent to antidepressant pharmacotherapy (Golden et al., 2005).

While we do not directly manipulate neurotransmitters or hormone levels, we explore the changes produced by altering the bright intensity of light produced by commercially available LED light fixtures (Partonen & Lönnqvist, 2000; Avery et al., 2001; aan het Rot et al., 2008). This exploratory analysis has practical implications because adjusting the

[1]Previous work relates social behavior with serotonin (Siegel & Crockett, 2013; Duman & Canli, 2010; Canli & Lesch, 2007; Bacqué-Cazenave et al., 2020; Moskowitz et al., 2003; Hansenne & Ansseau, 1999; Crockett et al., 2008; Emanuele et al., 2008; Bengart et al., 2021; Tse & Bond, 2002; Sarmiento Rivera & Gouveia, 2021), oxytocin (Sarmiento Rivera & Gouveia, 2021; Strang et al., 2017; Kosfeld et al., 2005), and dopamine (Sarmiento Rivera & Gouveia, 2021; Bellucci et al., 2020).

light ambient brightness is a relatively low cost intervention that might produce changes in social interactions as a result of its effect on known biological processes. There are numerous contexts in which light is manipulated in an attempt to influence emotions and human interactions. For example, darker environments can create a sense of relaxation, intimacy, or fear and uncertainty, while bright light produces alertness, heightened emotions, and associations with moral behavior (Frank & Gilovich, 1988; Schaller et al., 2003; Banerjee et al., 2012; Xu & Labroo, 2014). The original set of Hawthorne experiments also sought to understand worker productivity under differential lighting conditions, which generally shows that workers increase their productivity under bright light mostly due to the "Hawthorne effect"; however, recent analysis reveals that design and implementation of the study is lacking and inconsistent, resulting in inconclusive findings(Gale, 2004; Levitt & List, 2011; Izawa et al., 2011).

Previous literature explored changes in social preferences produced by several biological markers including hormones (e.g. oxytocin, testosterone, cortisol) and neurotransmitters (e.g. dopamine, serotonin, noradrenaline). For example, oxytocin has been associated with trustworthiness, moral decision-making, and greater generosity in empathetic people (Sarmiento Rivera & Gouveia, 2021; Strang et al., 2017; Kosfeld et al., 2005). Arginine vasopressin is linked to cooperation in decision-making (Sarmiento Rivera & Gouveia, 2021). Dopamine is associated with rewards and learning, the valuation of outcomes in decisions, and trust levels (Sarmiento Rivera & Gouveia, 2021; Bellucci et al., 2020). While some of these effects can be isolated and attributed to specific neurotransmitters or hormones, psychobiological interaction among different hormones and neurotransmitters obstruct the ability to isolate a specific effect (Sarmiento Rivera & Gouveia, 2021; Strang et al., 2017; Bellucci et al., 2020). For practical applications, this may be less of a concern in our experimental framework as we study the effect of exogenous variation in the brightness of light on social outcomes.

In this article, we explore the effect of exogenous variation in light brightness intensity (a low of 10 lux and a high of 350 lux, measured at eye level) on reciprocity using four economics games with a reciprocity element using monetary incentives: the trust game, the ultimatum game, the public goods game, and the gift-exchange game. We exogenously manipulate the lighting brightness in a controlled room. In one condition, we set up a dark condition where the light brightness in the room is kept to under 10 lux. In the bright condition, the light brightness is increased using bright LED office lighting to emit over 4,766 lumens (350 lux at eye-level) of bright light without changing the room temperature. We used this variation in bright light even though the bright condition has lower brightness than clinical bright light therapy exposure because this setting is within the range of conventional lighting regulation available to the public in most environments providing practical implications for our findings. The main outcome of interest is the level of reciprocity in the four games across the two light brightness conditions. Since previous work suggest positive changes in mood regulation of bright light equivalent to pharmacological treatment, based on previous economic literature of mood, we expect more prosocial behavior in the bright light condition compared to the dark (Young, 2007; Iwata et al., 1997). The goal of utilizing the four games is to capture different social preference domains. The ultimatum game is one of the most extensively studied games to measure preferences for fairness (Güth et al., 1982; Fehr & Krajbich, 2014; Houser & McCabe, 2014). The ultimatum game has been used to study the effect of serotonin manipulation on fairness without monetary incentives (Crockett et al., 2008; Emanuele et al., 2008). We first add to the literature by introducing monetary incentives tied to decisions in a one-shot setting that affects another individual. We explore whether previous results found through direct serotonin reduction manipulation showing higher rejection rates for low offers (i.e., higher demand for fairness) are replicated using exogenous bright light manipulation. We also extend the literature by introducing the other three games to measure trust, cooperation, and gift-exchange which allow us to separate reciprocity and generosity motives to evaluate the effect of light brightness on these environments.

The paper proceeds as follows: Section 2 discusses the experimental design and procedures. Section 4 features the results. In section 5 we discuss the results and conclude.

2 Experimental Design and Treatments

The study was conducted between October and November 2022. There were 35 sessions which had between four and twelve subjects per session for a total of 248 student participants to maintain a homogeneous sample.[2]

We screened out participants taking anxiety or depression medications, since these medications generally contain SSRIs which may alter serotonin levels interfering with the light brightness conditions. To further control diurnal variation of hormonal levels, all sessions were held in the morning before 10 in the morning. Subjects signed consent forms and entered the lab to the randomly assigned bright or dark condition that was set before participants arrived at the lab. After proceeding to their station, participants performed two tasks for about 30 minutes to allow the participants to to be exposed to their randomly assigned brightness condition and allow for the light to achieve a similar level of exposure. We chose 30 minutes because this is the amount of time required for light exposure to affect serotonin levels (Iwata et al., 1997; Young, 2007). The first stage of the session started with participants completing a series of hypothetical individual gambles to avoid eliciting social preferences and avoid any income effects. All subjects uniformly earned $5 for completing this task regardless of their choices. Next, subjects completed another individual task that involved sorting shapes with the same purpose to keep subjects occupied and induce similar levels of exposure to the randomly assigned brightness condition.

Following the individual tasks, subjects completed the four social preferences tasks in random order: a one-shot ultimatum game, a one-shot trust game, a one-shot gift exchange game, and ten rounds of a public goods game with the same grouping. We opted for repeated interactions with the grouping in the public goods game to evaluate the reputation effect and reciprocity based on findings from previous literature. We utilized the direct response

[2] Prior to the data collection, we conducted a pilot study, summarized in Appendices 3 and 4.

method, and randomly selected one of the tasks to be paid at the end of the study. After this stage, subjects completed a questionnaire to elicit circadian preferences and collected demographic information (Adan & Almirall, 1991).

2.1 Treatments

The lux level in the dark condition varied between 1 and 10 lux. Lights were turned off, the computer monitors had most of their blue light removed, and windows were blacked out. The bright light condition had a variation between 350 and 600 lux at eye level depending on the location of the room and whether the LED candle bulbs were directly above. The lights used in the study are the CPX LED panel by Lithonia Lighting, model CPX 2x4 4000LM 50K M2 which emits 4,766 lumens at the source. The windows were blacked out to control for external lighting variations across sessions, and the LED panel lights were turned on to their full brightness and the computer screens were adjusted to full brightness.

3 Games and Predictions

In this experiment, we introduced four games that are commonly used in economics to capture social preferences characterized by reciprocity: trust, ultimatum, public goods, and gift exchange. The games were presented in random order and subjects were randomly rematched across games. At the beginning of each game, subjects received instructions about the rules of the game as well as information about each role before receiving the role assignment, plus how the incentives were going to be distributed and the exchange rate of tokens to cash. The experimental instructions are included in Appendix 2.

Subjects participated in a one-shot trust game (Berg et al., 1995). They were randomly assigned to the roles of Player A (investor) or Player B (trustee). They each had a 10 token endowment. Player A had the option of choosing to send any amount of their own 10-token endowment to Player B. When it reached Player B, it tripled in amount. Player B then had the option of sending back any amount of the tripled amount back to Player A, not including Player B's endowment.

The welfare-maximizing decision is for the investor to send the entire endowment to the trustee, but the payoff-maximizing investor would have to 'trust' the trustee in order to have any earnings. The investor's dominant strategy is to not send any amount, but the amount sent reveals how much *trust* the investor places in the trustee. Furthermore, the amount sent back reveals *trustworthiness* which measures reciprocity on the trustee's end, since the payoff-maximizing trustee would keep all the amount sent. Higher serotonin levels are associated with higher levels of prosocial preferences, specifically, cooperation and reciprocity (Siegel & Crockett, 2013; Bengart et al., 2021). Given that bright light is associated with higher serotonin, we hypothesize that investors in the trust game may exhibit greater trust in the bright light condition than in the dark. We also hypothesize that trustees exhibit greater reciprocity (trustworthiness) in the bright light than in the dark, which is also consistent with higher levels of serotonin (Siegel & Crockett, 2013; Hansenne & Ansseau, 1999).

For the ultimatum game, subjects played a one-shot game, where they were randomly assigned to the role of Player A (proposer) or Player B (responder) (Güth et al., 1982; Andersen et al., 2011). Player A received a 10 token endowment (where 1 token equals $1 in this game), of which they had the option to propose a split of the 10 tokens between themselves and Player B who received a 0-token endowment. Once Player A sent the proposal, Player B had the option of either accepting or rejecting the proposal. If Player B accepted the proposal, the allocation was implemented according to the proposal, however, a rejection meant that both players received 0 tokens for the game.

The ultimatum game is used to measure preferences for fairness where unfair (i.e., low) offers are often rejected (Güth et al., 1982; Andersen et al., 2011; Fehr & Krajbich, 2014; Houser & McCabe, 2014). The optimal strategy for Player A to propose a split with the minimal amount such that the receiver will accept a positive allocation over a zero allocation implied by a rejection. The intuition is that any positive offer from the proposer is better than receiving nothing. The minimal amount for which the receiver is willing to accept can vary, which reveals the receiver's preferences for fairness or the cost willing to signal unfair offers and punish the proposer. While the sub-perfect equilibrium is for the proposer to keep almost all of the endowment, proposers usually make offers close to equal split and receivers reject low offers despite implying no earnings, especially with low stakes (Andersen et al., 2011). Previous literature show that reduced serotonin levels increase the rate of rejection in the ultimatum game, in particular when offers are most unfair (Crockett et al., 2008). This result suggest that offers perceived to be unfair are more likely to be retaliated against with lower serotonin levels. With light being a proxy for increasing serotonin, we hypothesize that individuals will similarly reject most unfair offers at a higher rate in the dark compared to the light condition. The results of this first game provide a test of environments where unkind acts are met with reciprocal unkindness.

Subjects also played a 10-round public goods game in groups of four (Andreoni, 1995). Each subject had 10 tokens to invest in a private or a public account. The private account returned 1 token for every token invested, whereas the public account returned 0.5 tokens per token invested by all members of the group. Subjects were randomly assigned to a group of four at the beginning of game and played with the same participants for all ten rounds. After the each round, players were given information about the previous round, including their own investments in the private and public accounts as well as the total investment in the public account. All 10 rounds were incentivized with tokens, and the exchange rate for the game was $0.10 per token earned.

While the dominant strategy is to contribute nothing to the public account ("free ride"), the highest payoff is achieved when all four members of the group invest their full endowment to the public account. Players have an incentive to deviate and contribute nothing and free ride from the contributions of the other players. The game is played for 10 rounds and previous literature show decreased contributions as rounds progress, especially with the presence of non-contributors. Contributions to the public account reveal willingness to cooperate, especially in the first few rounds. Based on neuroscience literature, serotonin is associated with a greater likelihood of cooperation (Tse & Bond, 2002; Siegel & Crockett, 2013; Bengart et al., 2021). Therefore, we hypothesize differential behavior in terms of how much individuals contribute to the public account by the bright light environment. Specifically, we anticipate that those in the light condition will contribute more to the public account than those in the dark condition. This game provides an environment with the opportunity for participants to endogenously observe contributions and reciprocate cooperation and punish uncooperators.

Subjects participated in a gift exchange game (Fehr et al., 1993). Subjects were randomly assigned to the role of employer or employee. They received information regarding the payoff tables as seen in the instructions in Appendix 2. First, the employer proposes a wage and effort level to the employee. The employee learns the wage and proposed effort level, and then chooses a stated effort level that may or may not match the employer's proposal. The payoff functions for the employee and the employer are as follows:

$$payoff_{employer} = (120 - w) * e$$

$$payoff_{employee} = w - c(e)$$

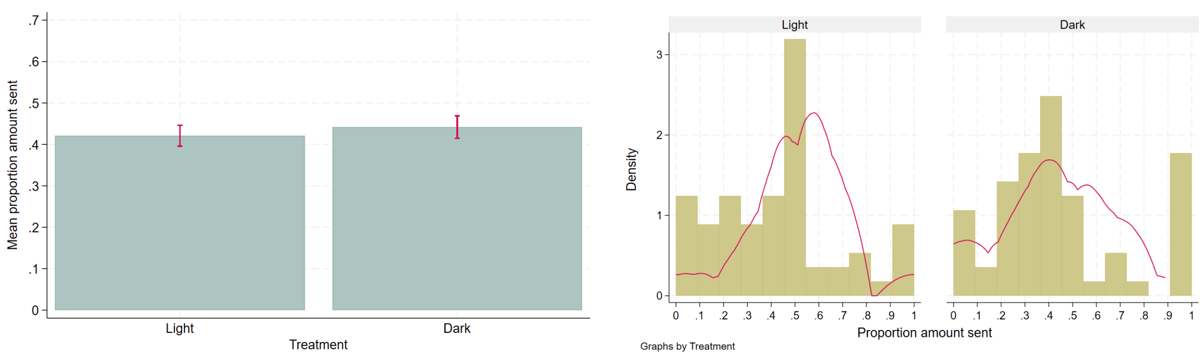
where w represents the wage that the employer offers, e represents the stated effort the employee exerts, $c(e)$ represents the cost of effort for the employee. The cost of effort is based on the scheduled seen in Appendix 2 for effort levels varying between 0 and 1. Importantly, the employees received the wage proposed regardless of whether they matched the effort that the employers proposed. Employers could not offer less than 20 tokens for the wage in order to ensure positive returns in the experiment. The exchange rate for this game was 1 token for \$0.20.

The gift exchange game serves as a measure of reciprocity. A payoff-maximizing employer would request the highest effort level with the lowest wage, and a payoff-maximizing employee would offer the lowest effort possible regardless of the proposal received. However, choosing an effort level greater than 0 reveals reciprocity toward the employer's behavior. Previous literature suggest that higher levels of serotonin are associated with greater reciprocity (Siegel & Crockett, 2013). Therefore, we expect to observe higher employee effort in the light than in the dark.

4 Results

We present summary statistics in table C1 of the Appendix.

Trust



(a) (b)

Figure 1: Investor behavior in trust game

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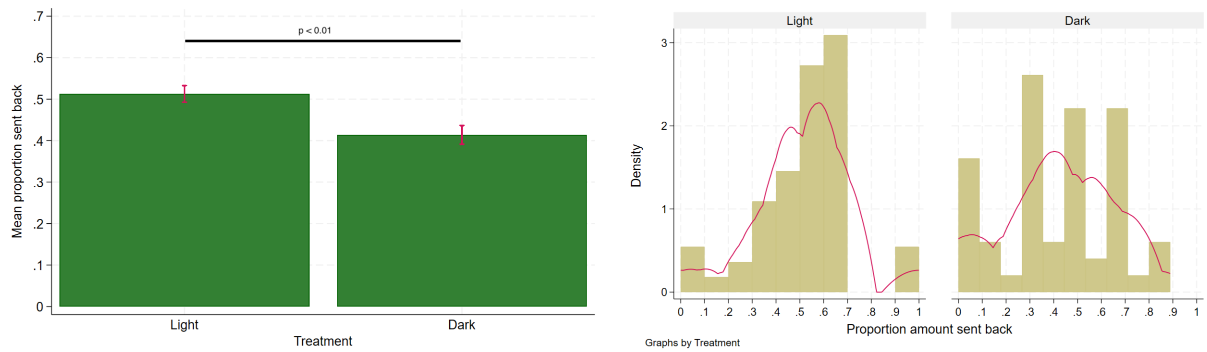
Table 1: Trustworthiness: Proportion sent back in the trust game with non-zero trust

	Overall	Light	Dark	p_{MW}
Overall ($n = 222$)	0.46	0.51	0.41	0.002***
	(0.23)	(0.21)	(0.24)	
Less than 40% sent from investor ($n = 74$)	0.46	0.49	0.43	0.30
	(0.25)	(0.26)	(0.24)	
Between 40% and 50% sent from investor ($n = 92$)	0.48	0.53	0.41	0.004***
	(0.22)	(0.21)	(0.20)	
Over 50% sent from investor ($n = 56$)	0.45	0.51	0.40	0.22
	(0.23)	(0.13)	(0.29)	

Figure 1 shows investor behavior in the one-shot trust game. On average, investors sent



(a) (b)

Figure 2: Responder behavior in trust game

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just under half of the ten-token endowment, but this does vary across conditions. Table 1 lists the overall responder behavior. We find that, on average, trustees send back 51% of the amount they received in the light condition, compared to the dark condition where they only send 41% back to the investors, consistent with greater trusthworthiness in the bright light ($p_{MW} < 0.01$, $p_{KS} < 0.01$).[3] We can visually see this in Figure 2. We further find that this trusthworthiness is driven by responders who are paired with investors who sent between 40% and 50% of their own tokens.

We confirm the results in an OLS regression in Table 2. In the first two specifications listed in this table, we do not observe significant effects of the treatment on the amount the investors sent to the trustees. However, we observe that trustees send back 0.10 percentage points less in the dark than in the light across treatments, even when controlling for other factors.

Ultimatum

Table 3 lists the outcomes of the ultimatum game across the light treatments in the lab experiment in a one-shot version in which a proposer is paired with a responder and only one decision is made. First, we find that overall, our sample converges to fair offers across

[3]We observed a similar effect in pilot sessions

Table 2: OLS regressions on trust game outcomes (proportions)

	Amount Sent	Amount Sent	Amount Returned	Amount Returned
Dark	0.02	0.03	-0.10**	-0.10***
	(0.06)	(0.05)	(0.05)	(0.05)
Controls	No	Yes	No	Yes
Observations	248	248	222	222

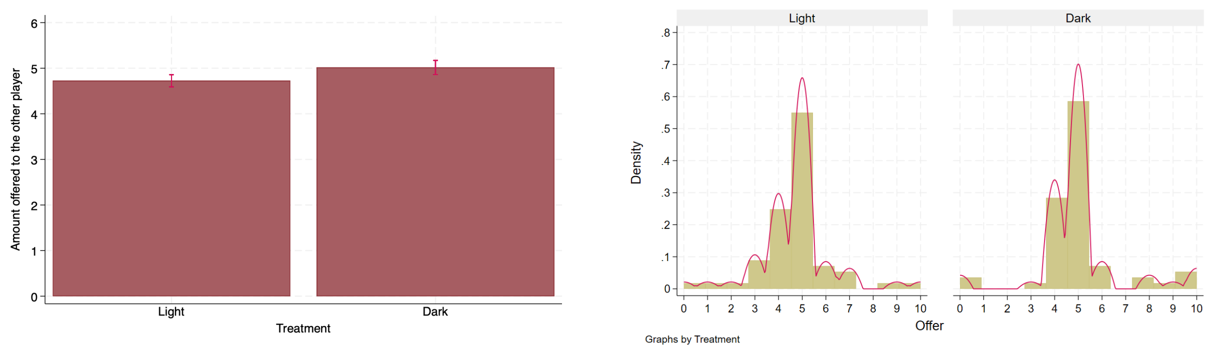
Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: Regression controls include the morningness-eveningness score, sex, race, age, year in school, income, and household size

treatments, as observed in Figure 3. The average offer is \$4.73 and \$5.02 in the bright light and dark conditions, respectively ($p_{MW} > 0.25$, $p_{KS} > 0.81$)(\$4.87 overall). Only 33% of the proposers made unfair offers (e.g. less than half of the endowment), and less than 10% made offers less than \$4, which is a lower rate of unfair offers observed than what is observed in other studies. As a result, we observe very low rejection rates both overall and across treatments as seen in Figure 4.[4] We then focus on the sample where Player A offered an unfair split and kept more than 5 of the tokens. In these cases, higher rejection rates are observed compared to the full sample, but the rejection rates remain insignificant across treatments ($p_{MW} > 0.35$, $p_{KS} = 1.00$). We confirm this finding in regressions in Table 4. The first specification is a logit model with offer rejection as the outcome variable and the treatment (dark) as the independent variable. The second specification adds control variables: circadian morningness-eveningness score, sex, race, age, year in school, income, and household size. The next two specifications are linear probability models with the same explanatory variables as the first two specifications.

We then consider the subsample where Player A makes a most unfair offer, that is, keeping \$7 or more of the tokens and only offering \$3 or less to Player B. The rejection rates are highest than when offers are simply unfair or fair, but the result is still not statistically different across treatments ($p_{MW} > 0.4$). Furthermore, since our experiment only involved

[4]This may be consistent with our pilot studies in which the average willingness to accept was less than \$4.



(a) (b)

Figure 3: Proposer behavior in ultimatum game

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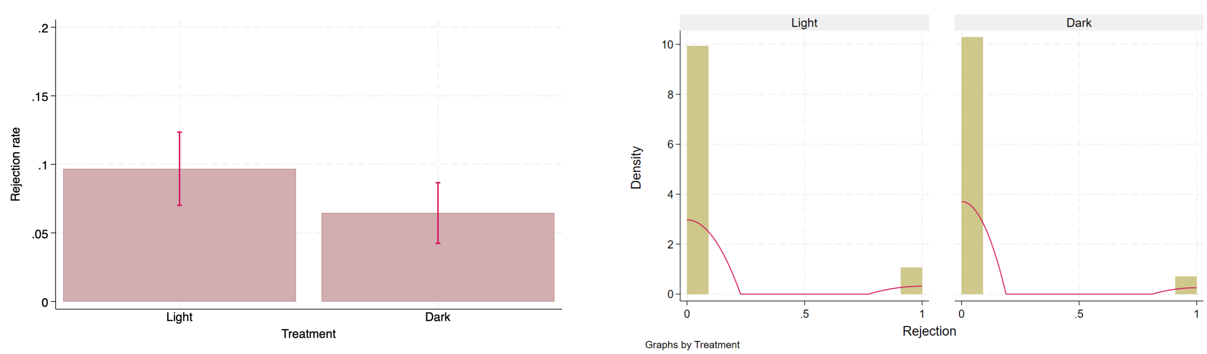

(a) (b)

Figure 4: Responder behavior in ultimatum game

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Table 3: Ultimatum Game Outcomes

	Overall	Light	Dark	p_{MW}
Overall Offers	4.87	4.73	5.02	0.26
	(1.61)	(1.49)	(5.02)	
Overall rejection rate	0.08	0.10	0.06	0.35
	(0.08)	(0.10)	(0.06)	
Rejection rate, unfair offers ($n = 82$)	0.22	0.27	0.16	0.35
	(0.22)	(0.27)	(0.16)	
Rejection rate, most unfair offers ($n = 22$)	0.55	0.5	0.67	0.49
	(0.55)	(0.50)	(0.67)	

one observation per group, we only observe 11 pairs in which there is a most unfair offer. Therefore, we do not replicate the results from Crockett et al. (2008) by altering light. Note that Crockett et al. (2008) directly manipulate serotonin levels using a pharmacological suppressant in a sample of 20 participants.

Table 4: Logit and Linear Probability Model estimates on ultimatum game rejection

	Logit	Logit	LPM	LPM
Dark	-0.44	-0.80	-0.03	-0.05
	(0.68)	(0.68)	(0.05)	(0.04)
Controls	No	Yes	No	Yes
Observations	248	234	248	248

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1.

Note: Regression controls include the morningness-eveningness score, sex, race, age, year in school, income, and household size

Public Good Games

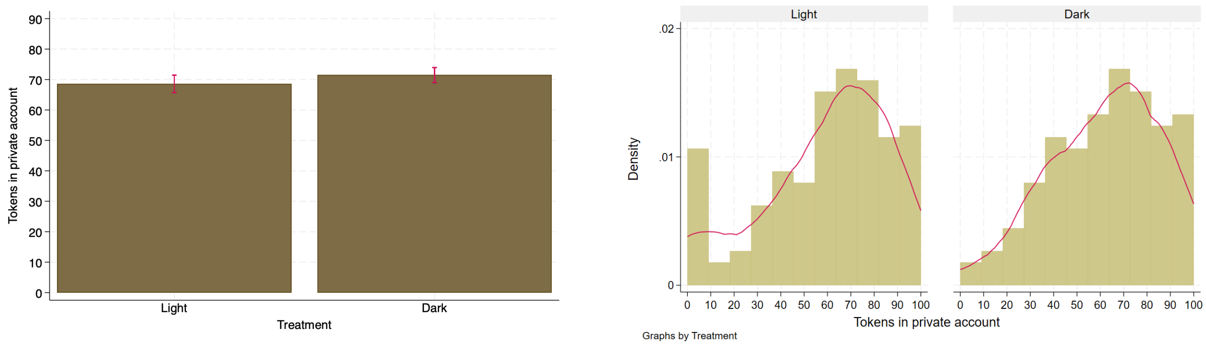
Table 5: Average overall contributions by treatment

	Light	Dark	p_{MW}
Group	162.61	150.94	0.49
	(80.16)	(74.48)	
Individual	40.65	37.73	0.66
	(27.58)	(37.73)	

Table 6: Individual contributions per round by treatment

	Light	Dark	p_{MW}
Round 1	4.81	4.91	0.66
	(3.22)	(3.17)	
Round 2	4.75	4.64	0.74
	(3.28)	(3.34)	
Round 3	4.51	4.29	0.56
	(3.42)	(3.38)	
Round 4	4.27	4.09	0.53
	(3.34)	(3.48)	
Round 5	4.31	3.92	0.38
	(3.39)	(3.38)	
Round 6	3.94	3.15	0.07*
	(3.48)	(3.18)	
Round 7	3.90	3.51	0.29
	(3.30)	(3.27)	
Round 8	3.70	3.44	0.43
	(3.32)	(3.37)	
Round 9	3.37	2.98	0.44
	(3.47)	(3.11)	
Round 10	3.10	2.81	0.46
	(3.34)	(3.18)	

Table 5 displays overall average total group and individual contributions to the public account in the public goods game across treatments, whereas Table 6 lists the average individual contributions to the public account in each round of the game. In our data as reflected in Table 5, overall average contributions to the public account increase by 7.7% but do not vary significantly across treatments ($p_{MW} > 0.48$). While we do observe reduced contributions to the public account as rounds progress in table 6, we do not observe differential behavior across treatments overall. In fact, Figure 5 shows the average amount of tokens overall invested in the private account across treatments. We find that, overall, subjects invested approximately 60 tokens in the private account and we observe similar behavior across treatments. We also estimated a linear regression in Table 7 that include controls for the previous period, both individual contribution and general contribution, as well as whether the other individuals in the group contributed more than half of the average



(a)

(b)

Figure 5: Tokens in private account across treatments

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contribution, which we include as a binary variable called "cooperative." We also control for round effects. As we might expect, the regressions reveal that own contributions and the group's contributions in the previous round have an effect on contributions in the subsequent round, but the lighting condition did not have an effect on individual contribution in each round. We do not find differential cooperative behavior under different lighting conditions in this experiment. The results from the linear regressions listed in table 8 also show that the the lighting condition does not affect the individual total contributions to the public account.

Gift Exchange

Table 9 features the overall outcomes from the gift exchange game. We first note the employer proposes a higher wage of approximately 71 tokens in the dark than in the light condition with approximately 63 tokens ($p_{MW} < 0.02$, $p_{KS} < 0.04$). At the same time, employers expect a lower effort level from the employees in the dark compared to the bright light condition ($p < 0.05$, $p_{KS} > 0.40$). In brief, our data reveals that employers expect less effort (i.e., less reciprocity) for a higher wage in the dark as compared to the light. Figure 6 features the wage - effort ratio, that is, the wage offered by unit of effort. Overall, we observe that in the light, employers offer a lower wage per effort unit that in the dark ($p_{MW} < 0.01$,

Table 7: OLS regressions on contributions in each round of public goods

	(1)	(2)	(3)	(4)	(5)
Dark	-0.14	-0.16	-0.08	-0.08	-0.08
	(0.22)	(0.24)	(0.11)	(0.11)	(0.11)
Previous round contribution	0.67***		0.52***	0.50***	0.54***
	(0.03)		(0.03)	(0.05)	(0.04)
Previous total contribution		0.15***	0.09***	0.09***	0.08***
		(0.01)	(0.01)	(0.01)	(0.01)
Cooperative				0.14	
				(0.17)	
Constant	1.49***	1.79***	0.54***	0.48**	0.42*
	(0.21)	(0.30)	(0.20)	(0.21)	(0.23)
Observations			2232		

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Note: Regression controls include the morningness-eveningness score, sex, race, age, year in school, income, and household size

Table 8: OLS regressions on individual total contributions to the public account

	(1)	(2)	(3)	(4)
Dark	-2.92	-2.66	-3.89	-3.84
	(3.27)	(3.37)	(3.02)	(3.11)
Cooperative			20.17***	20.84***
			(3.03)	(3.17)
Constant	40.65***	50.07	31.87***	49.68*
	(2.31)	(31.12)	(2.51)	(28.65)
Controls	No	Yes	No	Yes
Observations		248		

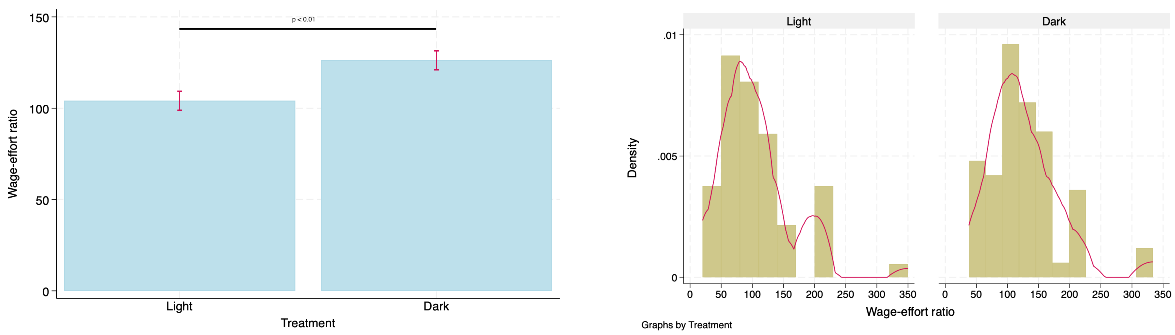
Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Note: Regressions include round number fixed effects, errors are clustered at the subject level

$p_{KS} < 0.01$). This may be indicative of higher expectations of reciprocity in the light than in the dark.

Regardless of the proposed effort from the employers, employees exert the same amount of effort across treatments. Due to the differences in proposed effort levels, we evaluate the difference between the proposed effort (what the employer requested) and the acutal effort (what the employee selected). A positive, greater difference indicates that the employer had

Table 9: Gift Exchange Outcomes

	Overall	Light	Dark	p_{MW}
Wage	67.59	63.65	71.53	0.02**
	(25.88)	(26.45)	(24.78)	
Employer proposed effort	0.65	0.68	0.62	0.04**
	(0.20)	(0.20)	(0.20)	
Employee's actual effort	0.43	0.41	0.46	0.15
	(0.29)	(0.29)	(0.28)	
Distance between proposed and actual effort	0.22	0.27	0.16	0.01***
	(0.30)	(0.30)	(0.28)	

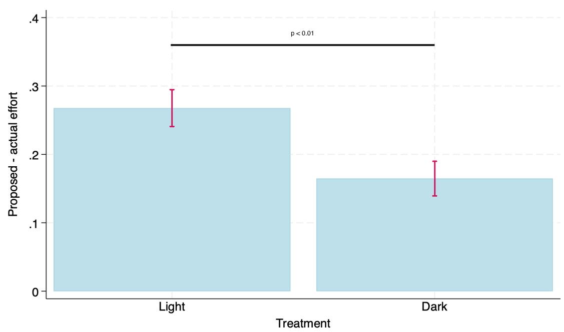


(a) (b)

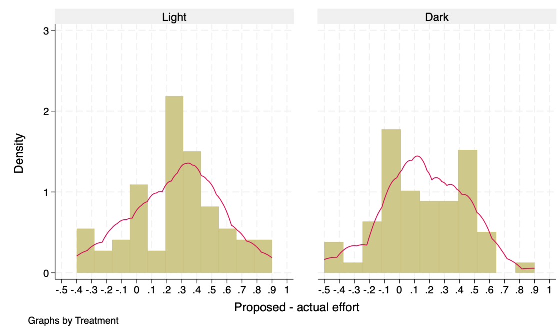
Figure 6: Wage-effort ratio (employer offer)

greater expectations for effort than what the employee offered. In some cases, there was a negative difference, indicating that the employee gave more effort than what the employee requested. We note that the difference between the actual effort and the proposed effort is different across treatments; that is, there is a larger difference in the light condition where subjects were expected to work more for less whereas in the dark condition, the difference is smaller as seen in Figure 7 ($p_{MW} < 0.01$, $p_{KS} < 0.02$).

We conduct an OLS regression on the different outcomes in the gift exchange, for which the results are in Table 10. We confirm that on average, the dark condition is associated with higher proposed wages. On average, those assigned to the dark condition offer 7.89 more in wages, and 8.16 when controlling for other factors. The third and fourth specifications reflect the wage-effort ratio that is at least 22 tokens higher in the dark than in the light



(a)



(b)

Figure 7: Proposed - actual effort (employee response)

Table 10: OLS regressions on gift exchange outcomes

	Wage		Wage-effort ratio		Effort difference (proposed-actual)	
Dark	7.89*	8.16**	22.18*	23.28*	-0.103*	-0.104
	(4.58)	(4.59)	(12.40)	(12.35)	(0.06)	(0.06)
Controls	No	Yes	No	Yes	No	Yes
Observations			248			

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: Regression controls include the morningness-eveningness score, sex, race, age, year in school, income, and household size per effort unit, findings which are robust to controls. In contrast, the difference between proposed effort and the actual effort in the dark is lower by 0.103 units of effort. This effect disappears when adding demographics. The findings in Table C2 of the appendix confirm the difference in proposed effort across treatments. The last two specifications in Table C2 demonstrate that the dark condition had no effect on actual effort. We estimate additional regression specifications reflected in Appendix table C3 adding a categorical variable for wages higher than the median wage as well as an interaction term with the dark treatment. We find that the higher wages result in greater actual effort, but we do not find significant effects when we interact this term with the treatment. This reflects that, in general, there is positive reciprocity from the employees to the wages offered, but the lighting condition does not impact the reciprocity differently.

5 Discussion and Conclusion

In this article, we conduct an exploratory study on whether the amount of light in an environment affects social preferences; given that light can affect serotonin levels, we aim to observe whether we replicate findings found in studies where serotonin is directly altered. We adjust lighting in a laboratory-controlled study in which we have our subjects play games that measure social preferences; specifically, our subjects play the trust game, the ultimatum game, the public goods game, and the gift exchange game.

Previous literature provides evidence of serotonin being a mechanism that alters social preferences in the form of fairness, cooperation, aversion to moral harm, and reciprocity (Crockett et al., 2008; Siegel & Crockett, 2013; Hansenne & Ansseau, 1999; Tse & Bond, 2002; Emanuele et al., 2008; Bengart et al., 2021; Sarmiento Rivera & Gouveia, 2021). Furthermore, light is known to alter serotonin levels (Bedrosian & Nelson, 2017; Biswas et al., 2017; Young, 2007) and also alter other aspects that are similarly affected by serotonin levels such as mood and appetite (Biswas et al., 2017; Bedrosian & Nelson, 2017; Liu et al., 2022;

Scheibehenne et al., 2010; Iwata et al., 1997). Therefore, we expected to observe prosocial responses in our subjects under brighter light than in darkness, assuming we replicate results where serotonin is directly manipulated. Specifically, we expected for our subjects in the dark to trust less in the trust game, reject more unfair offers in the ultimatum game, be less cooperative in the public goods game, and respond with less effort in the gift exchange game.

In our experiment, we find no effects in the ultimatum game across treatments, even when focusing on low offers, that is, both less than half the endowment and less than a third of the endowment. As such, we do not replicate the results from our study for the ultimatum game. We also study the trust, public goods, and the gift exchange games. While we do not observe more trust in the light condition, we do find that our subjects exhibit greater trustworthiness in the light condition than in the dark. We find that there are no observed effects in public goods from our treatment. In our gift exchange game, we observe that employers offer higher wages in the dark and expect less effort from employees than in the light, however, employees do not exert differential efforts across treatments. While in the trust game we find evidence of greater reciprocity in the light condition, we do not find the same direct evidence of reciprocity in the gift exchange game. We do, however, see a difference in reciprocity expectations from our treatment variation in the gift exchange game.

We believe there are a few reasons for the null effects in the ultimatum game. One major difference between the ultimatum game implemented here and the ultimatum game studied in other settings with direct serotonin alteration is the setting. Specifically, we implement a one-shot ultimatum game with incentives for both the proposer and the responder, in which we only have one offer for the responder. Given that many of the offers made in other studies are close to equal split (Andersen et al., 2011), we mostly observed responses to kind (fair) offers. Most of the other literature exploring the ultimatum game and serotonin focus on responders responding to preset offers at varying levels rather than one smaller stake size, and in some cases, these are hypothetical responses (Crockett et al., 2008). Furthermore, we do find that a student population would respond to a darker setting with higher rejection rates in most unfair offers, but we were only able to find this response implementing the strategy method in which, similar to other studies, subjects had a set of decisions to confront versus only one.

Furthermore, the method to alter serotonin level is vastly different in our experiment compared to other experiments. Other experiments use pharmaceutical approaches and direct measurement to observe behavior under different serotonin levels (Crockett et al., 2008; Crockett & Fehr, 2014). We explore light as a mechanism to alter the serotonin levels given what we know about light and its effect on serotonin, yet do not measure serotonin levels directly which is a limitation to this study (Young, 2007). Light can affect many other biological processes that are not restricted to serotonin alone (Bellucci et al., 2020; Sarmiento Rivera & Gouveia, 2021; Strang et al., 2017). In fact, while some literature has cited serotonin as the mechanism that affects food consumption behavior, some argue that light affects food consumption behavior through other mechanisms that are not necessarily serotonin (Stemer et al., 2015).

While there may be reasons for which we do not replicate the results for some social preferences under different lighting conditions, we cannot discard the possibility that lighting has an effect on any social preferences. In our laboratory-controlled setting, we find strong effects of trustworthiness in our subjects. Specifically, we find that our subjects are less trustworthy in the dark than in the light. We also find that employers offer higher wages and expect less effort in the dark than in the light. Both of these results capture effects and expectations of reciprocity from different angles that need to be further explored. Future study may also include incentivized ultimatum games at different stake sizes as well as measurement of serotonin levels under the different lighting conditions.

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Appendix

1 Additional Tables and Graphs

Table C1: Summary statistics from lab study

	Overall	Light	Dark	p
Full sample ($n = 248$)				
Morningness-Eveningness Score	11.1	11.2	11.0	0.65
Female	0.47	0.49	0.44	0.49
Asian	0.48	0.48	0.49	0..80
African American	0.05	0.06	0.05	0.78
White	0.39	0.42	0.36	0.36
Hispanic	0.17	0.16	0.17	0.87
Native American	0	0	0.01	0.32
Other Race	0.05	0.05	0.09	0.21
Age	23	23.2	22.7	0.46
Year in School	4.42	4.51	4.32	0.44
Income	2.8	2.8	2.9	0.95
Household size	3.4	3.5	3.3	0.44

Table C2: Additional Gift Exchange Regressions

	Proposed effort		Actual effort	
Dark	-0.06	-0.06*	0.05	0.04
	(0.04)	(0.04)	(0.05)	(0.05)
Controls	No	Yes	No	Yes
Observations		248		

Standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: Regression controls include the morningness-eveningness score, sex, race, age, year in school, income, and household size

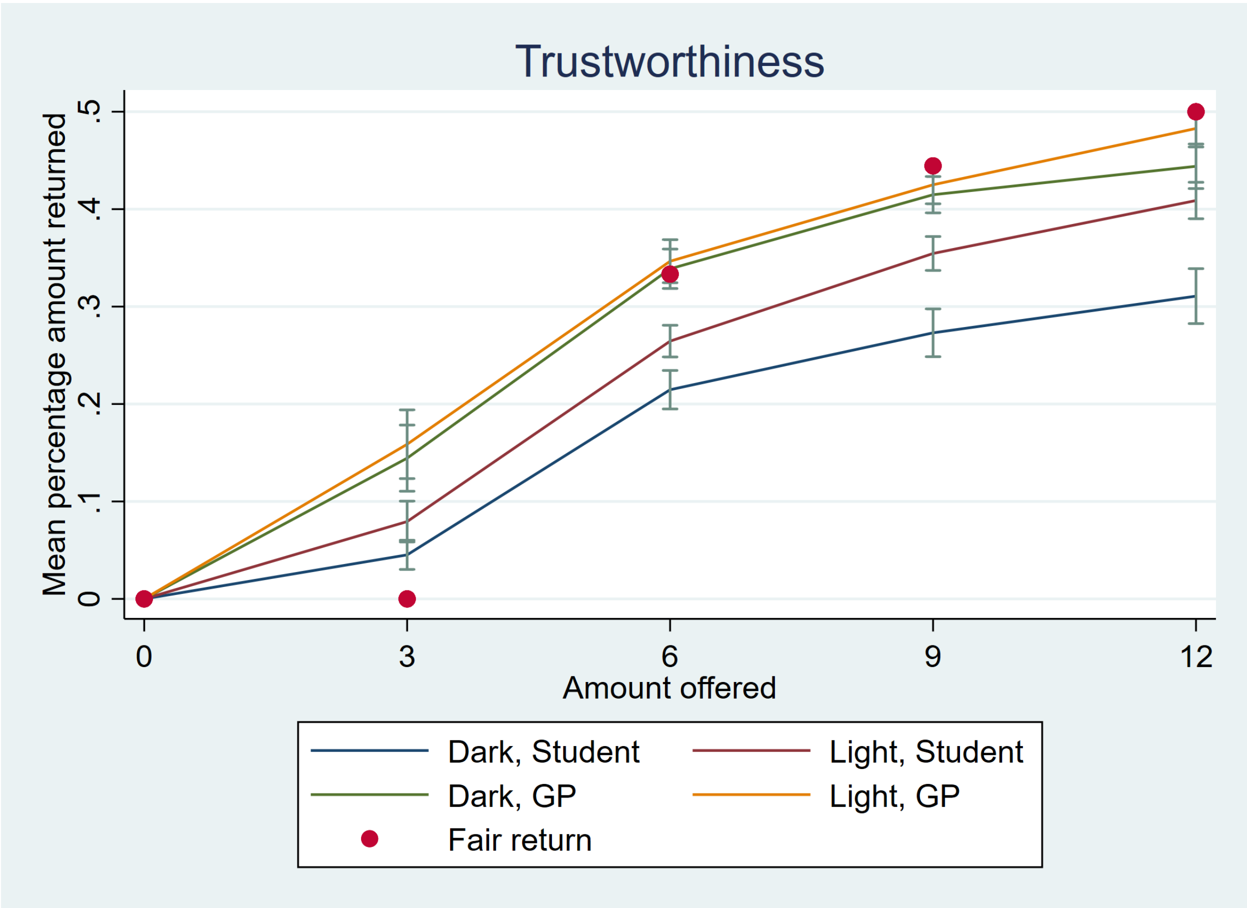

Figure C1: Trustworthiness by amount sent in pilot study, separated by students and non-student adults

Table C3: Additional Wage Regressions

	Actual effort			
Dark	0.03	0.03	-0.02	-0.02
	(0.05)	(0.05)	(0.07)	(0.07)
Above Median Wage	0.09*	0.03	0.05	
	(0.05)	(0.05)	(0.07)	(0.08)
Above Median Wage * Dark			0.11	0.10
			(0.10)	(0.10)
Controls?	No	Yes	No	Yes
Observations		248		

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: Regression controls include the morningness-eveningness score, sex, race, age, year in school, income, and household size

2 Lab Experiment Instructions

(Instructions for Stage 1) Welcome! Thank you for your participation in today's session. At this time, please set aside your belongings and silence your phone. Your participation today is voluntary and you may end the study at any time. However, to receive compensation, you must stay until the end of the experiment.

You are receiving a participation fee plus the earnings you accumulate. In the first half of the study, you will receive a $5 flat fee for completing the first set of tasks. After the first set of tasks, we will move on to the second half of the study. In the second half, you will complete four tasks. One of these four tasks will be randomly selected for payment at the end of the session. After completing the four tasks, you will complete a brief questionnaire. Your total payment will be the participation fee, the flat fee from the first half, and the earnings from the randomly selected task in the second half. Please raise your hand if you have any questions. Otherwise, you may proceed.

(Instructions for Stage 2)

Task 1

[5] In this task, you will be randomly paired with another person in the room. One of you will be randomly selected as Player A and one of you will be Player B. You will not be told the identity of the person with whom you are paired. Player A begins with 10 tokens and Player B begins with 0 tokens.

Player A's decision:

Player A will be asked to propose to split 10 tokens between themselves and Player B. Player A can choose any integer among between 0 and 10 tokens.

Player B's decision:

Player B will be told the offer made by Player A and asked to choose either to **accept** or **reject** the offer. If Player B **accepts** the offer, both Player A and Player B receive the amounts specified in the accepted offer. If Player B **rejects** the offer, both players receive zero earnings from this task.

We remind you that one task will be randomly selected for payment at the end. In this task, 1 token = $1.

Please raise your hand if you have any questions, otherwise please click Next to continue

(page break)

You are Player *(A,B)*

(page break)

(Player A screen) You are assigned as Player A. You have 10 tokens. Please choose how many tokens you propose to send to Player B, if any. Please recall that Player B can accept or reject your offer.

(Player B screen) Player A had 10 tokens. Player A decided to offer you *(offer)* and keep *(amount kept)*.

[5] The tasks in Stage 2 were randomly shown to the subjects, but the title always started with Task 1 regardless of the actual task.

You can now decide if you want to accept or reject this offer. If you reject the offer, both of you will receive 0 tokens in this task.

Please select whether you accept or reject Player A's offer.

-Accept

-Reject

Task 2

In this task, you will be randomly paired with someone in the room different from Task 1. One of you will be randomly selected as Player A and one of you will be Player B. You will not be told the identity of the person with whom you are paired. Player A and Player B both begin with 10 tokens.

We remind you that one task will be randomly selected for payment at the end. In this task, 1 token = $1.

Please click next to view more about the decisions you will make.

(page break)

Player A's decision

Player A moves first. Player A may send some, all, or none of the 10 tokens to Player B. Each token sent to Player B will be tripled. For example, if Player A sends 2 tokens, Player B receives 6 tokens (2x3=6). If Player A sends 8 tokens, Player B receives 24 tokens (8x3=24). Player B will then decide how many tokens to send back to Player A and how many tokens to keep. Player A indicates how many tokens to send to Player B by typing the appropriate amount of tokens on the decision screen.

Player B's decision

Player B begins with 10 tokens. In addition, Player B receives three times the amount sent by Player A. Player B may send back some, all, or none of the tripled amount to Player A

(Player B keeps the 10 tokens they started with). Any tokens sent back to Player A will not be tripled. Once Player A has sent some, none, or all of their tokens, Player B will then decide how many tokens to send back to Player A and how many to keep.

(page break)

Your randomly assigned role in this task has been listed below.

You were randomly selected to be Player *(A,B)*.

(for player A) Please click Next to decide how many tokens to send to Player B.

(for player B) Please click Next to wait for Player A's decision.

(page break)

(Player A screen) You are Player A. You can send some, all, or none of the 10 tokens. Please indicate how many tokens to send. You can send any integer amount between 0 and 10 tokens.

(page break)

(Player B screen) You are Player B. Player A sent *(amount sent)* tokens. This amount has tripled, so you have *(tripled amount)* in addition to your 10 tokens, which is in total *(tripled amount plus endowment)*. You now have an opportunity to send any amount of what you received to Player A. You will keep your original 10 tokens. Out of *(tripled amount)*, how much would you like to send to Player A?

Task 3

In this task, you will complete 12 rounds (2 practice, 10 real). You will be randomly assigned to a group of 4 members. Each member will receive 10 tokens each period and will decided how to divide the tokens between two accounts: **Private Account** or **Public Account**. The composition of your group will stay the same for every round. You will not know the identities of the other members, nor will they know your identity. We remind you that one task will be randomly selected for payment at the end. 1 token = $0.10.

Please click Next to learn about the accounts you can invest in

(page break)

Private Account: Every token you invest in the private account will yield a return of 1 token. The other members in your group will not be affected by your investment.

Example 1: Suppose you invest 10 tokens in the private account. Then you will get 10 tokens from this account and the other members of your group will not be affected.

Example 2: Suppose you invest 0 tokens in your private account. Then you will get 0 tokens from this account.

(page break)

Public Account: Every token you invest in the public account will yield a return of 0.5 tokens to each player, including yourself. Also, every token that any of your group members invests in the public account will yield a return of 0.5 tokens to each player in the group, including yourself. This means that your return from the public account will depend on the total number of tokens that you and the other members of your group invest in this account. The more the group invests in the public account, the greater the return to each member of the group from this account.

Example 1: Suppose you invest 0 tokens in the public account and the other three members of your group invest a total of 20 tokens in the public account. Then the total return to each player from the public account is 20*0.5=10 tokens. Your payoff for that round would be your return from your private account (10 tokens) plus the 10 tokens from the public account, totaling 20 tokens.

Example 2: Suppose you invest 10 tokens in the public account and the other three members of your group invest 0 tokens in the public account. Then the public account returns 10*0.5=5 tokens to each player, which would be your payoff for the round.

Example 3: Suppose each member in your group (including yourself) invests 10 tokens into the public account. The total number of tokens in the public account is 40 with a return of

40*0.5=20 tokens to each player.

(page break)

Your decisions and earnings in every period are confidential. This means you will not be given information about the investment decisions or earnings of any of your group members, nor will they be given information about your investment decisions or earnings.

After each period, you will receive the following information:

1. Number of tokens you invested in the private and public accounts

2. The total number of tokens invested by your group (including yours) in the public account

3. Your earnings for that period

Once all decisions have been made for all rounds, the game will end. We will calculate payoffs based on the decisions made.

(page break)

(Practice) Round x

Please enter your contribution to the private and public accounts and click next. Remember that your combined contribution to the private and public account must equal 10 tokens.

Your contribution in the private account:

Your contribution in the public account:

Your contribution into your private account in the previous round:

Your contribution into the public account in the previous round:

Total group investment into the public account in the previous round:

Your tokens for this period in the previous round:

(page break)

Your Profit, *(Practice)* Round x

Your contribution into your private account:

Your contribution into the public account:

Total group investment into the public account:

Your tokens for this period:

(page break)

This concludes Task 3. You may now proceed to the next task.

Task 4

In this task, there are two types of participants: **employer** and **employee**.

You will be randomly chosen with equal chance whether you will be an employer or an employee. Each person selected to be an employer will be randomly paired with another person in the room who has been selected as an employee.

The identity of the participants will remain anonymous. You will never know the identity of the person you were paired with and the other person will never know your identity.

We remind you that one task will be randomly selected for payment at the end. 1 token = \$0.20.

(page break)

The task consists of two stages. The employer pays a wage w to the employee. After receiving the wage w, the employee will choose an effort level e for the employer. The details are as follows.

Stage 1 (employer): a) The employer chooses the wage level, w for their employee; b) The employer also announces a non-binding effort level, $\hat{e}$, that they want the employee to do.

Stage 2 (employee): The employee has to choose their effort level, e, after he reviews the wage level set by the employer.

Note: The final payment of both parties will be decided by the employee's actual decision on effort e, and will NOT be decided by the proposed effort. The combination of wage and actual effort level determine monetary payoffs for the employer and the employee: The cost of each real e:

Effort Level	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Cost	0	1	2	4	6	8	10	12	15	18

(page break)

Effort Level	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Cost	0	1	2	4	6	8	10	12	15	18

Calculation of payoffs: **Payoff of the employer=**$(120 - w) * e$

The payoff of the employer equals: (120 - the wage paid to the employee) * the actual effort level selected by the employee.

Payoff of the employee $= w - c(e)$–20

The payoff of the employee equals: the wage received from the employer - the cost of the actual effort level he selected - 20.

Thus, the higher the effort level provided by the employee and the lower the wage, the larger the employer's payoffs. The lower the effort level provided by the employee and the higher the wage, the larger the employee's payoffs.

Example:

If the actual wage is 50 and the actual effort level is 0.5, then the payoffs would be:

Employer's payoffs = (120 - 50) * 0.5 = 35 points = $17.50

Employee's payoffs = 50 - 6 - 20 = 24 points = $12

(page break)

Effort Level	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Cost	0	1	2	4	6	8	10	12	15	18

Questionnaire

Just to be sure that you understand the instructions you have to solve a simple questionnaire. When everyone in the room has answered the questionnaire correctly we will start the task.

The wage for an employee is 100 and the proposed effort level from the employer is 0.8, and actual effort level selected by the employee is 0.3, then the payoffs would be:

Employer's payoff (experimental points):

Employee's payoff (experimental points):

(page break)

You are selected to be the *(employee/employer)*

(employee): Please proceed to the next page to wait for the employer's decision

(employer): Please proceed to the next page to make a decision

(page break)

(Employer page) What wage would you like to offer?

Effort Level	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Cost	0	1	2	4	6	8	10	12	15	18

What effort level do you expect from your employee?

*(Employee page)*Your employer has chosen wage *(wage)* for effort level *([proposed effort)*.

Which effort level would you like to choose?

(page break)

Results

Employer offered wage *(wage)* for effort level *(proposed effort)*.

Employee chose effort level *(actual effort)*.

Employer's final point value:

Employee's final point value:

(page break)

This concludes Task 4. Please click next to complete the questionnaire.

(page break)

Considering your own "feeling best" rhythm, at what time would you get up if you were entirely free to plan your day?

- Between 5 am - 6:30 am
- Between 6:30 am - 7:45 am
- Between 7:45 am - 9:45 am
- Between 9:45 am - 11 am
- Between 11 am - 12 pm

During the first half-hour after waking up in the morning, how tired do you feel?

- Very tired
- Fairly tired
- Fairly refreshed
- Very refreshed

At what time in the evening do you feel tired, and as a result in need of sleep?

- Between 8 pm - 9 pm
- Between 9 pm - 10:15 pm
- Between 10:15 pm - 12:45 am
- Between 12:45 am - 2 am
- Between 2 am - 3 am

At what time of the day do you think you reach your "feeling best" peak?

- Between 12 am - 4:30 am
- Between 4:30 am - 7:30 am
- Between 7:30 am - 8:45 am
- Between 8:45 am - 4:30 pm
- Between 4:30 pm - 11 pm
- Between 11 pm - 12 am

Please indicate your gender

- Male
- Female
- Other
- Prefer not to answer

Please indicate your race

- Asian/Pacific Islander
- African American
- Caucasian/White
- Native American/Indigenous
- Other

Are you Hispanic?

- Yes
- No

Please indicate your age

Please indicate your year in school

- 1st year undergraduate

- 2nd year undergraduate
- 3rd year undergraduate
- 4th year undergraduate
- 5th+ year undergraduate
- Graduate student
- Non-student

Please indicate your gross annual household income (if undergraduate student, you may consider your parent's income as your hosuehold income)

- Less than $30,000
- $30,000 - $49,999
- $50,000 - $74,999
- $75,000 - $99,999
- $100,000 - $124,999
- $125,000 +

How many people in your household? Note: if you used your parent's income in hte previous question, please indicate the number of that household, not your current living arrangement:

Please provide any comments that you would like to share with the research team at this time.

3 Pilot (Breakfast): Experimental Design and Procedure

We first conducted a breakfast pilot study[6]. We had two different conditions: dark and light. The lux level in the dark condition varied between 11 to 60 lux depending on where the subject was sitting in the room.[7] In the light condition, the level varied between 640 to 950 lux.[8]The breakfast study was conducted between March and June 2022. There were 40 sessions which had between three and twelve individuals per session for a total of 247 participants. Participants were from both a student and an adult non-student population, recruited using bulk emails.

Participants were asked to fast for at least three hours before their assigned session time. Once they arrived, they signed consent forms and waited to enter the breakfast area. Once they entered the breakfast area, they were seated, assigned a participant id number, and filled out a brief questionnaire, provided in Appendix 4. After completing the questionnaire, participants received the instructions for the breakfast procedures. Each participant was privately called using their id number to bring their food plate and self-serve their breakfast food in the amount they desired.[9]

The subject went to the breakfast table and had the option to serve as much food as they wanted. We offered a tray of mini chicken breakfast sandwiches and an assorted fruit tray. Each tray was sitting on a food scale. The food scale was covered by a table cloth that, from the subject's perspective, was there for aesthetics, so the subjects were unaware that a food scale was used to measure the weight of the food serving. A session monitor was monitoring the beginning and ending weight of the scale to measure actual food intake.

[6]The breakfast pilot study was conducted as part of a larger study measuring eating behaviors under different lighting conditions.

[7]While black out shades were available, the window still provided some variation to the room at different seats.

[8]Seating arrangement as well as outdoor lighting levels affected the variation in light levels.

[9]One participant was physically unable to take their own plate and a session monitor provided assistance, but the food decision was still private from the other subjects.

Once the subject gathered as much food as they wanted, they went back to their seat and the next participant was called up. This procedure was implemented to ensure that the decision of how much to eat was made at the individual level. Once each participant had at an opportunity to select food once, they were offered to come up for additional food as many times as participants desired simulating an all-you-can-eat buffet. There was enough food for multiple servings and the food did not run out in any session.

After everyone had as much food as they wanted, participants proceeded to the questionnaire and completed the trust game, ultimatum game, and a real-effort task. We did these tasks using pen and paper and employed the strategy method. Once subjects completed all tasks, the session monitor picked up the packets, had a subject draw a random number to determine the payment task, and if necessary, randomly paired the subjects using a computer randomizer, and implemented the decisions from the selected task. Subjects were paid accordingly and dismissed. After all subjects were dismissed, the session monitor weighed the plates that were left behind to measure food waste and calculated consumption by weight.

4 Breakfast Experiment Instructions

ID: ______________________________

Welcome! Thank you for your participation on today's session. You will start by completing the questionnaire below. Once you have completed it, you may turn in the questionnaire to the session monitor and get your breakfast. Only one person may get breakfast at a time. You are allowed to have as many breakfast items as you would like. You may get more as needed. You are not required to eat everything on your plate, but you will not be able to take any leftovers home. Once you have had your breakfast, a session monitor will collect your plate and you will receive further instruction on some additional tasks. This session will take no more than an hour. Please let a session monitor know if you have any questions.

Questionnaire

- Please read each qeustion very carefully before answering
- Answer all questions
- Answer questions in order
- Answer each question independently of others
- Please only select one answer which best reflects your situation
- Please answer each question as honestly as possible. Your answers will be kept confidential and anonymous.

How many hours did you sleep last night? ______________________________

How many days a week do you eat breakfast?

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7

At what time did you consume your previous meal? ______________________________

Rate at a scale of 1-9 how hungry you are currently feeling (1 = Full; 9 = Extremely hungry): ______________________________

Do you currently have a serious health issue?

- Yes
- No

Consider your own "feeling best" rhythm, at what time would you get up if you were entirely free to plan your day?

- Between 5 am - 6:30
- Between 6:30 am - 7:45 am
- Between 7:45 - 9:45 am
- Between 9:45 am - 11 am
- Between 11 am - 12 pm

During the first half-hour after having woken in the morning, how tired do you feel?

- Very tired
- Fairly tired
- Fairly refreshed
- Very refreshed

At what time in the evening do you feel tired, and as a result in need of sleep?

- Between 12 am - 4:30 am
- Between 4:30 am - 7:30 am
- Between 7:30 am - 8:45 am
- Between 8:45 am - 4:30 pm
- Between 4:30 pm - 11 pm
- Between 11 pm - 12 am

Please indicate your gender

- Male
- Female

- Other
- Prefer not to answer

Please indicate your race

- Asian/Pacific Islander
- African American
- Caucasian/White
- Native American/Indigenous
- Other

Are you Hispanic?

- Yes
- No

You have completed this questionnaire. Please take the completed questionnaire to a session monitor to get some breakfast.

ID: ____

You will now answer one question and complete a small series of tasks. Please read the instructions carefully. One of these tasks will be randomly selected for payment.

Rate at a scale of 1-9 how hungry you are currently feeling (1 = Full; 9 = Extremely hungry): ____

Task 1

You will be randomly paired with someone in the room. The identity of this person is anonymous. Of the two of you, one of you will be randomly assigned as Person A and the other will be the Person B.

Person A will be given a $10 endowment and will make the offer to split this amount with the Person B. Person B then has the decision to either accept the split or reject. If Person B accepts Person A's offer, the proposal will be implemented, that is, they will each earn the amount in the proposal. If Person B rejects the offer, both persons will earn $0.

If you are selected as Person A what split would you like to propose out of $10? Please only select ONE of these proposals. Your final payoff will be determined on whether Person B accepts the offer.

- $0 for me, $10 for Person B
- $1 for me, $9 for Person B
- $2 for me, $8 for Person B
- $3 for me, $7 for Person B
- $4 for me, $6 for Person B
- $5 for me, $5 for Person B
- $6 for me, $4 for Person B
- $7 for me, $3 for Person B
- $8 for me, $2 for Person B
- $9 for me, $1 for Person B
- $10 for me, $0 for Person B

If you are selected as Person B, which of these offers would you accept? Please select ALL the offers you would accept from Person A

- $0 for Person A, $10 for me
- $1 for Person A, $9 for me
- $2 for Person A, $8 for me
- $3 for Person A, $7 for me
- $4 for Person A, $6 for me
- $5 for Person A, $5 for me
- $6 for Person A, $4 for me

- $7 for Person A, $3 for me
- $8 for Person A, $2 for me
- $9 for Person A, $1 for me
- $10 for Person A, $0 for me

Task 2

You will be randomly paired with someone in the room. The identity of this person is anonymous. Of the two of you, one of you will be randomly assigned as Person A and the other will be Person B.

Person A will be given a \$4 endowment. Person A will send any amount of the \$4 (x) to Person B. When this money is being sent to Person B, the money will triple in amount, so the receiver will receive 3 times what was sent ($3x$). Person B will then send any of this amount of what was received (y) back to Person A. The final payoff for Person A will be \$4 minus the amount sent plus whatever Person B sends back ($4 - x + y$). The final payoff for Person B will be the tripled amount from Person A minus what is sent back to Person A ($3x - y$).

If you are selected as Person A, what amount would send of \$4? Please only select ONE of these proposals. Remember, the amount you send over will triple in amount. Person B may or may not send some amount back, which will determine your final payoff.

- \$0
- \$1
- \$2
- \$3
- \$4

If you are selected as Person B, please select ONE choice for each of these four scenarios for the tripled amount your Person A may send. Note: if your Person A does not send any amount over, you will receive \$0 and Person A will receive \$4 as final payment.

How would you split \$3? Select ONE

- Keep \$3, send back \$0 [Final payoff: \$3 for you, \$3 for Person A]
- Keep \$2, send back \$1 [Final payoff: \$2 for you, \$4 for Person A]
- Keep \$1, send back \$2 [Final payoff: \$1 for you, \$5 for Person A]
- Keep \$0, send back \$3 [Final payoff: \$0 for you, \$6 for Person A]

How would you split \$6? Select ONE

- Keep $6, send back $0 [Final payoff: $6 for you, $2 for Person A]
- Keep $5, send back $1 [Final payoff: $5 for you, $3 for Person A]
- Keep $4, send back $2 [Final payoff: $4 for you, $4 for Person A]
- Keep $3, send back $3 [Final payoff: $3 for you, $5 for Person A]
- Keep $2, send back $4 [Final payoff: $2 for you, $6 for Person A]
- Keep $1, send back $5 [Final payoff: $1 for you, $7 for Person A]
- Keep $0, send back $6 [Final payoff: $0 for you, $8 for Person A]

How would you split $9? Select ONE

- Keep $9, send back $0 [Final payoff: $9 for you, $1 for Person A]
- Keep $8, send back $1 [Final payoff: $8 for you, $2 for Person A]
- Keep $7, send back $2 [Final payoff: $7 for you, $3 for Person A]
- Keep $6, send back $3 [Final payoff: $6 for you, $4 for Person A]
- Keep $5, send back $4 [Final payoff: $5 for you, $5 for Person A]
- Keep $4, send back $5 [Final payoff: $4 for you, $6 for Person A]
- Keep $3, send back $6 [Final payoff: $3 for you, $7 for Person A]
- Keep $2, send back $7 [Final payoff: $2 for you, $8 for Person A]
- Keep $1, send back $8 [Final payoff: $1 for you, $9 for Person A]
- Keep $0, send back $9 [Final payoff: $0 for you, $10 for Person A]

How would you split $12? Select ONE

- Keep $12, send back $0 [Final payoff: $12 for you, $0 for Person A]
- Keep $11, send back $1 [Final payoff: $11 for you, $1 for Person A]
- Keep $10, send back $2 [Final payoff: $10 for you, $2 for Person A]
- Keep $9, send back $3 [Final payoff: $9 for you, $3 for Person A]
- Keep $8, send back $4 [Final payoff: $8 for you, $4 for Person A]
- Keep $7, send back $5 [Final payoff: $7 for you, $5 for Person A]
- Keep $6, send back $6 [Final payoff: $6 for you, $6 for Person A]
- Keep $5, send back $7 [Final payoff: $5 for you, $7 for Person A]
- Keep $4, send back $8 [Final payoff: $4 for you, $8 for Person A]
- Keep $3, send back $9 [Final payoff: $3 for you, $9 for Person A]
- Keep $2, send back $10 [Final payoff: $2 for you, $10 for Person A]
- Keep $1, send back $11 [Final payoff: $1 for you, $11 for Person A]
- Keep $0, send back $12 [Final payoff: $0 for you, $12 for Person A]

Task 3

In the next page, you will see some excerpts of text. Please count the number of times the letter “e” is printed in each of these excerpts. You will earn 20 cents for each e correctly found up to the correct number, and lose 20 cents for any additional e counted. You will have one minute to complete this task.

PLEASE DO NOT TURN THE PAGE UNTIL YOU ARE INSTRUCTED TO DO SO

Task 3

Adipiscing consequat vivamus. Cum augue Luctus conubia nonummy sodales accumsan rutrum maecenas rhoncus. Vitae tortor conubia. Sapien a fames morbi praesent lacus enim massa mus dictum a, class convallis interdum convallis primis nostra.

Number of “e”s in this paragraph: ____________________

Neque facilisis risus lobortis magnis maecenas nam sociosqu erat praesent cubilia inceptos porta tempus nostra tellus mollis turpis auctor leo volutpat nulla vivamus dolor in. Primis interdum magnis consectetuer dolor maecenas. Vehicula malesuada hendrerit ornare. Ligula ac facilisi. Ligula odio mauris convallis non. Massa.

Number of “e”s in this paragraph: ____________________

Porta ante nulla cras congue sem feugiat neque magnis tristique ridiculus malesuada justo ridiculus vehicula iaculis. Justo suscipit ligula sociis integer nostra hac.

Number of “e”s in this paragraph: ____________________

Total “e”s counted: ____________________

FINAL QUESTIONS

Your height: ____________________

Your weight: ____________________