Delaying gratification depends on social trust

by

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Abstract

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Delaying gratification depends on social trust

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Delaying gratification is hard, yet crucial to individual and societal success. Prominent theories focus on the importance of self-control, hypersensitivity to immediate rewards, and the subjective cost of time spent waiting. However, delaying gratification may also require trust in people delivering future rewards as promised. Four studies tested the role of social trust in delaying gratification. In Experiments 1 and 2, adult participants were presented with hypothetical character vignettes and faces that varied in trustworthiness, and then chose between smaller immediate or larger delayed rewards from those characters. In Experiment 3, children participated in the delay of gratification task with an experimenter who behaved in either a trustworthy or an untrustworthy manner toward a confederate. Across all three experiments, participants were less willing to wait for delayed rewards from less trustworthy individuals. Experiment 4 measured individual differences in social trust and delaying gratification. Trust measures did not correlate with delay choices. This work demonstrates that manipulating social trust influences delay of gratification, across hypothetical and realized scenarios, in adults and children.

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Delaying gratification depends on social trust

Delaying gratification is hard, yet critical to individual and societal success. For example, despite the importance of financial security, many people would rather enjoy a paycheck now than put money away to save for later. Healthy adults sometimes struggle to delay gratification, but children and certain clinical populations face particular difficulties (Anokhin, Goloshchekin, Grant, & Health, 2011; Casey et al., 2011; Hongwamishkul, Happaney, Lee, & Zelazo, 2005; Johnson, Bickel, & Baker, 2007; Vuchinich & Simpson, 1998). The ability to resist temptation is highly heritable (Friedman, Miyake, Robinson, & Hewitt, 2011; Miyake & Friedman, 2012), and early ability to delay gratification predicts important outcomes later in life (Ayduk et al., 2000; Casey et al., 2011; Mischel et al., 2011; Mischel, Shoda, & Peake, 1988; Moffit et al., 2011; Shoda, Mischel, & Peake, 1990), but this fundamental skill is not immutable: strategies such as cognitive reframing (Mischel, Shoda, & Rodriguez, 1989; Mischel, Ebbessen, & Zeiss, 1972; Mischel & Underwood, 1974) and modifying the environment (Griskevicius, Tybur, Delton, & Robertson, 2011; Lynam, Caspi, Moffit, Wikstrom, Loeber, & Novak, 2000; Taylor, Kuo, & Sullivan, 2002) can reduce the salience of immediate options, leading to improvements in the ability to delay. Therefore, an improved understanding of the factors that influence this fundamental skill is important, not only for refining theoretical frameworks, but also to maximize opportunities for intervention.

Prominent accounts of delaying gratification focus on self-control, sensitivity to immediate rewards, and the perceived cost of time spent waiting for the delayed option as possible explanations for why delaying is so difficult (Benzion & Rapoport, 1989; Figner et al., 2010; McClure, Laibson, Loewenstein, & Cohen, 2004; Zauberman & Lynch, 2005). However, growing evidence suggests social factors, such as trust, may also play an important role.

Delaying gratification relies on the fundamental assumption that the future reward will actually be delivered as promised (e.g., clients trusting that a portfolio manager will responsibly manage their savings; Mischel, 1961b). Therefore, delaying gratification might only occur in a trustworthy social context, where individuals are confident that they will actually receive the delayed reward in the future if they opt to wait for it. Under this framework, a lack of trust might partially explain lapses in the ability to delay gratification, particularly when other established factors appear to be intact.

Some existing correlational evidence is consistent with a role of social trust in delaying gratification, but is open to alternative interpretations. For example, children with fathers absent from the home (who might therefore struggle with trust issues) are also more likely to prefer smaller immediate rewards compared to larger delayed options (Mischel, 1961b). Additionally, cooperation in a trust game was associated with delay of gratification in a temporal discounting task, such that individuals who were less cooperative (indicating trust was lacking) were also more impulsive (Harris & Madden, 2002). However, such correlations could be driven by other factors, such as self-control (i.e., children without fathers in the home might have lower self-control, which leads to less delaying gratification). Alternatively, such correlations could be driven by a causal relationship in the reverse direction, such that social cooperation requires the ability to delay gratification (Harris & Madden, 2002).

Some experimental work suggests a causal role of social trust in delaying gratification, but could also be interpreted in terms of more general reward effects. For example, when rewards are promised by an experimenter but never provided, or delivered inconsistently, preferences for immediate gratification increase in humans and other animals (Kidd, Palmeri, & Aslin, 2012; Mahrer, 1956; Stevens, Rosati, Heilbronner, & Muhloff, 2011). This effect could

arise from reduced social trust, but might alternatively arise from the changes to subjective wellbeing, motivation, and willpower that accompany reward provision/omission (Gomez & McLaren, 1997) and are known to influence self-control (Vansteenkiste & Deci, 2003; Ifcher & Zarghamee, 2011; Lerner, Li, & Weber, 2013; Pyone & Isen, 2011).

A possible role of social trust in delaying gratification could also help to make sense of some puzzling developmental findings. Specifically, although most prominent explanations of the difficulties of delaying gratification in children focus on slow-developing executive abilities, such as selective attention and response inhibition (Hofmann, Friese, & Roefs, 2008; Metcalfe & Mischel, 1999), the emergence of cognitive control and delay choices do not always coincide. For example, preschoolers show improvements on measures of cognitive control across 2-4 years of age, but delay choices show no age-related changes over the same developmental period (Beck, Schaefer, Pang, & Carlson, 2011). In addition, training programs that improve cognitive control in children 4-12 years of age show no effects on measures of delay of gratification (Diamond & Lee, 2011). These findings suggest that other factors must also play a role in the development of delay of gratification, but such factors are not well specified or well understood. Given that trust develops slowly across childhood, and levels off in early adulthood (Sutter & Kocher 2003), a lack of trust could partially explain these early difficulties in delaying gratification.

The proposed research tests whether social trust influences delay of gratification, controlling for any effects related to reward. In Experiments 1 and 2, adult participants read vignettes about fictional characters, then considered each character in various delay of gratification situations. Adults were tested to build on prior manipulations of trust in the absence of rewards (Delgado, Frank, & Phelps, 2005; Fareri, Chang, & Delgado, 2012; Oosterhof &

Todorov, 2008), and to obtain more precise estimates of willingness to delay. Experiment 3 employs real, rather than hypothetical, trust manipulations and rewards, and tests for a role of trust in children. Experiment 4 examines individual differences in social trust and willingness to delay, to test for a relationship in the absence of experimental manipulations.

Experiment 1

All participants read three vignettes depicting trustworthy, untrustworthy, and neutral characters, then considered each character in delay of gratification situations.

Method

Participants

Seventy-eight participants (34 male, 39 female, five who preferred not to indicate gender) between 18 and 64 years of age (M_{age} = 31.1 years, SD = 11.1 years) were paid between $0.25 and $1.00 for completing the experiment, which lasted 10-15 min. Participants were recruited via Amazon's Mechanical Turk, a website that allows users to complete small tasks for pay, and had an average approval rating of at least 99% from previous jobs. Participants lived in the United States, and were normally distributed in terms of socioeconomic status, with the average participant having completed some college and receiving a financial income between $37,500 - $49,999 per year. All participants were included in the analyses; results were identical when excluding participants based on null discounting (i.e., all later responses in at least one condition, n = 2; as in Kirby and Marakovic, 1996).

Materials and procedure

The experiment was presented in an online survey format. Participants first completed demographic questions. Then, as in Delgado, Frank, & Phelps (2005), participants read three vignettes (see Appendix A) in fixed order (trustworthy, untrustworthy, neutral) and completed

trustworthiness ratings, using a scale of 1-7 to rate each individual described in the vignettes on trustworthiness, likability, approachability, and likelihood of sharing. Next, participants completed the intertemporal choice questions (as in Kirby & Marakovic, 1996), which varied in immediate reward values ($15-83), delayed reward values ($30-85), and length of delays (10-75 days). Each question was modified to mention an individual from one of the vignettes (e.g., "If [trustworthy individual] offered you $40 now or $65 in 70 days, which would you choose?"). Participants completed 63 questions in total, with 21 unique intertemporal choice questions three times each (once with each vignette character), interleaved in a single fixed but random order for all participants. The 21 choices were classified into 7 ranks (using the classification system from Kirby & Marakovic, 1996, which was based on the percentage of individuals that opted to delay on that trial) where higher ranks should yield higher likelihood of delaying, allowing a rough estimation of a subject's willingness to delay using a small number of trials. Rewards were hypothetical, given evidence that hypothetical rewards and real rewards elicit equivalent behaviors (Bickel, Pitcock, Yi, & Angtuaco, 2009) and patterns of brain activity (Ballard & Knutson, 2009), and were preceded by instructions asking participants to consider each hypothetical choice as if they were actually going to receive the option they selected. Participants took as much time as they needed to complete the procedures.

Results and discussion

Trust manipulated in the absence of reward, within subjects, influenced participants' willingness to delay gratification, with perceived trustworthiness predicting willingness to delay.

Approach and preliminary analyses. The effect of condition and rank on choice was analyzed with generalized linear mixed effect (lmer) models (with a logit link), using the lme4 package (Bates & Sarkar, 2006) in the R statistics program (R Development Core Team, 2006).

Intercepts were modeled as random effects. This technique is a common alternative to ANOVA (e.g., Laubrock, Engbert, Rolfs & Kliegl, 2007) and enables modeling of individual trial data to predict the probability of choosing the delayed option ("probability of delaying") without averaging within individuals or rank. Validating the short temporal discounting assessment, the probability of delaying increased with rank as expected, $b = 0.81$, $SE = 0.15$, $z = 54.12$, $p < .001$. Perceived trustworthiness was predicted by condition (untrustworthy < neutral < trustworthy), $b = 1.41$, $SE = .02$, $t = 90.9$, $p < .0001$, suggesting our trust manipulation was effective (Figure 1A). The difference between untrustworthy and neutral conditions was not significantly different from the difference between neutral and trustworthy conditions, $b = .18$, $SE = .27$, $t = 0.65$, $p > .51$.

Effects of social trust on delaying gratification. Participants' willingness to delay gratification, as indexed by probability of delaying, was predicted by trust condition, $b = 1.48$, $SE = .04$, $z = 17.72$, $p < .0001$; both untrustworthy ($b = 1.48$, $SE = 0.23$, $z = 6.35$, $p < 0.001$) and trustworthy ($b = 0.49$, $SE = 0.08$, $z = 5.93$, $p < 0.001$) conditions were significantly different from the neutral condition. The difference between untrustworthy and neutral conditions was greater than the difference between trustworthy and neutral conditions, $b = .87$, $SE = .17$, $t = 5.18$, $p < .001$, (Figure 1B); thus, the trust manipulation had a larger effect on delaying gratification at lower levels of trust, consistent with prior work that has found nonlinear effects of trust manipulations on other behaviors (e.g., Fareri, Chang, & Delgado, 2012). There was also an interaction between condition and rank, $b = .11$, $SE = .02$, $z = 6.1$, $p < .001$, such that the increase in delay choices with rank was smaller in the untrustworthy condition relative to the trustworthy and neutral conditions. This suggests that even as the delayed option became more appealing, those in the untrustworthy condition were nevertheless still inclined to choose the

immediate reward. Perceived trustworthiness predicted probability of delaying, $b = .49$, $SE = 0.03$, $z = 18.53$, $p < 0.0001$, such that lower perceived trustworthiness predicted lower willingness to delay (Figure 1C). Finally, there was an interaction between condition and trustworthiness ($b = 0.21$, $SE = 0.03$, $z = 6.30$, $p < 0.001$), such that trustworthiness predicted probability of delaying within only the untrustworthy condition, consistent with a non-linear effect of trust on delay of gratification.

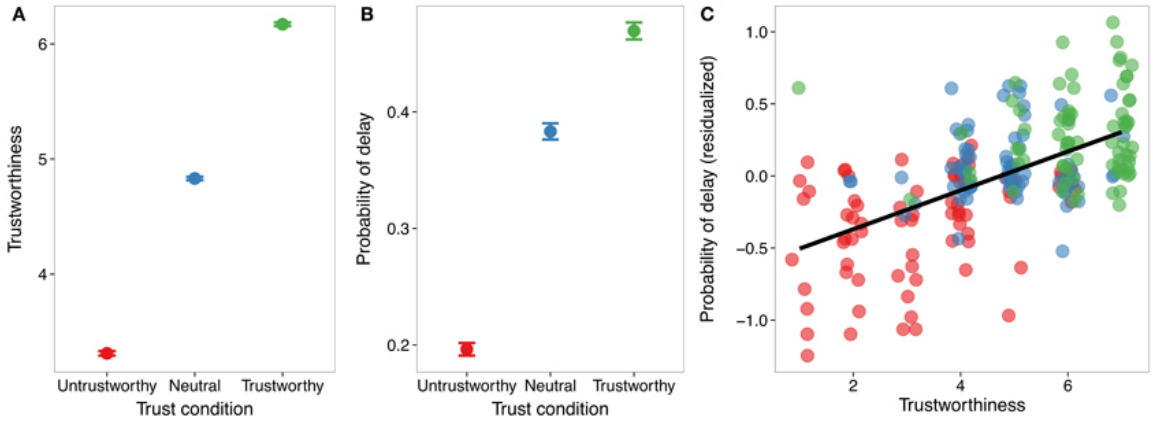

Figure 1. Trust effects willingness to delay gratification within subjects. (A) Perceived trustworthiness increased as a function of trust condition. Error bars are standard error. (B) Probability of delaying gratification was lower in the untrustworthy condition (red) compared to the neutral (blue) and trustworthy conditions (green). (C) Perceived trustworthiness correlated positively with probability of delay across conditions. Residuals after regressing out mean probability of delay for each subject are plotted on the y-axis. Individual data points representing individual observations are jittered 0.2 units on the x-axis for display purposes.

The results of Experiment 1 provide initial support for the idea that manipulating social trust, in the absence of rewards, can influence willingness to delay gratification. However, participants read all three vignettes and were asked to rate trustworthiness (as in Delgado et al., 2005) before making intertemporal choices, raising the possibility that participants realized the study was investigating the role of trust in their choices, and responded based on their belief that trust should increase their willingness to delay. The fixed order of the vignettes also leaves open the possibility that perceived trustworthiness, willingness to delay, and their relationship were

somehow driven by the order of vignettes. Experiment 2 addresses these issues by manipulating social trust between participants, and provides a replication test of the effects of social trust in the absence of rewards on delaying gratification.

Experiment 2

All details were identical to Experiment 1 except where noted. Participants were randomly assigned to trustworthy, untrustworthy, or neutral conditions, rather than reading all three vignettes, and personality ratings were moved to the end of the survey, to minimize demand characteristics. To enhance the manipulation of social trust, a trustworthy, untrustworthy, or neutral computer-generated face accompanied each vignette. These faces were drawn from a larger database of faces manipulated to vary in trustworthiness (Oosterhof and Todorov, 2008) and known to influence trusting behavior (e.g., Oosterhof and Todorov, 2009; Todorov et al., 2009). The between-subjects design enabled the use of a larger set of intertemporal choice questions, in a procedure similar to standard intertemporal choice tasks (Richards, Zhang, Mitchell, & de Wit, 1999; Ballard & Knutson, 2009), so discounting rates (k-values) could be calculated.

Method

Participants

One hundred and seventy two participants (65 males, 60 females, 13 who preferred not to indicate gender) between 18 and 61 years of age (M_{age} = 28 years, SD = 8.9 years) participated in this study. Participants were paid $0.25 for completing this study, which took approximately 10 min. This lower pay rate was chosen given the larger sample size, and because compensation rates on Mechanical Turk only influence enrollment rate, not quality of the data (Buhrmester et al., 2011). All participants lived in the United States, and were normally distributed in terms of

socioeconomic status, with the average participant having completed some college and receiving a financial income between $37,500–49,999 per year.

To maintain the between subjects design, 34 participants were excluded for completing surveys from more than one condition from the same IP address. All remaining participants were included in the analyses; results were identical when excluding subjects based on null or inconsistent temporal discounting behavior (as defined as in Johnson and Bickel, 2008, $N = 22$), or for completing the survey too quickly (<3 min, $N = 3$) as has been done in some studies (Lee, 2010; Bucholz and Latorre, 2011), but did not occur in Experiment 1. Final analyses included 46 participants in the trustworthy condition, 49 in the untrustworthy condition, and 43 in the neutral condition.

Materials and procedure

Participants read one vignette, accompanied by a face. Faces were selected from a sample of 100 possible white male faces developed by Oosterhof and Todorov (2008) and implemented in the FaceGen Modeller program (Singular Inversions, Toronto, Ontario, Canada). Three faces were used in each of the three conditions (trustworthy, untrustworthy, and neutral), to minimize effects of stimulus-specific variances related to the faces. This produced nine faces overall (see Figure 2 for example; full set of faces is presented in Appendix B).

Figure 2. Computer generated faces matched to trust conditions. Faces were paired with vignettes in Experiment 2, matching the condition to enhance the manipulation of trust. A total

of three different faces were used, each with untrustworthy, neutral, and trustworthy versions, yielding nine different faces overall.

Participants then completed the intertemporal choice task, which consisted of 49 binary choice questions between a smaller immediate reward ($5) and a larger delayed reward that varied in delay (4-150 days) and value ($11-34). The face from the vignette appeared three times across the intertemporal choice questions, to reinforce the character that the questions pertained to. Lastly, participants completed the personality ratings.

Results and discussion

Trust manipulated in the absence of reward, between subjects, influenced participants' willingness to delay gratification, with perceived trustworthiness predicting willingness to delay.

Approach and preliminary analyses. All analyses were completed using linear model (lm) in the R statistical package. A k parameter was estimated for each participant (as in Ballard & Knutson, 2009), with higher k-values indicating an increased preference for immediate rewards. Indifference points were calculated at each delay using logistic regression to determine the later value at which there was an equal probability of each response. When estimates were outside of the range of displayed later values (e.g. participants gave all later or now responses or gave inconsistent responses), indifference points were assumed to be just outside the range of values presented (34.5 for all “now” and 5.5 for all “later” responses). Discounted value (DV) was calculated at each delay (DV=$5/indifference point) and a hyperbolic discounting function was fit to all DVs using nonlinear least squares: DV=1/(1+k*delay), where k is the unknown discounting parameter. As in previous research, this hyperbolic model provided a good fit for the data, as assessed using visual inspection and model comparison with an exponential function. All results were confirmed using bootstrapping, as k-values are not normally distributed. Three

participants had some missing rating scores and were excluded from rating analyses. There were no significant main effects or interactions with the different versions of trustworthy, untrustworthy, and neutral faces, so subsequent analyses collapse across faces within each trust condition. Perceived trustworthiness was again predicted by condition (untrustworthy < neutral < trustworthy), $b = 0.85$, $SE = 0.16$, $t(130) = 5.34$, $p < .0001$, Cohen's d = 0.45, suggesting our trust manipulation was effective (Figure 3A). The difference between untrustworthy and neutral conditions was not significantly different from the difference between neutral and trustworthy conditions, as evidenced by overlapping 95% confidence intervals of trustworthy-neutral (0.32, 1.52) and neutral-untrustworthy (0.12, 1.38) parameter estimates.

Effects of social trust on delaying gratification. Findings were largely consistent with Experiment 1. Preferences for delayed rewards, as indexed by k, were predicted by trust condition, $b = -.03$, $SE = 0.01$, $t(136) = -3.31$, $p < .005$; participants were less willing to delay gratification in the untrustworthy condition than in the trustworthy and neutral conditions, $b = .02$, $SE = 0.01$, $t(136) = -4.13$, $p < .0001$, with no difference between trustworthy and neutral conditions $b = .02$, $SE = 0.01$, $t(87) = .59$, $p = .55$ (Figure 3B). The difference between untrustworthy and neutral conditions was greater than the difference between trustworthy and neutral conditions, as evidenced by the non-overlapping 95% confidence intervals of untrustworthy–neutral (0.01, -0.02) and trustworthy–neutral (-0.03, 0.10) parameter estimates; thus, as in Experiment 1, our trust manipulation had a larger effect on delaying gratification at lower levels of trust. The same pattern was observed across a model free, but less precise measure of delay of gratification: percentage of delayed choices across the experiment (trustworthy/neutral vs. untrustworthy: $b = 0.07$, $SE = 0.2$, $t(133) = 3.83$, $p < .001$; trustworthy vs. neutral: $p > .3$). Finally, perceived trustworthiness predicted k-values (using non-parametric

bootstrapping due to positive skew in discounting values, 95% CI: –0.001, –0.02, and using parametric analyses, $b = -0.011$, $SE = 0.005$, $t(135) = 2.4$, $p < 0.025$), such that participants were less willing to delay gratification with characters perceived to be less trustworthy (Figure 3C).

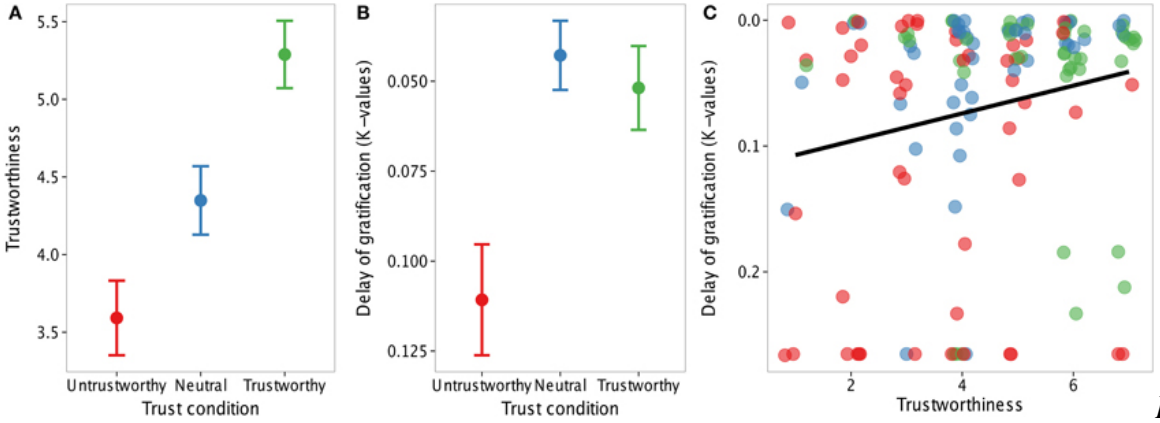

Figure 3. Trust effects willingness to delay gratification between subjects. (A) Perceived trustworthiness increased as a function of trust condition. Error bars are standard error. (B) Discounting rates were higher in the untrustworthy condition (red) compared to the neutral (blue) and trustworthy conditions (green), reflecting reduced willingness to delay gratification with untrustworthy individuals. y-axis is reversed for conceptual consistency. (C) Perceived trustworthiness correlates positively with discounting rates. Correlation (95% confidence interval of *r*: 0.02–0.36) was verified using non-parametric bootstrapping due to positive skew in discounting values. Individual data points are jittered 0.2 units on the x-axis for display purposes.

The results of Experiment 2 replicate those of Experiment 1: manipulating social trust, in the absence of rewards, influenced adults' willingness to delay gratification. These experiments represent the first manipulations of trust while avoiding manipulations of reward, demonstrating a causal relationship between trust and delay of gratification. Experiment 2 also extends Experiment 1 by showing that a single hypothetical interaction with one individual can influence decisions about the future—the contrast between trustworthy, neutral, and untrustworthy individuals was not necessary to affect delay decisions. In Experiment 3, real social trust is manipulated in the lab, and effects on delay of gratification for real rewards are measured, to move beyond the hypothetical manipulations and measures of Experiments 1 and 2. Experiment

3 also extends the Experiment 1 and 2 results by testing the relationship between social trust and delay of gratification in children.

Experiment 3

Twenty-eight 3 to 5-year-olds were randomly assigned to one of two conditions in which they viewed an experimenter behave in either a trustworthy or an untrustworthy manner toward another adult (as in Vaish, Carpenter, & Tomasello, 2010), then delayed gratification for a marshmallow that was contingent on that experimenter (as in Mischel, 1958). Trust manipulations were selected based on prior work in which similar demonstrations effected other behaviors thought to involve trust in slightly younger children, but were modified for this age group to involve two demonstrations rather than four (to avoid making the interactions seem staged) and to incorporate lying (to target impressions of social trust more specifically, as opposed to morality in general). The marshmallow test was selected because it has demonstrated sensitivity to the manipulations of the reliability of the environment (via the provision/omission of a promised reward; Kidd et al., 2012), but has not been examined using trust manipulations that avoid manipulations of reward (as in Experiments 1 and 2), and because seconds of delay time yields a precise index of willingness to delay.

Method

Participants

Forty 3-5 year olds (M_{age} = 54.77 months, SD = 8.05) participated in this study; 12 subjects were dropped due to fussing out (n = 6), knowing the experimenter from a prior experiment (n = 3), procedural interruption (e.g., having to go to the bathroom during marshmallow test, n = 2), and parental interference (n = 1). This left 28 usable subjects. Approximately 34 subjects will be recruited overall (M_{age} = 4 years 6 months; as in Kidd et al.,

2012), based on a power analysis conducted on group means from the first 19 subjects. Children were recruited through a departmental participant pool. Children were ineligible to participate if they had participated in any previous projects with the experimenter, and if they had food allergies that did not permit the consumption of marshmallows. Informed consent was obtained for all children, children received a small prize for participating, and parents were paid $5 for travel expenses.

Materials and procedure

After consent and warm-up, parents were led to an observation room where they viewed study procedures via live stream webcam. The child and recipient (a confederate who was the target of the trustworthy and untrustworthy behavior) went to the testing room and sat at a table, and were then joined by the experimenter and neutral adult (a "control" confederate who was involved in the manipulation checks). The experimenter sat with the child and recipient at the table, and the neutral adult sat in an adjacent chair, visible to the child but seemingly inattentive to the activities at the table. The recipient administered two pre-treatment measures of mood (a 6-item smiley face scale and a 5-item "thumbs up/thumbs down" scale; see Figure 4), and then proceeded into the trust manipulation. For the trust manipulation, the child made two art projects with the recipient while the experimenter observed with interest. First, the child and recipient used crayons and paper to draw separate but matching pictures of a tree. The recipient guided the child through the drawing of the trunk, the leaves, the grass, and the sun. Once finished (after 2-3 min), the recipient momentarily excused herself from the testing room ("You know what? I'm really thirsty. I'm going to go get a drink of water."). In her absence, the experimenter started to put the art supplies away, but damaged the recipient's drawing; in the trustworthy condition, it was an accident ("Look how pretty this is…Oops!"), while in the

untrustworthy condition, it was intentional ("Look how pretty this is…I'm going to tear this now"). The recipient returned to the room and discovered her damaged drawing, appeared upset, and confronted the experimenter ("Oh no, my drawing! Did you tear my drawing?"). In the trustworthy condition, the experimenter answered honestly ("Yes, I tore your drawing. It was an accident. I'm sorry."), while in the untrustworthy condition, the experimenter lied ("No, I didn't tear your drawing. I don't know how it got torn."). The second art project proceeded similarly, and involved a clay bird.

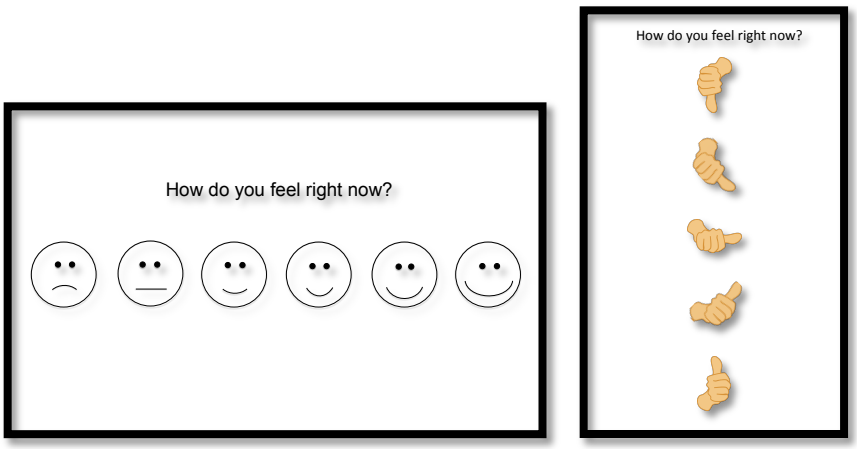

Figure 4. Mood measures used in Experiment 3. Children were asked to rate their mood before and after the trust manipulation, to address the possibility that mood effects from the trust manipulation subsequently influenced willingness to delay. Two scales were used to minimize measurement-specific variance.

The recipient then conducted an intermediate manipulation check using the art projects: "We're all done with art projects for now, but we should bring the art projects you made to your mom/dad/caregiver to hold onto while we play the rest of our games! Who would you like to bring your drawing to your mom/dad/caregiver? Her [motioned toward experimenter] or her [motioned toward neutral adult]?" The child made two sequential choices between the two adults, one for each art project.

The recipient and neutral adult then excused themselves from the room, and the experimenter administered the marshmallow test (as in Kidd et al., 2012). The child was told that he/she could have one marshmallow to eat right away, or could have two marshmallows if he/she waited until the experimenter returned. The experimenter then exited the room and monitored the child's behavior from the observation room for a maximum of 15 min. In both conditions, if the child ate the marshmallow before 15 min, all adults returned to the room and transitioned into the final manipulation check. If the child waited the full 15 min without eating the marshmallow, all adults returned to the room, and the experimenter delivered the promised second marshmallow.

The final manipulation check consisted of the helping test (as in Vaish et al., 2010). The experimenter and neutral adult simultaneously played separate but identical color-matching games in which four colored balls were to be placed in four matching-colored slots. Both adults needed a blue ball to complete their games, but only one blue ball was present, and it was out of the adults' reach but right in front of the child. After placing the three available balls in the appropriate slots, both adults simultaneously reached for the single blue ball. If the child did not act within 15 s, the recipient instructed him/her to "give the ball." If this was ineffective, the recipient asked the child to point to the person he/she wants to give the ball to. After the child selected one of the two adults, he/she was provided with a second blue ball, giving him/her the opportunity to help both individuals.

Finally, the recipient administered two post-treatment measures of mood. Children in the untrustworthy condition watched a staged reconciliation in which the experimenter apologized to the recipient and acknowledged it is wrong to lie and to be mean to friends.

Preliminary results and discussion

Children's impressions of experimenter trustworthiness, based on her unrelated interactions with another adult, influenced their willingness to wait for a desirable future reward.

Approach and preliminary analysis. Performance in the marshmallow test, mood ratings, and selections in the manipulation checks were coded from video. Coders recorded when each child's first taste of the marshmallow—a lick or bite—occurred. As in prior work (e.g., Kidd et al., 2013; Mischel et al., 1972; Mischel & Ayduk, 2004), wait times before the first bite were used in subsequent analyses; however, results were similar when examining wait times before the first lick. Mood ratings were coded as a function of scale type (smiley versus thumb) and measurement time (pre versus post-experiment). Two mood scales were used in order minimize scale-specific variance by allowing us to calculate an index of mood from ratings across scales, and preliminary results suggested responses on the two mood scales were highly correlated[1], $r = .70$, $p = .009$. However, because the thumbs scale was added to the procedures relatively late in data collection, only six participants rated mood using both the smiley scale and the thumbs scale. Thus, rather than combining mood ratings to form a mood index, only data from the smiley scale were examined in subsequent analyses. All analyses were conducted using the R statistical package (R Development Core Team, 2006).

The remainder of the results section is organized as follows. First, I examine results from the manipulation checks to evaluate whether our trust manipulations were effective as intended. Then, I compare performance in the marshmallow test between conditions, to test whether delay

[1] An examination of histograms from each of the mood measures suggested positive skew in the data, and violations of normality were confirmed using Shapiro-Wilk normality tests (ps $< .05$). Accordingly, a non-parametric Spearman's rank order correlation (i.e., Spearman's rho) was performed to address the correlation between the mood scales.

of gratification was influenced by social trust. Finally, I address the possibility that results might alternatively be explained by differences in mood elicited by the trust manipulations.

Manipulation checks. The two manipulation checks suggest our trust manipulations were effective, but results are not statistically significant. Each manipulation check consisted of two sequential choices between the experimenter (E) and neutral adult (N). Both initial selections and sequences of selections were examined as outcome variables.[2] Initial selections were examined using Pearson's chi-squared tests (Table 1). Sequential selections were examined by assigning children to one of the four possible outcome groups (EE, EN, NE, and NN) and measuring differences in distributions between conditions using Fisher's exact tests (Table 2), with *p*-values computed using Monte Carlo simulations based on 2,000 samples (as is standard for larger than 2x2 tables; Clarkson, Fan, & Joe, 1993).

Table 1
First selections in the manipulation checks by condition

	Intermediate manipulation check		Final manipulation check	
	Trustworthy	Untrustworthy	Trustworthy	Untrustworthy
E	10	8	7	3
N	4	6	7	11
Totals (*N*=28)	14	14	14	14

Note. E = experimenter, N = neutral adult. Final manipulation check is described as the helping test in the main text.

[2] First selections alone were examined because they may provide a cleaner measure of true preferences, especially if second selections also partially reflect children's tendencies to be fair: indeed, 27 of 28 children (96%) in the helping test equitably distributed their two choices in the manipulation checks across the two adults. However, only 12 of 28 (43%) in the intermediate manipulation check equitably distributed their two choices in the manipulation checks across the two adults. This difference could reflect differences in the cover stories: children might be more inclined to be equitable when the adults need help, and less likely to be equitable when selecting an adult to help them. For these reasons, both indices of preference were examined in each of the manipulation checks.

Table 2
Sequential selections in the manipulation checks by condition

	Intermediate manipulation check		Final manipulation check	
	Trustworthy	Untrustworthy	Trustworthy	Untrustworthy
EE	8	3	0	0
EN	2	5	7	3
NE	2	3	6	11
NN	2	3	1	0
Totals (*N*=28)	14	14	14	14

Note. E = experimenter, N = neutral adult. EE = chose E twice, EN = chose E first and N second, NE = chose N first and E second, NN = chose N twice. Final manipulation check is described as the helping test in the main text.

Initial selections in the intermediate manipulation check reflect a greater preference for the experimenter in the trustworthy condition (where 10 out of 14 children chose the experimenter, or 71%) relative to the untrustworthy condition (where 8 out of 14 children chose the experimenter, or 57%), but this difference was not significant, $X^2 = 0.16$, $p = .69$. Results were similar when examining sequential selections in the intermediate manipulation check, $p = .25$. Initial selections in the helping test reflect equal preferences for the experimenter and the neutral adult in the trustworthy condition (where 7 out of 14 of children chose the experimenter, or 50%), but greater preferences for the neutral adult in the untrustworthy condition (where 3 out of 14 children chose the experimenter, or 21%). This difference was not significant, $X^2 = 3.12$, $p = .21$, and results were similar when examining sequential selections, $p = .11$.

Effects of social trust on delaying gratification for real rewards. Children in the trustworthy condition waited without eating the marshmallow for longer (11.14 min, $SD = 6.42$) than children in the untrustworthy condition (6.42 min, $SD = 6.13$; Figure 5A). A Wilcoxon rank-sum test confirmed that this difference was statistically significant, $W = 141.5$, $p = .037$. Additionally, in a binary analysis of whether children waited the entire 15 min without tasting the marshmallow, a greater proportion of children waited the full 15 min in the trustworthy

condition (10 out of 14 children, or 71%), compared to the untrustworthy condition (only 3 out of 14 children, or 21%; Figure 5B), X^2- = 5.17, p = .02.

Figure 5. Trust effects preschoolers' delay of gratification for real rewards. (A) Children waited longer before tasting an immediately available marshmallow when a delayed but doubled reward had been promised by a trustworthy experimenter, relative to an untrustworthy experimenter. Error bars display standard error. (B) A larger proportion of children waited the full 15 min and received the larger reward when the reward was promised by a trustworthy experimenter, relative to an untrustworthy experimenter.

To examine any possible main effects of age and gender, a series of models were tested using age and gender to predict wait times while controlling for condition (as in Kidd et al., 2012). Neither age nor gender was significant, ps > .1.

Effects of social trust on mood. To account for the possibility that the trust manipulations could produce differences in mood (which, in turn, might affect delay of gratification), pre- and post-experiment mood ratings were analyzed. Mood did not vary across conditions, p = .44, or pre/post experiment ratings, p = .91, and did not predict wait times in the marshmallow test, p = .44. Thus, the effects of social trust on delay of gratification were not driven by differences in mood.

Overall, preliminary results from Experiment 3 suggest that manipulating children's social trust influences willingness to delay gratification for real rewards. Children had shorter wait times, and were less likely to wait the full 15 min, when an untrustworthy experimenter

promised a delayed reward, but were more willing to delay gratification with a trustworthy experimenter. These effects were not driven by differences in age, gender, or mood. Such findings compliment Experiments 1 and 2 by replicating the effects of manipulating social trust on willingness to delay rewards, and also extend prior studies in important ways by demonstrating the role of social trust in a real social setting involving real rewards, and in younger age groups.

A natural next question from the results of Experiments 1-3 is whether trust predicts delay of gratification in the absence of experimental manipulations, that is, whether baseline individual differences in generalized social trust relate to individual differences in delay choices. Willingness to delay gratification and social trust both vary broadly across individuals (Evans & Revelle, 2008). Evaluating the utility of social trust as a within-subjects predictor of delay of gratification not only provides an additional test of the ideas from Experiments 1-3, but could also be informative in terms of understanding the early origins of impulsivity during development, and for the development of individualized interventions designed to improve delay choices.

Experiment 4

We test whether individual differences in social trust relate to individual differences in willingness to delay gratification in an interotemporal choice task. We measure social trust using self-report surveys, as well as behavioral measures of trust, given that trust can be difficult to measure using self-reports surveys, and prominent measures may be tapping trustworthiness, rather than trust (Glaeser, Laibson, Scheinkman, & Soutter, 2000).

Method

Participants

One hundred and twenty subjects participated in this study. Participants were recruited via Amazon's Mechanical Turk, and had an average approval rating of at least 99% from previous jobs. To ensure quality control, data were dropped from participants who entered incorrect completion codes (n = 10) or incorrect responses to comprehension questions related to the trust game (n = 52; as in Amir, Rand, & Gal, 2012); patterns were the same regardless of whether these subjects were included. Individuals who participated in Experiments 1 or 2 were automatically ineligible to enroll in this study via TurkGate[3] (Goldin & Darlow, 2013). The final sample consisted of 58 participants (25 males, 33 females) between 18 and 63 years of age (M_{age} = 33.67, SD = 13.21). Participants were paid $0.35 for completing this study, which took an average of 18 minutes. All participants lived in the United States, and were normally distributed in terms of socioeconomic status, with the average participant having completed some college and receiving a financial income between $25,000 and $37,499 per year.

Materials and procedure

All participants completed one survey containing measures of temporal discounting, social trust, and risk seeking, presented in a fixed order. Participants first completed demographic questions, then the temporal discounting task from Experiment 2. The temporal discounting questions were slightly modified to no longer feature the characters from the vignettes used in Experiments 1 and 2, since Experiment 4 does not include any vignettes. Next, participants completed an adapted version of the trust game (Berg, Dickhaut, & McCabe, 1995),

[3] TurkGate was recently launched and not available at the time of Experiment 2. When a worker selected our experiment from the list of available tasks on Mechanical Turk, TurkGate accessed a database on our server and tracked the potential participant's worker ID numbers against a list of worker ID numbers from previous experiments I have conducted. If the potential participant's worker ID appeared on the list, they were automatically directed to an exit page and informed that they were ineligible. Repeat participants across multiple related studies are undesirable because such individuals may develop hypotheses about the purpose of the research and modify responses accordingly.

modified for Mechanical Turk to involve hypothetical rewards and anonymous partners, and shown to produce results comparable to laboratory-based trust games that involve real rewards (Amir et al., 2012). In this version of the trust game, participants were led to believe they were randomly paired with an anonymous partner who was simultaneously completing the survey online, and that they would be randomly assigned to play the part of either Player 1 or Player 2. As outlined in the instructions, Player 1 was provided with 10 hypothetical monetary units, and had one opportunity to transfer some, none, or all of the units to Player 2. All units transferred to Player 2 were tripled, and then Player 2 had one opportunity to transfer some, none, or all of the units back to Player 1. Thus, a large initial transfer with a fair return transfer could yield profits for both parties. On this basis, initial transfers in the trust game are commonly used to index generalized social trust. Participants completed three questions testing their comprehension of the task rules, and then proceeded to respond from the perspective of Player 1.

After the trust game, participants completed a number of self-report measures of social trust. Self-report measures were selected based on reliability across multiple studies and whether they predict behavior in the trust game. Final selections included 1) one question about trust in strangers (developed by Glaeser et al., 2000), 2) the Propensity to Trust Survey (PTS; Evans & Revelle, 2008), and 3) the New Democracies Barometer (NDB), a questionnaire in which participants indicate their level of trust in fifteen separate political and civil institutions. A fourth self-report measure of trust was developed for the purposes of this study, in which participants provided Likert-scale trust ratings for 30 trustworthy, untrustworthy, and neutral computer-generated faces drawn the same database as those used in Experiment 2 (Oosterhof & Todorov, 2008). This measure not only allowed us to measure individual differences in baseline trust

toward neutral faces, but also provides a within-subjects measure of how much trust increases or decreases to trustworthy and untrustworthy faces.

Finally, given evidence that trust involves calculations of risk (Ermisch & Gambetta, 2006), a simple measure of risk seeking was included, to examine possible relationships between trust, risk, and delay of gratification. Participants indicated their level of risk seeking on a scale of 0-10 in response to a question from the 2004 wave of the German Socio-Economic Panel (GSOEP). This measure of risk seeking was selected because it predicted actual risky behavior in a separate field experiment, and did better at predicting risk than standard lottery questions (Dohman et al., 2005).

Results and discussion

Three main sets of analyses were conducted. First, I evaluated the validity of the social trust measures by examining whether trust surveys were correlated with each other, and whether they predicted behavioral trust in the trust game. Second, I looked at relationships between k-values and social trust measures. Third, I conducted an exploratory analysis in which measures of social trust were pared down using principal components analysis (PCA) to examine the relationship between social trust and delaying gratification using a smaller number of trust variables. In general, behavioral and self-report measures of social trust did not correlate with one another, and did not relate to individual differences in willingness to delay gratification.

Approach and preliminary analyses. Using responses from the temporal discounting task, k-values were estimated for all participants, as in Experiment 2. For the trust surveys, variables were recoded when necessary so that higher positive values represent increased social trust. Outliers were identified on the basis of a 1.5 times interquartile range rule (Tukey, 1977), and were replaced with the mean for that variable (as suggested by Tabachnick and Fidell, 2007).

Patterns in the data were identical after performing outlier analyses, so results from the original data (preserving outliers' original values) are reported. Analyses were conducted using linear model (lm) and principal components analysis (prcomp) functions in the R statistics package (R Development Core Team, 2006).

Validating the faces measure, ratings of the trustworthiness of faces increased across the untrustworthy, neutral, and trustworthy face conditions, $b = 0.92$, $SE = .11$, $F(1, 172) = 64.83$, $p < .0001$. The difference in face ratings between untrustworthy and neutral conditions was greater than the difference between trustworthy and neutral conditions, $t(57) = 5.90$, $p < .0001$, suggesting participants decreased trust to untrustworthy faces more than they increased trust to trustworthy faces. Four indices of trust from the trust faces were examined in subsequent analyses: 1) "neutral faces", reflecting trust ratings to neutral faces, 2) "trust increases", reflecting the extent to which trust increased from neutral to trustworthy individuals, 3) "trust decreases", reflecting the extent to which trust decreased from neutral to untrustworthy individuals, and 4) "trust asymmetry", reflecting the extent to which increases in trust differed from decreases in trust.

Comparing measures of social trust. In the first step of the analysis, I examined relationships among the survey and behavioral measures of social trust. Appendix C gives means for each measure, and Table 3 depicts correlations. Correlations between the trust measures were generally low, with the PTS being one possible exception. Trust ratings in the PTS were positively correlated with ratings of institutional trust in the NDB, $r = 0.49$, $p < .001$, and with ratings of neutral faces, $r = .31$, $p = .02$. Additionally, PTS ratings were higher in individuals who reported trusting strangers ($M = 4.14$, $SD = 0.64$) relative to individuals who reported not trusting strangers ($M = 3.23$, $SD = 0.88$), $t(56) = -7.59$, $p < .01$. Looking

specifically at the variables calculated from the face ratings, individuals increased trust to trustworthy faces and decreased trust to untrustworthy faces similarly, $r = -.41$, $p = .0001$. Trust increases were negatively correlated with ratings of neutral faces, $r = .27$, $p = .03$, perhaps reflecting a ceiling effect (individuals who rated neutral faces highly had less room to increase ratings to trustworthy faces). Risk seeking was not reliably correlated with the trust measures, but did show some relationships: higher risk seeking corresponded to higher trust on the PTS, $b = 0.37$, $SE = 0.12$, $F(1, 56) = 8.82$, $p = .004$, and individuals who reported trusting strangers were also higher in risk seeking ($M = 7.18$, $SD = 2.06$) than individuals who reported not trusting strangers ($M = 5.81$, $SD = 2.38$), $t(56) = -9.44$, $p < .001$.

Table 3
Correlations between trust measures

Measure	**PTS**	**NDB**	**Neutral faces**	**Trust increases**	**Trust decreases**	**Trust asymmetry**	**Trust strangers**	**Risk**
Amount sent	-.23^	-.05	.18	-.13	.21	.09	-.09	-.23^
PTS		.49**	.31*	-.16	.05	-.08	.47**	.37**
NDB			.21	.03	-.03	-.01	.08	.18
Neutral faces				-.27*	-.19	-.42**	.23	-.04
Trust increases					-.41**	.45**	-.09	.05
Trust decreases						.63**	.21	-.07
Trust asymmetry							.05	-.03
Trust strangers								.29*

Note. Correlation coefficients for trust measures. Gray values reflect correlations between different transformations of the same variable, which are not meaningful. ^ = p < .10, * = p < .05, ** = p < .001.

Survey measures of social trust did not predict behavioral trust. The PTS actually showed a trend for predicting lower transfers in the trust game, $b = -0.75$, $SE = 0.43$, $F(1, 56) = 3.00$, $p = .09$, and the remaining survey measures were unrelated to the amount sent, ps > .13.

Risk also showed a trending negative relationship with behavioral trust, such that individuals who reported being more risk seeking transferred slightly less in the trust game, $b = -.23$, $SE = .13$, $F(1, 56) = 3.10$, $p = .08$.

Individual differences in social trust and delay of gratification. Relationships between social trust measures and k-values were examined with and without controlling for demographic characteristics that also affect social trust, in order to examine resting state relationships between social trust and k-values over and above other known influences. Binary control variables were dummy coded (male/female and white/nonwhite groups; as in Gachter et al., 2004; Glaeser et al., 2000). Generally, these control variables were not significant, and their inclusion or exclusion did not affect the results.

Relationships were tested in a series of models where trust measures were regressed on k-values. Not one measure of social trust significantly predicted delay of gratification, all ps > .2. Since willingness to delay gratification increased with income level, $b = -0.32$, $SE = 0.13$, $F(1, 56) = 6.45$, $p = .01$, in males relative to females, $b = 0.9$, $SE = 0.42$, $F(1, 56) = 4.82$, $p = .03$, and marginally increased in white relative to nonwhite participants, $b = -1.02$, $SE = 0.53$, $F(1, 56) = 3.71$, $p = .06$., these variables were also analyzed as predictors. Results were unchanged in the multiple regression models that controlled for relevant demographic variables, all ps > .2. Including risk seeking as a predictor also did not change the results, all ps > .3.

Reducing the dimensionality of trust measures. The last stage of investigation consisted of an alternative exploratory approach for examining social trust, in which survey and behavioral measures of trust were subjected to a principal components analysis (PCA). Patterns in the results were similar using this approach. PCA was used because it is a common technique for reducing the dimensionality of correlated observed variables to a smaller set of independent

composite variables that account for a larger proportion of the total variance, and in theory, this would enable the examination of relationships between social trust and delaying gratification using a smaller number of trust variables. However, some of the assumptions of PCA were violated in the present dataset. The trust measures did not have strong correlations, violating the assumption that input observations will be correlated with one another. Additionally, the analysis may have been underpowered[4], with a sample size of 58 (due to the exclusion of subjects who failed the comprehension questions in the trust game, $n = 52$). Thus, it may not have been appropriate to apply PCA here, and it is perhaps unsurprising that results were similar using this alternative approach. Regardless, a summary of the PCA results is reported for completeness.

The principal axis method was used to extract the components, followed by a varimax (orthogonal) rotation. Only the first three components displayed eigenvalues greater than 1 (Figure 6), meaning subsequent components did not explain more variance in the data than the variables themselves. Therefore, only the first three components were retained. This is one of several methods for determining how many PCs should be investigated versus ignored (Holland, 2008). Combined, the first three components accounted for approximately 60% of the total variance in the trust measures.

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[4] This sample size falls below many of the "rule of thumb" recommendations for principal components analysis, which range from a minimum of 100 (Gorsuch, 1974) to 500 cases (Comrey and Lee, 1992).

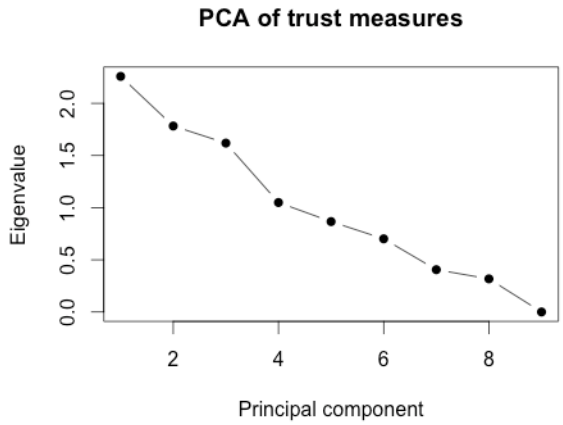

Figure 6. Principle components analysis of trust measures. A principal components analysis was used to reduce the dimensionality of the trust variables. Eigenvalues (y-axis) reflect the variance explained by each principal component. The first three components accounted for approximately 60% of the total variance in the trust dataset, but were unrelated to delay of gratification.

Trust measures and corresponding factor loadings are presented in Table 4. In interpreting the rotated factor pattern, a measure was said to load on a given component if the factor loading was .40 or greater for that component, and was less than .40 for the others (e.g., Matsunaga, 2010). Using these criteria, two measures loaded on the first component: the PTS, and neutral faces. Trust asymmetry loaded on the second component, and amount sent and trust increases loaded on the third component.

Table 4
Loadings from principal component analysis of trust measures.

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
Amount sent	-0.163	0.066	-0.470	-0.478	0.320	-0.528	0.282	0.243	0.000
Trust strangers	0.367	-0.310	-0.076	0.173	0.623	0.228	0.442	-0.313	0.000
PTS	0.536	-0.269	0.009	-0.070	-0.103	0.156	0.008	0.775	0.000
NDB	0.352	-0.165	0.079	-0.580	-0.509	-0.031	0.269	-0.418	0.000
Neutral faces	0.400	0.277	-0.278	-0.303	0.279	0.153	-0.676	-0.191	0.000
Trust increase	-0.209	-0.115	0.601	-0.419	0.336	0.087	-0.096	0.087	0.519
Trust decrease	-0.146	-0.523	-0.494	0.131	-0.189	0.036	-0.200	-0.093	0.598
Trust asymmetry	-0.321	-0.610	0.026	-0.228	0.100	0.110	-0.278	-0.017	-0.611
Risk	0.316	-0.254	0.290	0.253	0.063	-0.774	-0.265	-0.120	0.000

Note: The first three components explained approximately 60% of the total variance in the data.

None of the first three principal components of trust predicted k-values in a linear regression model, or in a series of multiple regression models that controlled for demographic variables.

Experiment 4 discussion. Individual differences in social trust were unrelated to individual differences in willingness to delay gratification. This is in contrast to prior work that has shown such a relationship (Harris & Madden, 2002), and diverges from the results of Experiments 1-3, where manipulating social trust influenced willingness to delay. However, Experiment 4 addressed a related but distinct question from Experiments 1-3: whether baseline social trust correlates with willingness to delay gratification within individuals. It is possible that willingness to delay is only affected by social trust when social trust is made salient by increases or decreases from baseline, which would be consistent with the results of Experiments 1-3 combined with null results in Experiment 4 (and would suggest prior correlational findings might be false positives).

The modifications made to the delay of gratification measure for Experiment 4 also might have contributed to the null results. In modifying the text from the Experiment 2 interotemporal choice questions to no longer feature characters from the vignettes, all social contingencies of the delayed reward were removed: rather than "If Christopher Thompson offered you…", the questions in Experiment 4 read, "If you had to choose between…". This changed the framing of the questions in a subtle but important way, with the resulting questions being completely devoid of social considerations. The social contingencies in the interotemporal choice questions used in Experiments 1 and 2, and in the marshmallow test used in Experiment 3, might have elicited "hot" discounting systems that are driven by emotion and impulse (Metcalfe & Mischel, 1999), whereas the Experiment 4 questions might have elicited more slow and strategic "cool" discounting systems. Given that trust is inherently social, a better modification might have been "If a person offered you…"

It is also possible that individual differences in social trust are correlated with delay of gratification (consistent with Harris & Madden, 2002), but Experiment 4 failed to capture this relationship due to measurement issues. Survey-based trust measures did not correlate with one another, and did not predict behavioral trust in the trust game. This lack of predictive validity across the trust surveys is not consistent with prior research: individuals who trusted strangers transferred over $2.00 more to their partners in the trust game (Glaeser et al., 2000), and contributed over 1.73 tokens more to the public good (Gachter et al., 2004), relative to individuals who did not trust strangers. Much evidence suggests that social trust is difficult to measure (Gachter et al., 2004; Glaeser et al., 2000), but our results suggest that even "valid" measures may not be reliable. In addition, the anonymity of our trust game might have been an important departure from prior studies. Even if our participants were deceived into believing

that they were interacting with a real partner online, such interactions were still anonymous, and lacked social elements that were present in prior studies that used these measures in a laboratory setting (Gachter et al., 2004; Glaeser et al., 2000). Such realized elements might not be critical when trust is manipulated, as in Experiments 1 and 2, where self-reported trust ratings of hypothetical characters did predict behavioral trust (as measured by willingness to delay gratification)—but real interactions might be critical to the previously observed relationships between individual differences in self-reported trust and behavioral trust in the trust game. Also, although the procedures for the trust game were taken directly from a prior study, many participants failed the comprehension questions and therefore were not included in the final analyses, which substantially limited statistical power.

General Discussion

Across three experiments, manipulating social trust influenced willingness to delay gratification. In Experiments 1 and 2, adults' willingness to delay gratification for hypothetical rewards varied with reported trust of the hypothetical individual who would be delivering the delayed reward. This was true when contemplating a single interaction with one individual, and when engaging in interactions with multiple individuals. In Experiment 3, preschoolers waited longer before consuming an immediate reward, and were more likely to wait through a full delay period for a delayed reward, with a trustworthy experimenter relative to an untrustworthy experimenter. These studies provide the first test for a causal role of social trust. Although the results complement prior correlational and experimental work that is consistent with such a link (Harris & Madden, 2002; Kidd et al., 2012; Mahrer, 1956; Mischel, 1961b; Mischel, 1965), such work has been difficult to interpret, and the direction of the relationship between trust and delaying gratification was not clear. The present studies manipulated social trust experimentally,

in the absence of other factors that can also influence delaying gratification, providing strong evidence for a causal relationship between social trust and delaying gratification.

Establishing a role for social trust represents a substantial contribution to basic theoretical understanding of delay of gratification. The importance of social trust in delaying gratification has been emphasized by some (Mischel, 1961a; Mischel, 1961b; Mischel, 1984), but most prominent accounts of delaying gratification focus on cognitive control, reward valuation, and future-oriented thinking (Peters & Buchel, 2011, Luhmann, 2009; Wittman & Paulus, 2008; Wulfurt et al., 2002), without incorporating the importance of social factors. The present findings show that delaying gratification does not occur in a social vacuum, highlighting the need to incorporate social factors in models of delaying gratification. Additionally, social trust could help to explain why some individuals struggle with delay choices. Evidence that early ability to delay gratification predicts successful outcomes years or decades later in life (Casey et al., 2011; Shoda, Mischel, & Peake, 1990) could be interpreted in terms of individual differences in trust from an early age (e.g., Kidd et al., 2012), and the characteristic impulsivity of certain populations, such as addicts and criminals, could be interpreted in terms of doubt that the future reward will be delivered as promised, rather than a diminished ability to delay rewards. Such populations typically face unstable environments and unpredictable futures, so delaying gratification might not involve a simple choice between "some now" and "more later," but instead, a choice between "some now" and "*maybe* more later, " given reason to doubt the delayed reward would actually come through.

Although manipulations of social trust affected delay of gratification across three of our experiments, baseline measures of social trust were unrelated to delay of gratification in Experiment 4. One possible interpretation is that social trust only plays a role when it is

increased or decreased from baseline, or when the delayed reward is contingent on other people (which was not the case in the individual differences study, but was the case in the experimental studies). Another possibility is that our social trust measures were not tapping their intended constructs. Trust measures did not hang together well, and survey measures did not predict our behavioral measure of social trust. This failure to successfully measure social trust might have prevented a true test of the relationship between individual differences in social trust and in delaying gratification. Experiment 4 thus highlights the need for the development of improved measures of social trust, which predict real-life trusting behavior and demonstrate reliability across multiple studies.

Future experiments should address some of the issues of Experiment 4, and expand on the results of Experiments 1-3. For example, I am currently developing a study to test for a relationship between individual differences in social trust and delay of gratification in criminals at Boulder County Jail. Criminals are a population of particular interest because such individuals are known to have difficulty delaying gratification (Arantes, Berg, Lawlor, & Grace, 2012; Petry, 2002), and also increase trust less in trustworthy situations, relative to controls (Khadjavi & Lange, 2013). The Boulder County Jail survey was originally planned to be an identical to that of Experiment 4, with the Experiment 4 sample ultimately serving as a control group for later comparisons; instead, the results of Experiment 4 will be used to refine and improve the Boulder County Jail survey. I am also manipulating adult social trust in a laboratory setting using oxytocin, a neuropeptide that influences trust and cooperation (e.g., Mikolajczak et al., 2010), measuring individual differences in children's social trust by examining oxytocin receptor genotypes (OXTR), and developing a study to test delay of gratification in individuals with Williams Syndrome, who are notoriously trusting with strangers (e.g., Landau & Ferrara, 2013).

Establishing the importance of social trust in delaying gratification represents a significant contribution, but many open questions remain. Future studies should more precisely operationalize the trust factor, and should elaborate on the mechanisms underlying the trust effects. One possibility is that trust does not change the perceived value of the delayed reward, but just changes the likelihood of choosing a delayed option that is "worth" waiting for. That is, delayed rewards are discounted similarly regardless of social trust, but a lack of social trust makes otherwise desirable delayed rewards less likely to be selected. Alternatively, trust may influence the valuation process by causing individuals to discount delayed rewards more or less steeply. From this account, trust does change the perceived value of the delayed reward, which then indirectly influences the likelihood of choosing to delay.

Other questions include: How does the role of social trust differ from other forms of expectancy, such as risk? Do dyadic, generalized, interpersonal, and other types of social trust differentially influence delay choices? Does the effect of trust change as a function of reward amount or delay interval? How does the role of trust relate to the predictive validity of early delay of gratification for later life outcomes? Overall, the role of trust in delaying gratification is a promising topic of research with implications across a variety of domains. Testing additional possibilities for the role of social trust, and investigating how social and other factors interact, may greatly advance our understanding of the fundamental ability to delay gratification.

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Appendix A: Vignettes (Delgado, Frank, & Phelps, 2005)

1. Trustworthy

Christopher Thompson

Christopher Thompson was born on August 14, 1977, in Providence, Rhode Island. After graduating from Mount Pleasant High School in Providence, he entered the University of Notre Dame in the fall of 1994, where he earned a letter in varsity crew before graduating with a bachelor's degree in English in June of 1998.

He then enrolled in the graduate program in English at the University of Iowa, where he earned his master's degree in June of 2000. Thompson then spent two years in the Teach for America Program, during which time he taught English to high school sophomores and juniors in Newark, New Jersey.

In September of 2002, Thompson left Iowa City to enroll in the Ph.D. program in English at New York University in Manhattan.

A recent experience, as described in the University of Iowa's February 28, 2003 *Daily Iowan*:

Iowa graduate rescues woman in club fire

Former University of Iowa student Christopher Thompson was at the Station Concert Club in West Warwick, Rhode Island when fire broke out on the evening of Feb 20, killing 98 people. While visiting relatives in Providence, he had gone to the club with Tom Battle, a high school classmate, and Battle's wife, Susan.

Thompson was seated at a table near an exit when the fire started. The Battles, however, were standing among scores of others spectators crowded near the stage, where Great White, a heavy-metal band, had just begun its first set.

After leading several others out of the club to safety, Thompson went back inside in an attempt to locate the Battles. Tom Battle was nowhere in sight, but Thompson quickly spotted Susan Battle lying unconscious on the floor and managed to drag her to safety. In the process, he suffered third-degree burns on his neck, left arm and hand.

Battle, 25, was listed in stable condition Sunday. Thompson, 26, was released from Providence hospital yesterday.

2. Untrustworthy

Alex Tudor

Alex Tudor was born on January 2, 1977, in Dallas, Texas. After graduating from Hillcrest High school in north Dallas, he began classes at Baylor University, where he earned a degree in business administration in 1998. During his junior year at Baylor, Tudor served as social committee chairman for the Sigma Nu fraternity.

In September of 1998 Tudor entered the graduate program in business at the University of Nevada at Las Vegas, where he earned his MBA in May, 2000. After vacationing in France and Italy that summer, he served as a financial analyst for Merrill-Lynch in Manhattan from September, 2000 until August, 2001.

In September of 2001, Tudor enrolled in the Ph.D. program in finance at the Stern School of Business at New York University. He resides in midtown Manhattan.

A recent experience, as described in UNLV's February 5, 2003 *Rebel Yell*:

Formal business school student arrested

Federal prosecutors announced yesterday that UNLV graduate Alex Tudor of New York had been arrested the previous evening on charges of attempting to sell two heat insulating tiles from the space shuttle Columbia on the internet auction site eBay. According to the arrest report, Tudor had been visiting his parents southeast of Tyler when he found the tiles while hiking in a remote area on the day after the disaster.

In defense of his actions, Tudor, 26, told investigators that because many other tiles had already been found and turned over to NASA investigators, he saw no reason to believe that his failure to turn over the particular tiles he found would compromise the agency's efforts to determine the cause of the accident.

Chief Judge A. Joe Fish of the United States District Court for the Northern District of Texas disagreed. Pending Tudor's arraignment on felony charges of impeding a federal investigation, Fish ordered Tudor held on $50,000 bail.

Tudor was released last night upon posting bail.

3. Neutral

Thomas Sweeney

Thomas Sweeney was born on January 12, 1977, in Chicago, Illinois. After graduating from Evanston Township High School in June of 1994, he enrolled at Purdue University in Lafayette, Indiana, the following September. Sweeney earned his bachelor's degree in mechanical engineering from Purdue in June of 1998.

After graduation, he worked for two years as a staff engineer at the General Motors transmission assembly facility in Toledo, Ohio. In the fall of 2000, he began graduate studies in mechanical engineering at New York University. He now lives in Brooklyn.

A recent experience, as described in Purdue University's January 10, 2003 Exponent:

Student narrowly misses doomed flight

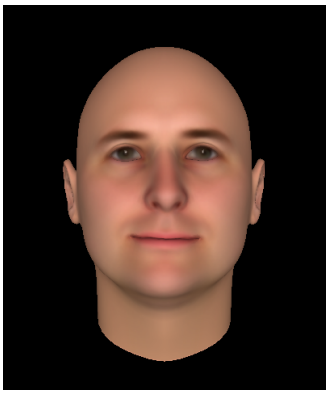
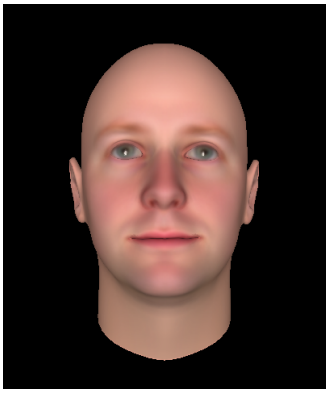
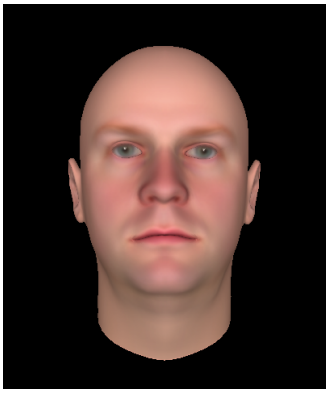
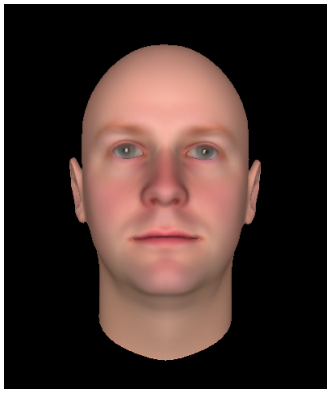
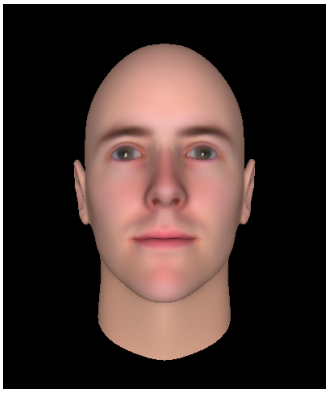
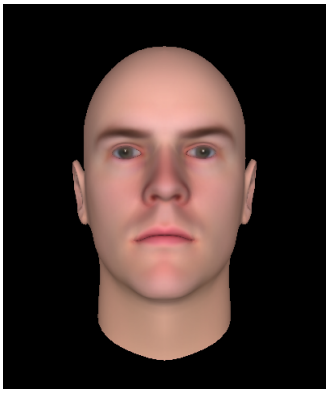
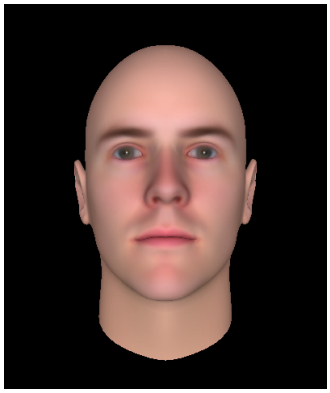
Former Purdue student Thomas Sweeney, 25, yesterday came within moments of being the twenty-first person killed in the US Airways Express flight that crashed in a fiery explosion shortly after takeoff yesterday morning at Charlotte-Douglas Airport in Charlotte, North Carolina.

Because of unusually heavy rush-hour traffic delays on the morning of January 9, Sweeney arrived at the airport to discover that flight 5481 had pushed back from the gate just seconds earlier. Less fortunate was James Whitaker, 42, of Greenville, South Carolina, the standby passenger who had claimed Sweeney's seat in his absence.

In a telephone interview, Sweeney appeared shaken by the close call. He expressed sympathy for the families of Whitaker and the other victims, but vowed to continue with his trip. "You can't control fate," he explained.

Sweeny graduated from Purdue in 1998 with a B.S. in mechanical engineering.

Appendix B: Faces (Oosterhof & Todorov, 2008)

	Trustworthy	Untrustworthy	Neutral
006			
010			
014			

Appendix C: Experiment 4 Trust Variables

Variable	**Example question/description**	**# items**	**Response range**	**Mean (standard deviation)**
Amount sent	Amount sent to Player 2 in the trust game	1	0-10	5.83 (2.99)
PTS	"Please rate the extent to which each item describes you: 'Believe that most people would lie to get ahead'"	7	1-6	3.60 (0.90)
NDB	"Indicate your level of trust in a number of political and civil institutions: 'Congress'"	15	1-7	3.58 (0.99)
Neutral faces	"How trustworthy is this person?"	10	1-9	4.85 (1.16)
Trust increases	Difference between neutral and trustworthy ratings	10	-9 – 9	0.59 (0.773)
Trust decreases	Difference between neutral and untrustworthy faces	10	-9 – 9	1.84 (1.32)
Trust asymmetry	Difference between trust increases and trust decreases	10	-9 – 9	-0.66 (0.86)
Trust strangers	"You can't count on strangers anymore."	1	1 = agree, 2 = disagree	1.62 (0.49)
Risk	"Please rate the extent to which you are risk seeking versus risk averse."	1	1-11	6.32 (2.34)