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SOCIAL DISCOUNTING AND CIGARETTE SMOKING DURING PREGNANCY

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Abstract

In this study we examined the association between social discounting and smoking status in a cohort of pregnant cigarette smokers (n=91), quitters (n=27), or never-smokers (n=30). The smokers and quitters were participants in clinical trials on smoking cessation and relapse prevention, while the never-smokers were controls in a study on nicotine withdrawal during pregnancy. Social discounting was assessed using a paper and pencil task that assesses the amount of hypothetical money a person is willing to forgo in order to share with individuals in their social network ranging from the person who is emotionally closest to them to a mere acquaintance. The amount that women were willing to forgo in order to share decreased hyperbolically as a function of social distance, with smokers exhibiting steeper discounting functions (i.e., less generosity) than quitters or never-smokers; discounting functions of quitters and never-smokers did not differ significantly. In multivariate analyses controlling for potential sociodemographic and other confounds, social discounting remained a significant predictor of smoking status among smokers versus quitters. Overall, these results suggest that individual differences in social discounting may be a factor influencing the choices that women make about quitting smoking upon learning of a pregnancy.

Introduction

Smoking during pregnancy is a leading preventable cause of poor pregnancy outcomes in the U.S. and other industrialized countries (Bonnie, Stratton, & Wallace, 2007; U.S. Department of Health and Human Services [USDHHS], 2001). Women who smoke during pregnancy are at increased risk for many serious adverse maternal, fetal, and neonatal outcomes (Cnattingius, 2004; Pauly & Slotkin, 2008). Despite extensive evidence concerning the immediate and longer-term adverse consequences of smoking during pregnancy, the majority of women who are smokers at the time they learn of a pregnancy continue smoking through the pregnancy (Ershoff et al., 2004; Lumley et al., 2009). That is a puzzling statistic when considering that one would expect a woman to refrain from activities that may harm her developing fetus/infant. Importantly, there is a small subgroup of women (~20%) who quit smoking without treatment shortly after learning of a pregnancy. The vast majority of these women, referred to in the literature as “spontaneous quitters” are able to sustain smoking abstinence from shortly after learning of their pregnancy through 6-months postpartum (Solomon & Quinn, 2004). That is a notable level

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of success compared with non-pregnant smokers who quit without treatment where the majority (95%) is unable to sustain abstinence through 6 months after quitting (Hughes et al., 2004). These two groups of women, those who continue to smoke upon learning of pregnancy and those who quit spontaneously, represent striking individual differences in the choices that women make about smoking upon learning of a pregnancy.

While there are both maternal and fetal/infant health benefits of quitting smoking, the latter is clearly an overarching rationale for doing so when a woman learns that she is pregnant. While not frequently discussed in these terms, the mother is faced with a demand to forgo a highly reinforcing activity that she engages in multiple times daily in order to benefit the health of someone else (i.e., the fetus). If one considers that there is an element of altruism or generosity[1] in a mother's choice to discontinue smoking upon learning of a pregnancy, then perhaps individual differences in generosity to others might contribute to the individual differences in smoking during pregnancy described above. To our knowledge, generosity has not been previously investigated in relation to smoking or any other form of substance abuse during pregnancy.

One potential obstacle to investigating this hypothesis is identifying an instrument to measure the construct of generosity towards others. We attempted to surmount that obstacle in the present study by using an instrument developed to measure social discounting, which was derived from investigating the topic of temporal discounting in the area of behavioral economics and the study of inter-temporal choice and decision making (Jones & Rachlin, 2006; Lowenstein, 2007). This social discounting instrument is designed to measure the degree to which one discounts generosity within a social network.

The social discounting task asks an individual to make a mental list of 100 people in her social network, ranging from the person closest and dearest to her at position number 1 to a mere acquaintance at position number 100. She then makes a series of exclusive choices between keeping a designated sum of money exclusively for herself or a 2nd option wherein a sum of money is divided evenly between her and a designated person in her social network (e.g., choose option A. $155 for you alone, or choose option B. Give $75 to person #50 on your list and get $75 to keep for yourself; see Table 1 for a sample version of the task with instructions). The amount to be kept for herself is systematically decreased until a value is reached at which she crosses over to the shared option (Jones & Rachlin, 2006; Jones & Rachlin, 2009). A crossover point is expected due to its occurrence in previous studies and the assumption that this task measures generosity. This same procedure is repeated with seven persons from one's social network (e.g., persons 1, 2, 5, 10, 20, 50, & 100) and a crossover value is obtained for each of these seven social distances. This task permits a quantitative assessment of within-individual and between-individual differences in the likelihood of generosity (Jones & Rachlin, 2006; Jones & Rachlin, 2009).

We are aware of five published studies on the topic of social discounting, all of which were conducted with college undergraduates. Jones and Rachlin (2006) reported the seminal study on this topic demonstrating that generosity decreases as an orderly, hyperbolic function of social distance. Rachlin and Jones (2008a) replicated the hyperbolic nature of the social discounting function while also demonstrating that the degree of social discounting increased as reward value increased, and that temporal delays in obtaining rewards in the selfish option on the social discounting task increased choice of the shared option with greater delays being necessary as social distance increased. Later studies demonstrated greater generosity with family members vs. non-members (Rachlin & Jones, 2008b) and that social discounting correlated with temporal and probability discounting (Jones & Rachlin,

[1]Because there is an explicit potential health benefit to the mother of quitting, we prefer the term generosity to altruism.

2009). Lastly, Osinski (2010) reported that social discounting rate was influenced by social distance to another individual, prior experience of reciprocity with that other individual, reward magnitude, and when the decisions on how to use the money were made mutually between participant and receiver. Relevant to the present study, Jones and Rachlin (2009) reported that social discounting was positively correlated with the amount contributed in a hypothetical public goods game. A public goods game gives participants an allotted sum of hypothetical money from which they can keep a self-determined amount for themselves and put the remaining portion of the allotment into a shared pool, which will then be divided among all who are playing the game. The shared pool is usually multiplied to encourage contributions, but contributing can result in a net loss for an individual participant if she contributes generously while the majority of other participants do not. The positive correlation between generosity in the social discounting task and public goods game in the Jones and Rachlin (2009) study suggests that the social discounting instrument may be a valid measure of individual differences in generosity.

The primary aim of the present study was to investigate whether individual differences in social discounting might be associated with the decisions that smokers make about quitting smoking during pregnancy. Secondarily, we explored how other socioeconomic and psychological differences between pregnant smokers and spontaneous quitters may relate to social discounting and generosity. Sociodemographic variables are particularly important to examine in pregnant smokers and spontaneous quitters. Pregnant smokers in the U.S. are largely socioeconomically disadvantaged women, but spontaneous quitters generally are less disadvantaged than smokers (Higgins et al., 2009; Solomon & Quinn, 2004). Spontaneous quitters are more affluent and educated, are more likely to be married and to have a partner who is a nonsmoker, are more likely to be having their 1st child, smoke fewer cigarettes per/day pre-pregnancy along with other smoking characteristics indicative of less severe nicotine dependence, and have fewer smokers in their social network (Higgins et al., 2009; Solomon & Quinn, 2004). Quitters are also less likely than smokers to have elevated depressive symptoms and acute stress, which can influence generosity (Christiansen & Blake, 1975; Linares-Scott et al., 2009; Parchman, 1991; Rosenhan et al., 1974; Skodova et al., 2008; Sonne, et al., 2010). Thus, it is important to examine how any differences in social discounting noted between smokers and quitters are related to these well established sociodemographic differences. In order to achieve these goals and a more complete understanding of how individual differences in social discounting may relate to individual differences in smoking during pregnancy, we also examined a third group of pregnant never-smokers (i.e., reported smoking <100 cigarettes in their lifetime).

Methods

Participants

Participants were 148 pregnant and recently postpartum women who were participating in other ongoing studies on smoking during pregnancy. One hundred and eighteen of these women were participants in clinical trials on the efficacy of monetary incentives for smoking cessation and relapse prevention (Heil et al., 2008; Higgins et al., 2004). Ninety-one of those women were still smoking upon entering prenatal care, while 27 quit before entering prenatal care (i.e., spontaneous quitters). The remaining 30 women reported being never-smokers (<100 cigarettes lifetime) and were participating as controls in a study on nicotine withdrawal during pregnancy. All participants were recruited from local obstetric clinics as well as from a Women, Infants, and Children (WIC) program in the greater Burlington, VT area. Study inclusion criteria for all three groups of pregnant women were endorsing items on a smoking form given to recruitment clinics that the participant either has continued to smoke after learning of pregnancy, has quit since learning of pregnancy, or never smoked cigarettes (< 100 cigarettes lifetime); biochemical verification of smoking

status with breath carbon monoxide (CO) and urine cotinine, gestational age ≤ 25 weeks; reside within the county in which the study clinic is located; and plan to remain in the geographical area for the duration of the study. Specific smoking frequencies (cigarettes/day pre-pregnancy) among continued smokers, quitters and never-smokers, based on self-report are available in Table 2. Exclusion criteria for all three groups were incarceration, having previously participated in the study, or currently residing with someone who participated in the study.

Assessments

In addition to the social discounting task, all of the women completed a brief questionnaire regarding basic sociodemographics and smoking status, including age, race, years of education, estimated gestational age (EGA), and smoking rate for the previous week (e.g., number of cigarettes smoked/day in the past 7 days). All participants also completed a Likert scale (0-10) of stress rating in the previous 7 days, the Beck Depression Inventory (BDI; Beck et al., 1961) which is a 21-item scale measuring depressive symptoms with higher scores indicating greater severity, and answered questions regarding any history of depressive symptomatology. All participants also completed a temporal delay-discounting task that is described in more detail below.

Social Discounting Task

The social discounting task was administered to all participants using a paper- and-pencil format in a quiet room with a study staff member present. Instructions for the social discounting task's procedure were read aloud to the participant. Following the instructions, the first page of the task was filled out by the test administrator and the participant together to demonstrate how the task was to be completed. After addressing any questions the participant raised, the participant was asked to complete the remaining six pages with the test administrator available for assistance if needed. An example of the social discounting task is available in Table 1.

In completing the social discounting task, participants were read the following instructions:

> The following experiment asks you to imagine that you have made a list of the 100 people closest to you in the world ranging from your dearest friend or relative at position # 1 to a mere acquaintance at #100. The person at number one would be someone you know well and is your closest friend or relative. The person at #100 might be someone you recognize and encounter but perhaps you may not even know their name.
>
> You do not have to physically create the list-----just imagine that you have done so.
>
> Next you will be asked to make a series of judgments based on your preferences. On each line you will be asked if you would prefer to receive an amount of money for yourself versus an amount of money for yourself and the person listed. Please circle A or B for each line.

Instructions at the top of each of the seven pages of the task indicated which person in the social network participants were supposed to be imagining while making choices. These specific instructions are presented in Table 1. Participants then made a series of exclusive choices between keeping a designated sum of hypothetical money ranging from $75 to $155 exclusively for themselves or a 2nd option wherein $150 is divided evenly in $75 amounts between themselves and a designated person in their social network. Each page of the task assessed preferences for sharing hypothetical money with individuals at one of seven different steps of separation within the 1-100 list of people in the social network. More specifically, the exercise was completed for people at positions 1, 2, 5, 10, 20, 50, and 100

in the social network consistent with practices in prior studies (Jones & Rachlin, 2006; Jones & Rachlin, 2009; Rachlin & Jones 2008a,b). Both monetary value amounts and the order in which individuals at varying social distances were presented were counter-balanced across study participants.

An exemplar page from the task is outlined in Table 1. At the top of Table 1, instructions remind the participant to think of their entire network while filling out the choice questionnaire that follows below. The instructions then ask the participant to make choices between an amount of money for herself or for person number 50 in her social network, in this example. Participants are to circle the A or B option for each line indicating their choice. Presentation of the monetary values for option A as well as the order of social distance that each individual page had presented for option B were either ascending or descending for the entire task for a particular participant. That is, the monetary amounts for option A on each page, like the one in Table 1, either started at $155 and decreased to $75 in $10 decrements or started at $75 and increased to $155 in $10 increments. Additionally, the order in which the pages representing different social distances either started with 1 and ascended to 100, or started with 100 descended to 1. There were four possible combinations of ascending or descending monetary values in option A and ascending or descending social distance in option B across pages, such that a participant could have ascending money and descending social distance, descending money and ascending social distance, both ascending money and ascending social distance, or both descending money and descending social distance.

A crossover value was determined at each of the social distances based on the value where participants switched from choosing the monetary value kept for themselves to the sharing option (i.e., where participants crossed from choosing option A to choosing option B). Additionally, crossover values determined for each social distance served to create a social discounting function using the equation outlined in the statistical methods section below.

Among the pregnant smokers, the social discounting task was assessed at the start of smoking-cessation/relapse prevention treatment (79 women) or during a regularly scheduled antepartum or postpartum clinic visit (39 women). There were no differences in discounting rate between those who completed the assessment at treatment initiation compared to those who completed the assessment during the treatment protocol. All of the never-smokers completed the task antepartum.

Temporal Delay Discounting Assessment

The temporal delay discounting (DD) assessment was conducted in a quiet room, in which participants used a notebook computer running Microsoft Visual Basic 6.0 with a staff member present. The DD program used has been described previously (Johnson & Bickel, 2002). In brief, participants were seated in front of the computer screen, which displayed:

> Imagine that you have a choice between waiting _____ and then receiving $1000 and receiving a smaller amount of money right away. Please choose between the two options.

In the instructions, the length of time given was either 1 day, 1 week, 1 month, 6 months, 1 year, 5 years, or 25 years. When participants were ready to begin the task, the staff member clicked on the start button located on the screen, and the DD program began. Participants chose between two different options, always ($1000) at a fixed delay, or a smaller amount available immediately. The DD program adjusted the value of the smaller reward across trials according to an algorithm wherein different values of the smaller reward were presented until an indifference point was found, in which the value of the smaller, immediate amount was subjectively equivalent to the delayed $1000 reward (Johnson &

Bickel, 2002). Once the indifference point for a given delay was determined, the next delay was introduced until an indifference point was established for each of the 7 delays noted above. The order of the delays was presented in a fixed ascending or descending order for a given participant but randomized across participants. Prior to assessment of each new delay, participants were presented again with the instructions listed above.

Statistical Methods

Social discounting equation modeling—An adapted form of the Mazur (1987) hyperbolic equation [$v = V/(1+s\mathrm{N})$] as reported by Jones and Rachlin (2006) was fit to the median crossover values at each social distance. In this equation v is the discounted value of the reward and V is the undiscounted value of the reward, s is the constant measuring the degree of social discounting and N is a measure of social distance. For these data the undiscounted value at N = 0 was calculated ($97.43) and then held constant in order to determine the social discounting rate (s) for median crossover data for all participants as well as for individual participant crossover data. A conventional exponential equation used to describe discounting functions ($v = Ve^{-s\mathrm{N}}$) was also fit to median crossover values at each social distance and compared with the adapted Mazur (1987) equation. Also, participant's social discounting task data was excluded if they crossed over from the selfish to the generous option and then crossed back to the selfish option or if they skipped a page when completing the task (Jones & Rachlin, 2006; Rachlin & Jones 2008b). Only three women were excluded from the analyses due to these performance-related criteria.

To aid the interpretation of temporal discounting rates, the length of delay necessary to discount the subjective value of a commodity by 50% can be calculated, which is referred to as ED50 (Yoon & Higgins, 2008). ED50s can be understood by the same principle as a half-life in pharmacology research. In the present study we calculated ED50s to reflect the social distance necessary to discount by 50% the amount of money participants were willing to forego in order to share.

Temporal discounting equation modeling—The Mazur (1987) hyperbolic equation [$v = V/(1+k\mathrm{D})$] was fit to median indifference points representing 7 different delays: 1 day, 1 week, 1 month, 6 months, 1 year, 5 years, and 25 years. In this equation v is the discounted value of the reward and V is the undiscounted value of the reward, k is the constant measuring the degree of social discounting and D is the length of delay. For these data the undiscounted value at N = 0 ($1000) was held constant in order to determine the temporal discounting rate (k) for median indifference point data across all participants and individual participant data. A conventional exponential equation used to describe discounting functions ($v = Ve^{-k\mathrm{N}}$) was also fit to median indifference points at each delay and compared with the Mazur (1987) hyperbolic equation.

Planned Analyses

Univariate analyses of sociodemographics—Smoking status groups were compared on sociodemographic, smoking, and psychiatric characteristics using analyses of variance (ANOVA) and chi-square tests for continuous and categorical variables, respectively. For variables in which the global test was significant ($p<.05$), pairwise comparisons between groups were performed using Fisher's Least Significant Difference (LSD) for continuous variables and pairwise chi-squares for the categorical variables (Table 2).

Univariate analyses of social discounting—ANOVA was used to compare the degree of social discounting log (s) across smoking status groups with pairwise comparison examined based on Fisher's LSD. The bivariate associations between social discounting and

sociodemographics, smoking characteristics, psychiatric symptoms, and temporal discounting were examined based on Pearson correlation coefficients.

Multivariate analyses predicting smoking status—Stepwise logistic regression analyses were used to examine the independent effect of the degree of social discounting log (*s*) in predicting smoking status. In addition to the degree of social discounting other potential predictors were participant sociodemographics, smoking characteristics, and psychiatric symptoms that were either significantly related to smoking status or correlated with the degree of social discounting in bivariate analyses. Three sets of models were performed to contrast the three smoking status groups: current smokers vs. spontaneous quitters, current smokers vs. never-smokers, and spontaneous quitters vs. never-smokers. Significance to enter and stay in the final regression model was set at $p < .05$. All analyses were performed using SAS software Version 9 (SAS Institute, Cary, NC).

Results

Sociodemographics, Smoking Characteristics, and Psychiatric Symptomatology

Sociodemographics—Current smokers completed fewer years of education and entered prenatal care earlier than spontaneous quitters (Table 2). Current smokers differed from never-smokers on those same two variables as well, and were younger and less likely to be married. Spontaneous quitters and never-smokers differed on one sociodemographic characteristic, with the former being more likely to be pregnant for the first time (Table 2).

Smoking characteristics—Compared to spontaneous quitters, current smokers reported starting to smoke at a younger age, smoked a greater number of cigarettes per day pre-pregnancy, were more likely to permit smoking in their home, had fewer nonsmoker friends/family, and made fewer attempts to quit smoking during pregnancy (Table 2). Compared to never-smokers, current smokers were more likely to report living with a smoker, allowing smoking in their home, and having fewer non-smoker friends/family. Spontaneous quitters were also more likely than never-smokers to live with a smoker and less likely to have non-smoker friends/relatives (Table 2).

Psychiatric symptomatology—Current smokers and spontaneous quitters did not differ on measures of stress or depression, both groups reported greater depression than never-smokers, and current smokers reported more stress than never-smokers (Table 2).

Social Discounting

Discounting among all participants—Median crossover values decreased as an orderly function of social distance across all study participants (Figure 1). Lines and data points in Figure 1 represent the adapted Mazur (1987) hyperbolic equation and a conventional exponential equation fit to the median crossover values at each social distance for all participants. The hyperbolic equation provided a slightly better fit ($v = V/(1+sN)$; $R^2 = 0.98$) than the conventional exponential function ($v = Ve^{-sN}$; $R^2 = 0.97$). For these data, degree of discounting (*s)* was 0.10 for the hyperbolic function.

The social distance at which the maximum amount forgone in order to share with another decreased by half (ED50) was 10 people.

Social discounting across smoking status groups—Based on the better fit to the data of the hyperbolic than the exponential equation in the analysis above we analyzed results across smoking-status groups using the hyperbolic equation. The degree of social discounting log (*s*), significantly differed across smoking groups (Figure 2; $F(2, 145) = 5.17$,

$p < .01$). In post-hoc testing, current smokers differed from quitters and never- smokers ($p < .05$). Quitters and never-smokers were not significantly different. Figure 2 displays the best-fit hyperbolic Mazur (1987) equation fit to each group's median crossover values. The equation provided excellent fit to the group's median crossover values for smokers, quitters, and never-smokers ($R^2 = 0.98$; $s = 0.15$, $R^2 = 0.98$; $s = 0.08$, $R^2 = 0.92$; $s = 0.03$, respectively). The estimated ED50s for smokers, quitters, and never- smokers were 6.66, 12.50, and 33.33 people, respectively.

Temporal Discounting

Discounting among all participants—Median indifference points decreased as an orderly function of temporal delay across all study participants (Figure 3). Lines and data points in Figure 3 represent the Mazur (1987) hyperbolic equation and a conventional exponential equation fit to the median indifference points at each temporal distance for all participants. The hyperbolic equation provided a better fit ($v = V/(1+kN)$; $R^2 = 0.94$) than the conventional exponential function ($v = Ve^{-kN}$; $R^2 = 0.84$). For these data, degree of discounting (k) was 0.0013 for the hyperbolic function.

The delay at which the maximum hypothetical amount forgone ($1000) decreased by half (ED50) was 1.84 years.

Temporal discounting across smoking status groups—There was no significant difference among smoking status groups in the degree of temporal discounting log (k) (Figure 4; $F(2, 145) = 0.32$, $p = .72$). Figure 4 displays the best-fit hyperbolic Mazur (1987) equations to each group's median indifference points.

The adapted Mazur (1987) equation provided a good fit to the median indifference points for smokers, quitters, and never-smokers ($R^2 = 0.92$; $k = 0.0017$, $R^2 = 0.97$; $k = 0.0013$, $R^2 = 0.91$; $k = 0.001$, respectively). The ED50 for smokers, quitters, and never-smokers was 1.61, 2.11, and 2.74 years, respectively.

Univariate Associations with Social Discounting

Sociodemographics—The degree of social discounting log (s) was negatively associated with being married, ($r = -0.22$, $p < .01$, Table 3). There were no other significant associations between the degree of social discounting and sociodemographic variables.

Smoking characteristics—The degree of social discounting log (s) was negatively associated with age of first cigarette ($r = -0.20$, $p < .05$, Table 3), positively associated with the number of smokers living at home ($r = 0.20$, $p < .05$, Table 3) and negatively associated with not allowing smoking in the home ($r = -0.24$, $p < .01$, Table 3). There were no other significant associations between the degree of social discounting and smoking characteristics.

Psychiatric symptomatology—The degree of social discounting log (s) was positively associated with BDI scores ($r = 0.20$, $p < .05$, Table 3) but was not significantly associated with stress ratings, though this relationship trended in a positive direction ($r = 0.16$, $p = .06$).

Temporal discounting—The degree of social discounting log (s) was not associated with the degree of temporal discounting log (k) (Table 3).

Multivariate Analyses Predicting Smoking Status

Stepwise logistic regression predicting smokers vs. quitters—Stepwise logistic regression was used to determine whether the degree of social discounting log (s)

discriminated between smokers and quitters after controlling for differences in participant characteristics. The following univariate items significantly associated with smoking status or social discounting were included in the model: educational attainment, age, marital status, whether it was the first pregnancy, age of first cigarette, cigarettes smoked/day pre-pregnancy, whether a woman attempted to quit smoking pre-pregnancy, living with another smoker, not allowing smoking in the home, having none or few friends/family who smoke, stress in the past seven days, BDI total score, and history of depressive symptoms.

The degree of social discounting significantly discriminated between current smokers and quitters, being the third and final variable to enter the model (Table 4). For every unit increase in the degree of social discounting log (s), there was a 41% increase in the likelihood of being a smoker. The other two variables that discriminated between smokers and quitters were the number of cigarettes smoked/day pre-pregnancy and age of first cigarette. For every one-cigarette increase in the number of cigarettes smoked/day, there was a 1.17-fold increase in the likelihood of continuing to smoke upon learning of pregnancy. For each one-year increase in age of first cigarette, there was an 18% decrease in the likelihood of continuing to smoke.

Stepwise logistic regression predicting smokers vs. never-smokers—Stepwise logistic regression was used to discriminate smokers from never-smokers with the degree of social discounting log (*s*) as an eligible predictor. All univariate items significantly associated with smoking status or social discounting were included in the model, except for smoking characteristics.

Social discounting did not significantly discriminate between current smokers and never-smokers. The three variables that did discriminate were being married, stress rating in the past seven days, and maternal age (Table 5). Being married was associated with a 77% decrease in the likelihood of being a smoker. For every one-unit increase in stress rating (on a 10 point scale) in the past 7 days, there was a 1.36-fold increase in the likelihood of continuing to smoke upon learning of pregnancy. For every one-year increase in maternal age, there was a 9% decrease in the likelihood of being a smoker.

Stepwise logistic regression among quitters vs. never-smokers—This was the final stepwise logistic regression conducted and compared quitters vs. never-smokers. This analysis used the same eligible variables used in the previous analyses. Social discounting did not significantly discriminate between quitters and never-smokers. The two significant variables were BDI total score and whether this was the woman's first pregnancy. For every one-unit increase in the BDI total score, there was a 1.17-fold increase in the likelihood of being a quitter (Table 6). If it was a woman's first pregnancy, there was a 6.47-fold increase in the likelihood of being a quitter (Table 6).

Discussion

This study extends the emerging area of behavioral economic research on social discounting to a new population, pregnant women. Consistent with prior reports in college students (Jones & Rachlin, 2006; Jones & Rachlin, 2009; Rachlin & Jones 2008a, b), pregnant women were significantly more willing to share hypothetical money with those in their social network with whom they were closer emotionally than those who were more distant, with the function relating generosity to social distance being hyperbolic in shape (Figures 1 & 3). The hyperbolic shape of the function reflects changes in generosity across social distances being more pronounced between steps 1 through 20 than 20 through 100, consistent with prior reports (Jones & Rachlin, 2006; Jones & Rachlin, 2009; Rachlin & Jones 2008a, b). While the social discounting literature is relatively small, the consistency of

the results across studies and now populations suggests that the social discounting task may be assessing something fundamental about the manner in which humans make choices about sharing within social networks.

Our overarching aim in examining social discounting in pregnant women in the present study was to determine whether individual differences in this characteristic might increase understanding of the striking individual differences that exist in the choices that pregnant smokers make about quitting upon learning of a pregnancy. The present results support that possibility. As hypothesized, the present results demonstrate that social discounting is a predictor of quitting smoking during pregnancy even after controlling for the many potential confounding influences of sociodemographic and smoking characteristics that differed between smokers and spontaneous quitters in the present study as they have in prior studies (i.e., Solomon & Quinn, 2004). Admittedly, though, the unique variance accounted for by social discounting in quitting smoking upon learning of pregnancy among continued smokers and quitters in the present study is modest compared to the two largest predictors, cigarettes smoked/day pre-pregnancy and maternal age. A prior study with a larger sample has shown cigarettes smoked/day pre- pregnancy remains the largest predictor of quitting or continuing to smoke during pregnancy and maternal age, not only predicting quitting as it does in the present study, but also abstinence from smoking at 6 months postpartum (Higgins et al., 2009).

Interestingly, smokers in the present study also differed from never-smokers in social discounting, suggesting that the differences in social discounting noted between smokers and quitters may not be specific to quitting smoking. However, the differences noted between smokers and never-smokers were accounted for by differences in sociodemographics (marital status, age) and psychiatric symptoms (stress rating in the past seven days), whereas that was not the case with the differences between smokers and quitters. These results suggest that the differences in social discounting observed between smokers and quitters may indeed be a factor influencing the different choices that smokers make about quitting smoking during pregnancy. Of course, it is also possible that having quit smoking may have reduced social discounting rate among the spontaneous quitters, though the direction of this relationship would be an empirical question for a future longitudinal study.

Certainly a complex decision such as whether to quit smoking during pregnancy is almost surely going to be multidetermined, and as was noted above the differences in social discounting between smokers and quitters observed in the present study are modest in size. Nevertheless, this study identifies an additional factor that significantly discriminates between smokers and quitters that, to our knowledge, has not been previously reported. Because temporal discounting has been shown to differ between current smokers and ex-smokers in at least one prior study (Bickel, Odum, & Madden, 1999), we thought it was important to control for its possible influence in this examination of social discounting. Temporal and social discounting were not significantly associated in the present study and we saw no evidence that temporal discounting contributed to the differences in social discounting observed between current smokers and quitters in the present study. To the extent that temporal discounting is a measure of impulsivity or self-control, those constructs do not appear to be involved in the social discounting differences observed between current smokers and quitters. The independence of temporal discounting across different commodities has been reported recently (Weatherly & Terrell, 2011) and the present findings suggest independence across different types of discounting. A modest association between temporal and social discounting has been reported in at least one prior study (Jones & Rachlin, 2009) and merits further investigation, but we were satisfied that it did not

appear to have any significant role in the differences in social discounting noted between current smokers and quitters in the present study.

Unlike some of the more established predictors of smoking during pregnancy (e.g., educational attainment), this social discounting variable may be more readily amenable to intervention. While we know of no evidence regarding the malleability of social discounting per se, it seems plausible that one could devise interventions to promote generosity as part of a multi-element intervention to see if that might be helpful in getting more women to quit smoking. This social-discounting finding might also suggest potential utility in framing the choice that pregnant smokers face in terms of an opportunity to be generous to their developing fetus.

In summary, we extended the study of social discounting to a pregnant smoking population, documenting a similar hyperbolic discounting function in them as in other populations, while also documenting that individual differences in those discounting curves can discriminate between pregnant smokers and quitters even after controlling for potential confounding influences of other differences between them in sociodemographics and smoking characteristics. This predictive relationship seems to be specific to quitting smoking during pregnancy as differences between smokers and never-smokers in the social discounting task were fully accounted for by differences in sociodemographics and psychiatric symptoms. Cigarettes smoked/day pre-pregnancy remained the largest predictor of quitting smoking. Whether women who are relatively steep social discounters could be taught to be more generous and whether doing so might decrease the likelihood of smoking during pregnancy are interesting practical questions that could be addressed in future studies.

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Biography

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Matthew is currently a fourth year graduate student in the Department of Psychology, University of Vermont and is working on data collection for his dissertation. He is a student member of the College on Problems of Drug Dependence and Division 28 of the American Psychological Association.

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Dr. Heil is an Associate Professor of Psychiatry and Psychology, University of Vermont. She is nationally recognized for her research on substance abuse and women, especially pregnant women and their infants; behavioral pharmacology; women's health; and use of incentives to promote healthy behavior change.

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Molly was a research project assistant in the Department of Psychiatry, University of Vermont for 3 years working with Dr. Heil on a multi-site study examining different opiate's effects on maternal and fetal/infant health during pregnancy and postpartum. She now attends pharmacy school at the Albany College of Pharmacy.

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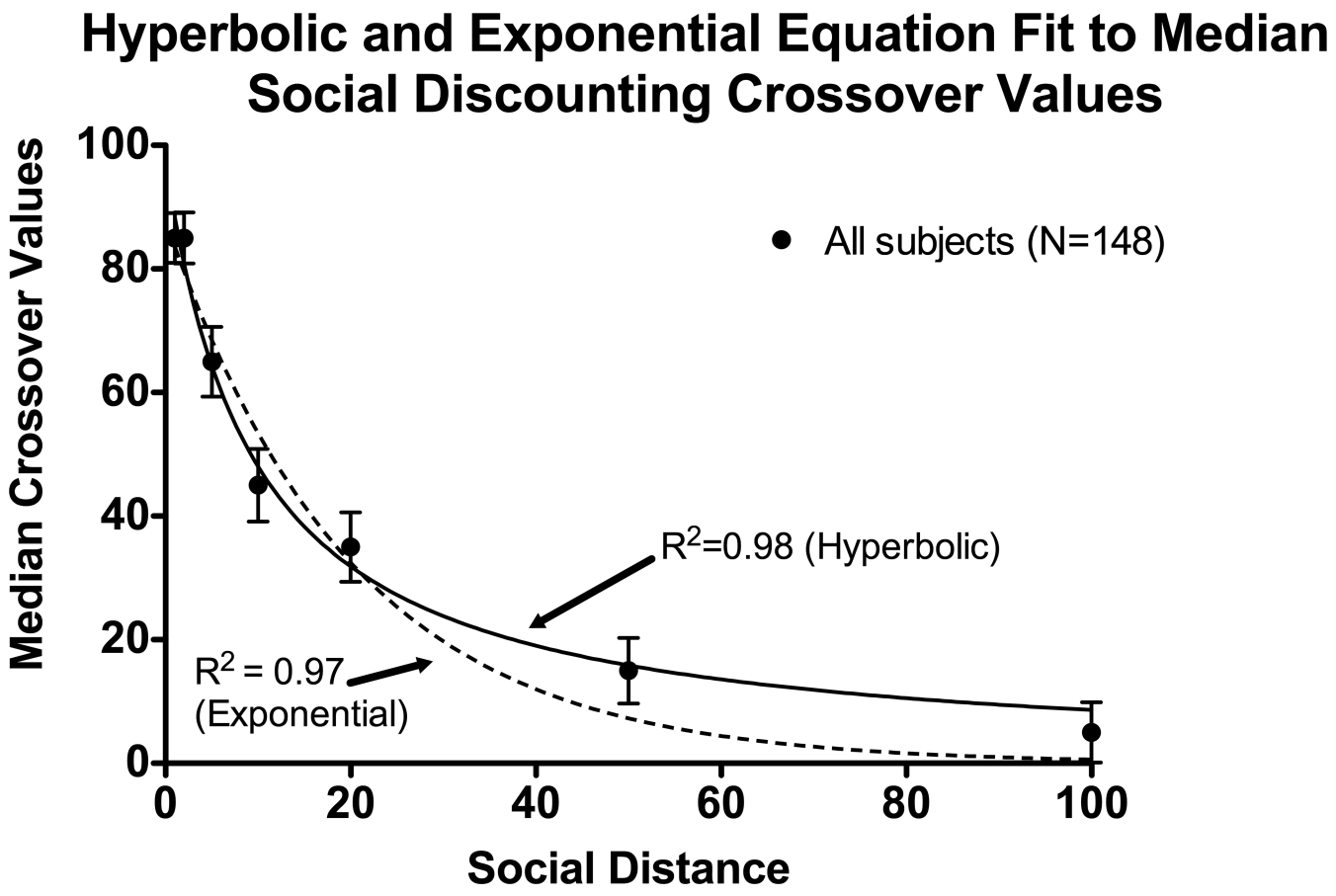

Figure 1.
Social discounting median crossover values (across participants) as a function of social distance for all study participants. Each data point represents the median crossover value at the corresponding social distance. The solid line is the best-fitting hyperbolic function. The dotted line is the best-fitting exponential function. Error bars represent ± one standard error of the median.

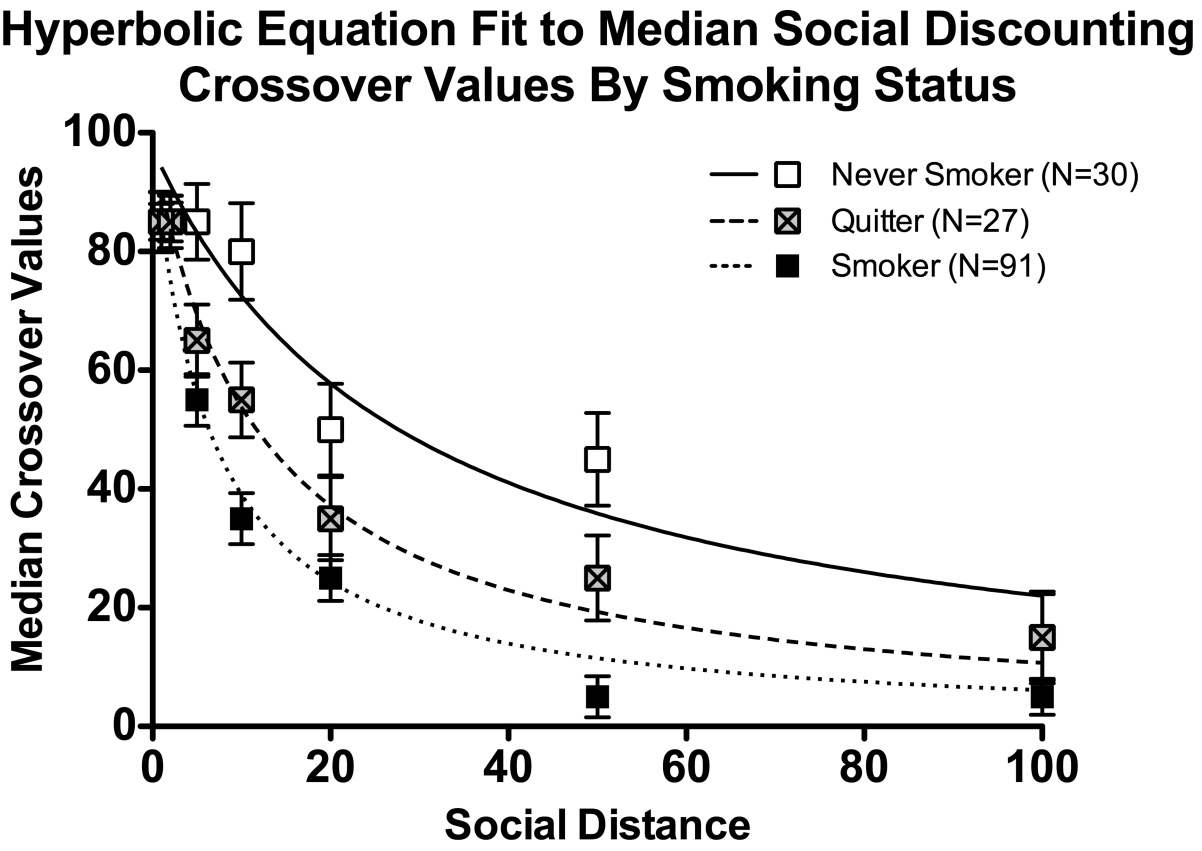

Figure 2.
Social discounting median crossover as a function of social distance for each smoking-status condition (across participants within condition). Each data point represents the median crossover value at the corresponding social distance. Never-smokers are represented by open symbols (solid-line), spontaneous quitters by symbols containing an X (dashed-line), and smokers by filled symbols (dotted-line). Lines are the best-fit hyperbolic functions. Error bars represent ± one standard error of the median.

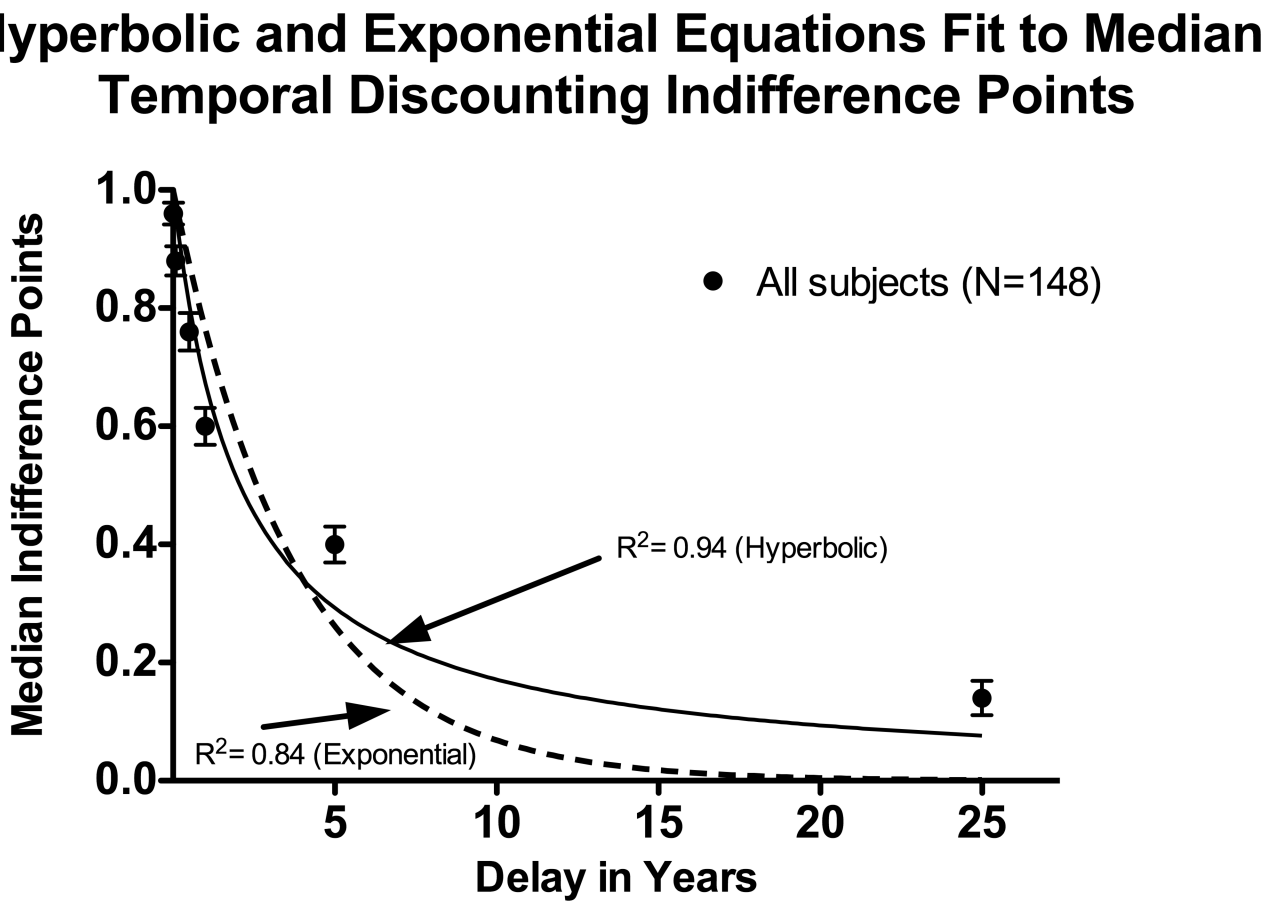

Figure 3.
Temporal discounting median indifference points (across participants) as a function of delay for all study participants. Each data point represents the median indifference point at the corresponding temporal delay. The solid line is the best-fitting hyperbolic function. The dotted line is the best-fitting exponential function. Error bars represent ± one standard error of the median.

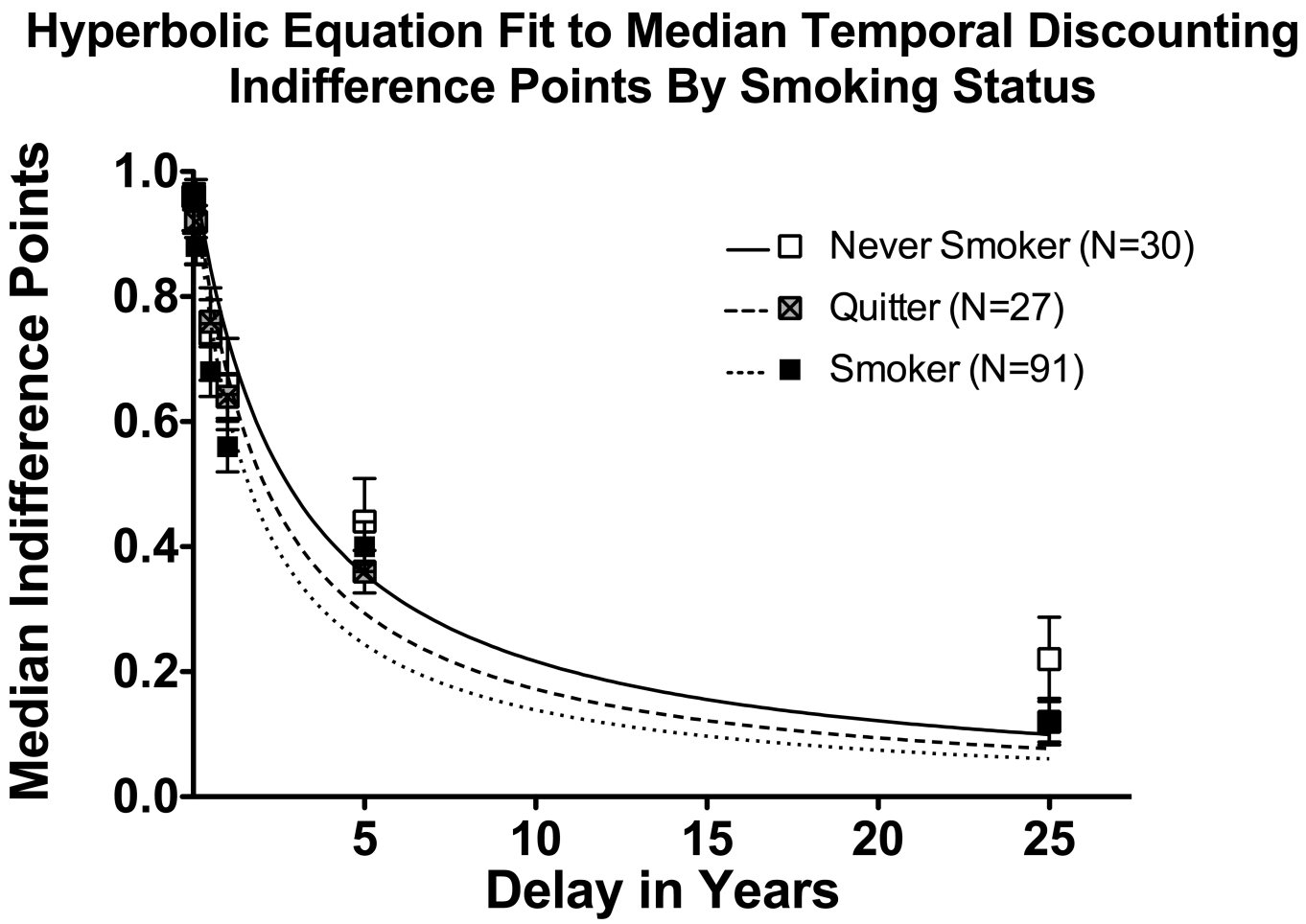

Figure 4.

Temporal discounting median crossover as a function of delay for each smoking-status condition (across participants within condition). Each data point represents the median indifference point at the corresponding temporal delay. Never-smokers are represented by open symbols (solid-line), spontaneous quitters by symbols containing an X (dashed-line), and smokers by filled symbols (dotted-line). Lines are the best-fit hyperbolic functions. Error bars represent ± one standard error of the median.

Table 1

Exemplar Page From Social Discounting Task (Person # 50)

A. $155 for you alone.	B. $75 for you and $75 for the # 50 person on the list.
A. $145 for you alone.	B. $75 for you and $75 for the # 50 person on the list.
A. $135 for you alone.	B. $75 for you and $75 for the # 50 person on the list.
A. $125 for you alone.	B. $75 for you and $75 for the # 50 person on the list.
A. $115 for you alone.	B. $75 for you and $75 for the # 50 person on the list.
A. $105 for you alone.	B. $75 for you and $75 for the # 50 person on the list.
A. $95 for you alone.	B. $75 for you and $75 for the # 50 person on the list.
A. $85 for you alone.	B. $75 for you and $75 for the # 50 person on the list.
A. $75 for you alone.	B. $75 for you and $75 for the # 50 person on the list.

Imagine you made a list of the 100 people closest to you in the world ranging from your dearest friend or relative at #1 to a mere acquaintance at #100. Now imagine the following choices between an amount of money for you [A] and an amount for the # 50 person on the list [B]. Circle A or B to indicate which you would choose in EACH line.

Table 2

Participant Characteristics

Demographics	Smoker (N=91)	Quitter (N=27)	Never-smoker (N=30)	Overall *p*-value
Maternal age (years) (mean±sd)	24.60±4.87[a]	26.41±5.09[ab]	28.07±6.49[b]	0.01
Caucasian (%)	96	96	90	0.45
Educational attainment (mean±sd)	12.13±1.81[a]	13.52±2.87[b]	13.43±2.36[b]	**0.002**
Weeks pregnant at trial intake (mean±sd)	9.78±3.62[a]	11.67±3.46[b]	13.17±3.12[b]	**<.001**
Primagravida (%)	56[ab]	70[a]	37[b]	**0.04**
Married (%)	18[a]	30[ab]	53[b]	**<.001**
Private insurance (%)	26	41	37	0.28
Working for pay outside of home (%)	51	63	50	0.5

Smoking Characteristics				
Age first started smoking cigarettes (mean±sd)	14.90±2.94[a]	16.56±3.11[b]	NA	**0.01**
Cigarettes per day pre-pregnancy (mean±sd)	18.34±8.20[a]	10.67±6.96[b]	NA	**<.001**
Living with another smoker (%)	74[a]	67[a]	20[b]	**<.001**
Smoking not allowed in home (%)	55[a]	81[b]	93[b]	**<.001**
None or few friends/family who smoke (%)	25[a]	48[b]	83[c]	**<.001**
Attempted to quit pre-pregnancy (%)	70	81	NA	0.25
Number of quit attempts during pregnancy (mean±sd)	0.77±1.50[a]	1.37±0.56[b]	NA	**0.04**
Minnesota Nicotine Withdrawal Questionnaire mean score (0-4) (mean±sd)	1.44±0.80	1.30±0.66	NA	0.41

Psychiatric Symptoms				
Stress rating (0-10) (mean±sd)	5.61±2.60[a]	4.70±2.20[ab]	3.67±2.31[b]	**0.001**
Beck Depression Inventory total score (0-63) (mean±sd)	10.88±7.60[a]	10.58±6.37[a]	5.77±4.75[b]	**0.002**
History of depressive symptoms	45[a]	44[a]	17[b]	**0.02**

For continuous variables, the overall p-value was based on Analysis of Variance and for categorical variables the p-value was based on Chi-square tests. For variables with a significant overall p-value pairwise comparisons were examined using LSD for continuous variables and pairwise chi-squares for categorical variables. Means/percents with a common letter (a,b, or c) are not significantly different (α=0.05).

Table 3

Univariate Associations Between Participant Characteristics and Social Discounting

Temporal Discounting	**Log (*s*) Pearson *r***	***p*-value**
Log (*k*)	0.09	0.27
Demographics		
Age	-0.14	0.09
Being married	-0.22*	**0.006**
Educational attainment	-0.14	0.09
Smoking Characteristics		
Age of first cigarette	-0.20*	**0.03**
Living with another smoker	0.20*	**0.02**
Not allowing smoking in the home	-0.24*	**0.003**
Having none or few friends/family who smoke	-0.12	0.16
Psychiatric Symptoms		
Stress rating in the past 7 days	0.16	0.06
BDI total score	0.20*	**0.02**

*N*ote: asterisks denote significant associations at $p < .05$.

Table 4

Stepwise Logistic Regression Predicting Smokers vs. Quitters

Predictor	Odds Ratio (95%CI)	Effect Size[a]	*p*-value
Cigarettes smoked/day pre-pregnancy	1.17 (1.07-1.27)	3.82	<0.001
Age of first cigarette	0.82 (0.69-0.97)	0.55	0.02
Log (*s*)	1.41 (1.04-1.91)	1.95	0.03

Note: Model estimates reflect prediction of status = Smoker.

[a]Effect size estimates correspond to odds ratio per 1 SD change in each predictor

Table 5

Stepwise Logistic Regression Predicting Smokers vs. Never-Smokers

Predictor	Odds Ratio (95%CI)	Effect Size[a]	*p*-value
Being married	0.23 (0.08-0.62)	0.52	0.004
Stress rating in the past 7 days	1.36(1.11-1.67)	2.21	0.003
Maternal age	0.91 (0.84-0.99)	0.60	0.040

Note: Model estimates reflect prediction of status = Smoker.

[a]Effect size estimates correspond to odds ratio per 1 SD change in each predictor

Table 6

Stepwise Logistic Regression Predicting Quitters Vs. Never-Smokers

Predictor	Odds Ratio (95%CI)	Effect Size[a]	*p*-value
BDI total score	1.17 (1.04-1.31)	3.06	0.007
Primagravida	6.47 (1.70-24.5)	2.54	0.006

Note: Model estimates reflect prediction of status = Quitter.

[a]Effect size estimates correspond to odds ratio per 1 SD change in each predictor