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Temporal horizon: modulation by smoking status and gender

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Abstract

Recently, delay discounting has been argued to be conceptually consistent with the notion of temporal horizon (Bickel et al., 2008). Temporal horizon refers to the temporal distance over which behavioral events or objects can influence behavior. Here we examine the results on two putative measures of temporal horizon, future time perspective (FTP) and delay discounting, collected over three separate studies ($n = 227$), to determine the influence of smoking and gender on temporal horizon. By comparing the results on these temporal horizon measures we address our population of interest: women who smoke. One of the measures of FTP indicates that smoking women have a shorter temporal horizon than their nonsmoking counterparts. Additionally, the story completion measures of FTP are positively correlated with delay discounting. In contrast, results of delay discounting measures showed no difference between smoking women and nonsmoking women, while results of delay discounting measures indicated smoking men have a shorter temporal horizon than non-smoking men. Additionally, the results of the FTP story completion measure indicated that lower third income earners had a shortened temporal horizon compared to upper third income earners. A possible explanation for these results is explored, and the implications of the modulation of temporal horizon by gender and smoking are discussed.

Keywords

smoking; women; delay discounting; temporal horizon; risk taking

1. Introduction

Recently, an argument has been made that temporal horizon is an important aspect of addiction (Bickel et al., 2008). From this theoretical viewpoint, the term *temporal horizon* refers to the expanse of time over which behavioral events or objects can influence behavior. As such, temporal horizon describes the window in time in which an individual is capable of perceiving and planning. The aperture of temporal horizon extends into both the future and the past, with the influences of past experiences and future consequences of current choices limited by the range of an individual's temporal horizon. From our view, temporal horizon is a phenomenon that defines the interaction of an environment (including reinforcers) with each individual's unique biology and behavioral history, and influences and is influenced by the choices that that

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an individual makes. Thus, understanding the factors that modulate the temporal horizon will help inform addiction treatment design and enhance our understanding of the underlying neurocognitive processes associated with decision making. In the present study, we explored future temporal horizon via two measures: future time perspective (FTP) and delay discounting.

The FTP measure (Wallace, 1956) consists of two types of questions that address the time frame over which an individual considers future actions or outcomes. For example, the first question asks participants to write a list of 10 events that will occur in their lives and to indicate the age that they would expect to be when each event would occur. The second type of question asks participants to write endings to short stories and to indicate the duration of the story. Both measures provide estimates of how far into the future a person typically plans. Consequently, the FTP is consistent with the notion of temporal horizon.

Delay discounting refers to the decrease in value of a temporally distant reward as a function of the duration of delay. The notion of discounting is intuitive in that most of us would prefer, for example, \$100 now rather than the same \$100 in the future. Delay discounting determines the subjective preference for immediate rewards by employing methods standard to psychophysical assessments (Stevens and Marks, 1956). In the delay discounting paradigm, participants choose between adjusting amounts of a smaller reward available immediately and a fixed amount of a larger reward after an interval of delay (Rachlin et al., 1991). Calculation of numerous indifference points, the subjective present equivalents of delayed rewards, indicates that delay discounting typically reaches an asymptote: beyond this asymptote, further delays do not significantly change behavior.

Importantly, delay discounting has been recast from being a measure of impulsivity to being a measure of temporal horizon (Bickel et al., 2008). Specifically, the extension of discounting to the valuation of past rewards has been shown to be hyperbolic, to exhibit the magnitude effect, and to differentiate smokers from nonsmokers in a manner similar to the discounting of future rewards. On the basis of these results, delay discounting is inconsistent with the construct of impulsivity (as indicated by a failure of response inhibition or an inability to delay gratification; also see Reynolds et al., 2006) and may be considered as a measure of temporal horizon.

Together, measures of FTP and delay discounting may delineate components of the temporal horizon. Both measures ask participants to consider future actions, and are influenced by current circumstances. However, they differ in how they are executed and in what they specifically measure. As such, the differences between the measures of temporal horizon may be exhibited by comparing vulnerable populations such as women who smoke to a similarly vulnerable population of smoking men and their nonsmoking counterparts. In this report, we attempt to understand the influence of two variables that may modulate measures of the temporal horizon: smoking and gender.

No prior studies have reported using FTP to compare smokers and nonsmokers, though differences in FTP have been found between addicts and non-addicts of other substances (Petry et al., 1998; Murphy and DeWolfe, 1986; Alvos et al., 1993). However, a considerable number of studies have examined the effect of smoking status on delay discounting. Smokers exhibit steeper rates of discounting than nonsmokers, and their smoking rate is positively correlated with the discounting rate (Mitchell, 1999; Bickel, et al., 1999; Odum et al., 2002; Epstein, et al., 2003; Baker et al., 2003; Reynolds et al., 2004; Ohmura, et al. 2005; Reynolds, 2006; Johnson, et al., 2007). Consistent with the prior literature regarding delay discounting, we hypothesized that smokers will show a decreased temporal horizon as measured by assessments of FTP and delay discounting.

Gender is another factor that may modulate temporal horizon or the influence of other factors on temporal horizon. The influence of gender on the FTP measure has not been directly addressed, though several studies have shown that women, compared to men, have deficits in planning for future events such as retirement (Jacobs-Lawson et al., 2004). Gender has been implicated as an important modulator of delay discounting. Among college students, men exhibit steeper rates of discounting than women (Kirby and Marakovic, 1996). Men also seem to be more sensitive to the influence of environmental cues on their temporal horizon. Wilson and Daly (2004) found that men discounted money more steeply after being exposed to pictures of attractive women than to control pictures, but women exhibited no change in discounting when viewing pictures of attractive men compared to control pictures. Thus, we expected to find an influence of gender on temporal horizon.

In the present report, we have combined data from three studies: one previously published (Bickel et al., 2008) and two in preparation that were designed to study questions different from the ones addressed here. The selected studies included both males and females, and cigarette smokers and nonsmokers.

2. Methods

2.1. Participants

The three experiments included in this study were selected because they used a common set of demographic and temporal horizon measures, described below. Table 1 shows a summary of the participant demographic data.

Across these three studies, a total of 227 participants (84 men and 143 women) with a mean age of 40.1 years ($SEM = 13.6$) were recruited via community fliers and newspaper advertisements. Two studies recruited both smokers ($n = 59$) and nonsmokers ($n = 87$), and one study recruited participants ($n = 81$) having a range of body mass index values; all participants completed measures of FTP and delay discounting. Non-smokers were recruited to match the smoking participants using a number of criteria including: age, race, income, and other factors. Individuals were screened for mental health and health-related problems. The delay discounting data from one study ($n = 59$) have previously been published (Bickel et al., 2008), while the data from the other studies are unpublished to date. As indicated by a carbon monoxide (CO) breath sample, 86 participants were classified as smokers ($CO > 11$ ppm) and 141 participants as nonsmokers. Three participants did not report income; the median monthly income for the remaining 224 participants was \$1,200.

2.2. Measures and procedure

Common demographic and baseline data across the three studies were gender, monthly income, age, and education. Smoking status was assessed with an EC50-Micro CO monitor (Bedfont Scientific Ltd., Kent, UK). Participants then completed a computerized delay discounting task, which included hypothetical \$100 and \$1,000 amounts, and a pen-and-paper FTP task during the course of each study. The order of presentation of delay discounting measures was counterbalanced, and participants always completed the delay discounting measure before the FTP measure. The tasks of the FTP measure were always completed in the same order.

The pen-and-paper FTP measure was modified from the original Wallace (1956) measure. For part 1, the FTP extension, 10 spaces were provided for participants to list events that they would experience in the future and the ages at which the events would occur. This part of the FTP measure produced determinations of the number of years between a participant's current age and the furthest life event described (maximum extension) and of the average number of years between current age and all events (mean extension). For part 2 of the FTP measure, participants

were asked to write endings for two short stories (stories 3 and 4 from Wallace, 1956, respectively referred to here as stories 1 and 2). Mean and extension data for the FTP measure were missing for two participants, and the duration of at least one FTP story was missing for five participants.

Instructions for part 2, the FTP story completion task, read as follows: “Now I am going to start telling a story and then I want you to finish the story for me. There are no right or wrong ways to finish the story; just finish the story any way you want to.” The first story read: “Joe is having a cup of coffee in a restaurant. He's thinking of the time to come when....” The second story read: “After awakening, Bill began to think about the future. In general, he expected to....” Both stories included an additional line that asked “How long a time was involved with the story, not in telling, but in the action(s) you described?” The duration (in minutes) to the proposed end of each story was documented.

The delay discounting procedures were presented on a personal computer in either the double-limit (described by Johnson and Bickel, 2002) ($n = 146$) or the decreasing-adjustment algorithm (Du et al., 2002) ($n = 81$). In both methods, the immediately available alternative appeared on the left side of the screen and changed from trial to trial; the delayed alternative remained fixed on the right side of the screen. Indifference points were determined at the following delays: 1 day, 1 week, 1 month, 1 year, 5 years, and 25 years. Data for one magnitude of delay discounting were missing for three participants.

Additional measures of discounting, self-report measures of impulsivity, and other assessments were completed in each study but were not included in this analysis because of a lack of commonality among the studies.

2.3. Data analysis

2.3.1. FTP measures—All four of the FTP measures were not well approximated with normal distributions; all but the mean FTP values were not amenable to usual normalizing transformations. Hence, we computed the normal scores across the entire sample within each FTP measure type. A normal score is a standard normal quantile that corresponds to the percentile of a particular FTP value among all FTP values of the same type. As a consequence, results of the analyses for the FTP measures were expressed in terms of standard normal quantiles. To aid in the interpretation, we transformed the FTP results into percentiles of a general population. Again, this transformation is monotonic and does not change statistical inferences.

2.3.2. Delay discounting—Each set of indifference points provided by each of the participants for discounting of hypothetical gains of \$100 and \$1,000 was fitted with a reparameterized version of Mazur's (1987) original hyperbolic discounting model:

$$E(Y) = \frac{1}{1+kD} \quad \text{Equation 1}$$

In Equation 1, $E(Y)$ is the expected indifference point, expressed as a proportion of the larger valued choice offered at delay D and the discounting coefficient k , which we reparameterized as $\exp(g)$, where g is the natural logarithm of k . Rather than estimating k , we estimated g .¹ Because the estimated values of g were not known with the same precision (i.e., variability in

¹ $g = \ln(k)$ implies $e^g = k$. We chose this parameterization for two reasons: (1) the natural logarithm of k is a normalizing transformation and (2) estimated values of g come automatically with standard errors which are used in computing weights of the g estimates.

discounting is heterogeneous among individuals), weights for the estimated discounting coefficients were computed with the use of their corresponding standard errors by the method described in Sidik and Jonkman (2005). These weights were used when conducting the analyses described below. To graphically present the results in terms of the discount rate k , we transformed point and confidence interval estimates of g back into k . Because the transformation is monotonic, statistical inference is not altered.

2.3.3. Analyses for FTP and delay discounting measures—The families of discounting and FTP measures were analyzed separately. For each family of measures, we fitted a linear mixed model having a random effect for study; fixed effects for smoking status (smoker or nonsmoker), gender (men or women), measure type (FTP: mean, extension, story 1, and story 2; discounting: \$100 and \$1,000 amounts), all two- and three-way interactions of smoking status, sex, and measure type; and, as covariates, income, age, and years of education. This model is a type of analysis of covariance (ANCOVA). Each level of the measure type factor was measured within an individual; hence, we considered a compound symmetric and general (i.e., unstructured) covariance structure as possible models of the within-individual correlation. The Bayesian Information Criterion (BIC) was used to select the covariance structure (Wolfinger, 1993). The compound symmetric covariance structure was preferred for the general structure of the FTP measures and discounting measures. As recommended by Milliken and Johnson (2002), we estimated the error degrees of freedom for all tests with the method described by Kenward and Roger (1997) and available in SAS version 9.1 (2004). We controlled familywise Type I error rates at 0.05 with Holm's step-down method for multiple comparisons.

2.3.4. Additional analyses—Overall, participants' monthly income and years of education had little to no effect in the above analyses, possibly due to the low amount of variability in these measures. We thus explored whether the extremes (upper vs. lower earners; upper and lower educated) differed in their temporal horizons. In order to do so, we classified the sample into tertiles (lower, middle, and upper thirds) of income and of education, and entered this factor into an ANOVAs having gender, smoking status, income (alternatively, education) level, and measure type as factors, along with all interaction; study was entered as a random factor, and the within-individual covariance structure was taken to be general for FTP measures and compound-symmetric for discounting measures.

To compare between the delay discounting measures collected with the decreasing-adjustment and the double-limit discounting algorithms used in the three studies, we modeled the logged discounting coefficients (i.e., estimated g values) and regression error variances, each with a repeated-measures analysis of variance having study as a random factor and algorithm (decreasing-adjustment and double-limit), amounts (\$100 and \$1,000), and their interaction as fixed effects. The amount was the within-individual factor. The covariance structure was compound symmetric.

Spearman rank correlation coefficients were used to describe the relationships among the FTP and delay discounting measures. These correlations were examined across the genders and for each gender.

3. Results

3.1. FTP results

The overall ANCOVA findings (Table 2) showed no evidence that gender or smoking had an average effect over the four FTP measures ($F_{1,213} = 0.16$, $p = 0.686$; and $F_{1,203} = 1.24$, $p = 0.287$, respectively). There was, however, evidence that differences between men and women depended upon the type of FTP measure (gender-by-FTP measure interaction: $F_{3,216} = 3.99$,

$p = 0.009$). This interaction did not depend on smoking status (three-way interaction: $F_{3,216} = 1.74$, $p = 0.161$). There was also no evidence of interactions of FTP measures with smoking status ($F_{3,216} = 0.76$, $p = 0.516$) or with gender ($F_{1,212} = 0.46$, $p = 0.498$). Because of a priori comparisons of interest and the interactions between gender and FTP measures, we compared each FTP measure between the smokers and non-smokers separately for women and men. Figure 1 presents the mean percentiles ($\pm$ SEM) for FTP mean and extension, and Figure 2 does the same for stories 1 and 2 of the FTP measures; Table 3 contains the mean percentiles and 95% CIs by group.

3.1.1. FTP extension—Among smokers, the women's mean percentile for the FTP extension was 22.1 points (CI: 6.0, 36.0) lower than the men's percentile of 57.2 ($t_{205} = -2.67$, adjusted $p = 0.016$). This difference in percentiles equated to women smokers exhibiting a temporal horizon of 9 years to smoking men's 15 years. The same pattern of results between men and women did not hold for nonsmokers, with the nonsmoking women having a mean percentile of 49.2 compared to a mean percentile of 54.7 for nonsmoking men ($t_{206} = 0.72$, adjusted $p = 0.473$) or 12 years for nonsmoking women and 14 years for nonsmoking men,

3.1.2. FTP mean, story 1, and story 2—The interaction of FTP measure with gender was made apparent when the results within the FTP extension were contrasted with the lack of any detectable differences within the remaining three FTP measures. For each FTP measure, mean extension, story 1, and story 2, no difference was found between smoking women and men (mean extension: $p = 0.112$; story 1: $p = 0.386$; story 2: $p = 0.212$) or between nonsmoking women and men (mean extension: $p = 0.504$; story 1: $p = 0.089$; story 2: $p = 0.867$). Women completed story 1 with a median ending of 2 days into the future and men completed story 1 with an ending 1 hour into the future. Women completed story 2 with an ending of 1 year into the future, and men completed story 2 with a median ending 6 months into the future.

3.1.3. Additional FTP results—There was no evidence that income, age, or years of education had effects on FTP measures when included as covariates; regression slopes and 95% confidence intervals are found in Table 3 (for all three factors, $p > 0.14$).

3.2. Discounting results

The overall ANCOVA results showed strong evidence of an interaction between gender and smoking status ($F_{1,215} = 13.58$, $p < 0.001$). This interaction did not depend on the discounted amount (three-way interaction: $F_{1,217} = 1.58$, $p = 0.211$), and there was no evidence that the patterns for smoking status or gender depended on the discounted amount ($F_{1,217} = 0.13$, $p = 0.714$; and $F_{1,217} = 0.28$, $p = 0.600$, respectively). Though the main effects of gender and smoking were significant ($F_{1,215} = 5.41$, $p = 0.021$; and $F_{1,214} = 8.86$, $p = 0.003$, respectively), the gender-by-smoking status interaction necessitated examination of their simple effects. These simple effects were precisely those in which we had a priori interest; we examine these relationships below.

3.2.1. Consistency of hyperbolic discounting and discounting algorithms—

Discounting coefficients (see Equation 1) were estimated for 431 of the 432 discounting measures. One dataset for the discounting of \$100 was eliminated from the analysis because the nonlinear regression failed to converge. The remaining 431 discounting datasets were used. The median (interquartile range) squared correlation of predicted and observed indifference points (a pseudo- R^2) was 0.928 (95% CI: 0.794, 0.969).

Before analyzing the estimated discounting parameters in the ANCOVA, we checked for differences between the decreasing-adjustment and double-limit algorithms used to collect the discounting data, and found no differences between the algorithms in the means of the logged

discounting coefficients (mean difference = 0.127, SEM. = 0.686, $t_{426} = 0.19$, $p = 0.853$) or in the means of the regression error variances (mean difference = 0.001, SEM = 0.003, $t_{426} = 0.18$, $p = 0.861$).

3.2.2. Comparisons between men and women—The interaction between smoking status and gender is clearly evident when men and women are compared at each level of smoking status. For both the \$100 and \$1,000 amounts, the average discount rates among smoking women were about one-tenth of the average rates among smoking men: for \$100, the mean ratio was 0.10 (CI: 0.03, 0.31, $p < 0.001$), and for \$1,000, the mean ratio was 0.11 (CI: 0.04, 0.32, $p < 0.001$). Among nonsmokers, however, women and men did not statistically differ for either the \$100 or the \$1,000 amount ($p = 0.240$ and $p = 0.559$, respectively). Mean discount rates and their CIs for each group are presented in Table 2.

3.2.3. Comparisons between smokers and nonsmokers—The discount rates of female smokers did not significantly differ from those of female nonsmokers for either the \$100 or the \$1,000 amount ($p = 0.677$ and $p = 0.907$, respectively). In contrast, among male smokers, the discount rates far exceeded those of nonsmoking men: for the \$100 amount, the discounting rate was between 4.71 and 54.36 times greater (adjusted $p < 0.001$); and for the \$1,000 amount, the rate was between 3.71 and 36.7 times greater (adjusted $p < 0.001$). Figure 3 compares the estimated means ($\pm$ SEM) of the discount rate (k) between smokers and nonsmokers by gender for the \$100 and \$1,000 amounts (left and right panels, respectively).

3.2.4. Additional discounting results—The overall ANCOVA results showed no evidence that the covariates income, age, or years of education had an effect on delay discounting; Table 2 provides regression slope values and 95% confidence intervals for these three factors (for all three, $p > 0.54$). Consistent with magnitude effects reported by others (Baker et al., 2003; Estle et al., 2006), the mean discount rate for the \$100 amount, averaged over the levels of smoking status and gender, was between 1.25 and 1.83 times the rate for the \$1,000 amount ($p < 0.001$).

3.3. Relationships among FTP and delay discounting measures

In the entire sample, participants with lower discounting rates tended to provide longer times on stories 1 and 2 of the FTP measures than those with higher discounting rates. The rank correlations of discounting coefficients for the \$100 and the \$1,000 amounts with story 1 times were -0.159 ($p = 0.020$) and -0.176 ($p = 0.010$), respectively. Slightly stronger were the analogous correlations with story 2: -0.186 , $p = 0.007$ for \$100; and -0.225 , $p = 0.001$ for \$1,000. Though all correlations of the FTP extension and mean extension with the two discounting measures were negative, as would be expected, the largest magnitude (and smallest p value) was $|-0.074|$ ($p = 0.277$) between the discounting of \$1,000 and the FTP extension.

Discounting coefficients for the \$100 and the \$1,000 amounts strongly correlated ($r = 0.908$, $p < 0.001$), as did the FTP extension and mean extension values ($r = 0.857$, $p < 0.001$). Stories 1 and 2 of the FTP measures also correlated, but not as strongly as the aforementioned two pairs ($r = 0.408$, $p < 0.001$). FTP story 2 correlated better with FTP extension ($r = 0.254$, $p < 0.001$) and mean extension ($r = 0.252$, $p < 0.001$) than did FTP story 1 ($r = 0.107$, $p = 0.108$ for extension; $r = 0.139$, $p = 0.037$ for mean extension).

3.4. Income and education

Although income and education did not produce significant effects in our ANCOVA model, we feel a comparison of these demographics between smoking status and gender would be useful for understanding the impact that these factors have on temporal horizon. Overall, the median income \$1,200 (IQR: \$600, \$2,250) represented a fairly low earning bracket. Smoking

women did not differ in income between nonsmoking women (median test: $p=0.0694$), nor did smoking men differ from non-smoking men (median test: $p =0.2388$) consistent with our criteria of matching participants on income. However, smokers showed significantly less years of education than nonsmokers, in both women (median test: $p <0.0001$) and men (median test: $p =0.0004$). Because of overall low income, we decided to compare the top and bottom third of earners on measures of education, age, gender, and measures of temporal horizon. Participants were split into three groups by the 33.3 and 66.7 percentiles of income, which were \$808 and \$1800 per month, respectively.

A four factor ANOVA that included smoking status, gender, income group, FTP measures, and their interactions as factors revealed a significant effect for high third versus low third income on FTP story 1 ($p = .037$) and FTP story 2 ($p = .021$). The average lengths of Stories 1 and 2 for high-income earners were 2 weeks and 2 years, respectively, while the low-income earners completed Stories 1 and 2 with an average length of 1 hour and 6 months, respectively. However, the analogous four-factor ANOVA on discounted amount found no significant effect for either \$100 or \$1000 future discounting between upper and bottom third earners on discounting (\$100 $p = .29$; \$1,000 $p = .37$).

Any comparisons between high and low education that involved averaging over smoking women could not be made as there were no smoking women in the upper third of education. The absence of information from this particular group eliminated the ability to make claims regarding education and temporal horizon in our population of interest: women who smoke.

4. Discussion

Our results indicate that our population of interest, women who smoke, exhibit a shortened temporal horizon compared to smoking men on the FTP extension measure. That is, women who smoke described their furthest event on average 9 years into the future while smoking men described events that would occur on average 15 years in the future. We believe that the shortened temporal horizon expressed by the FTP measure is predictive of some of the difficulties women have in substance abuse treatment. For example, a shortened temporal horizon may play a role in determining why women have shorter and less frequent periods of abstinence when compared to men during smoking cessation attempts (Royce et. al, 1997; Lynch et. al, 2002).

Additionally, our results indicate that low-income earners indicated shorter temporal horizon on FTP story completion measures compared to high-income earners, even though the overall range of income reported by the sample was relatively low. Finally, we find that the delay discounting rates of women who smoke do not differ from non-smoking women or men; however smoking men smoke exhibit shorter temporal horizons on measures of delay discounting compared to women who smoke. We will address five topics that relate to these findings: the effects of the interaction of smoking and gender on FTP and delay discounting, the effects of gender on FTP, the influence of the socio-economic status on temporal horizon, potential limitations of this study, and finally a summary of the results and suggestions on a future direction for understanding the role of temporal horizon on the treatment of addiction.

4.1. Effects of the interaction of smoking and gender on FTP and delay discounting

This study is the first to explore the effects of the interaction between gender and smoking status on measures of FTP and delay discounting, and its findings show that gender and smoking status modulate these measures of temporal horizon. Our primary population of interest, women who smoke, showed a shorter temporal horizon when compared to smoking men on the FTP extension measure. While few studies on the FTP have included gender as a component, an extensive amount of previous work on delay discounting has revealed that

smokers discount future gains more steeply than nonsmokers (Mitchell, 1999; Bickel et al., 1999; Reynolds et al., 2004). Additionally, men have been shown to discount more steeply than women (Wilson and Daly, 2004; Kirby and Marakovic, 1996). The current study found largely congruent results: men who smoke discounted more steeply than men who do not smoke; however, no such effect was observed with women.

4.2. Effects of gender on FTP

In contrast, results of the FTP extension measure show a different pattern of results: women smokers had a shorter FTP extension duration than nonsmoking women, but smoking and nonsmoking men did not differ in this regard. Previous work has shown that FTP extension duration is shortened by drug use (Petry et al., 1998), though the present results can only confirm that this effect applies to women. That women plan less far into the future than do men is not unprecedented. Jacobs-Lawson et al. (2004) found that women typically planned into the future less than men for major life events. Interestingly, this appears to be precisely what the FTP extension measures demonstrate.

The FTP extension measure asks participants to project self-relevant future events, and our informal review of completed assessments indicates that many of these events are major life events. Additionally both FTP story 1 and story 2 could be completed with short duration endings, which may explain why delay discounting rates correlate with FTP story measures. Therefore, while assessments of FTP and delay discounting may both measure aspects of temporal horizon and some components of the FTP measure correlate with delay discounting rates, they may also measure different varieties or forms of the temporal horizon construct. This is not dissimilar to Evenden's (1999) proposal that different varieties of the impulsivity construct exist.

What aspects of the temporal horizon do the present results suggest? A closer examination of the results of the delay discounting and the FTP extension measures can yield insights to answer this question. As noted above, the listing of self-relevant future life events requested from participants in the FTP extension measure was often concerned with major life events. In our informal review, these events tended to be largely optimistic (e.g., get a promotion, buy a house, retire) rather than negative (e.g., lose job, get evicted, die), reflecting a perception of the self that is mostly idealized. It is in this assessment that we observed that women smokers had the shortest temporal horizon. Perhaps, this finding is related to the established connection between depression and smoking, particularly in women (Fenander et al., 2006; Husky et al., 2007; Wise et al., 2004).

In contrast to the FTP extension assessment, delay discounting assessments ask participants to choose between a small, immediate reward and a large, delayed reward, in other words to sacrifice something immediate for something in the future. The delay discounting assessment implicitly notes that to get the promotion, buy the house, or retire, one has to show up to work every day, save money, and deposit regularly in a retirement account. Thus, the hopeful, optimistic outcome in the future comes with immediate costs and sacrifices. The present results indicate that male smokers have the most difficulty giving up the immediate for the delayed, an unsurprising result, given that males and smokers appear to be more oriented to the present (Keough et al., 1999; Henson, et al., 2006).

4.3. Socio-economic gradient

Additionally, we found that the even with the limited income of our participants the highest earners showed a significantly longer temporal horizon, measured by the FTP stories, than did the lowest third of earners. This result indicates that these differences in temporal horizon occur even within a sample of relatively homogeneous socioeconomic status. We predict that if the

same measures given to participants from a wider range of socioeconomic strata results would replicate the finding that lower socioeconomic status is related to greater levels of smoking and have worse cessation treatment outcomes than their higher socioeconomic counterparts (Barbeau, Krieger, and Soobader, 2004). Deficits in temporal horizon may be the underlying cause of problematic health behaviors such as smoking and thus may explain some of the disparities found among women who smoke. Additional work will be needed to clarify this relationship.

4.4. Limitations

Our failure to find a difference with respect to delay discounting behavior between smoking and nonsmoking women is contrary to previous work showing that women who smoke have steeper rates of discounting than nonsmoking women (Reynolds et al., 2009). One explanation for this failure to replicate results may be related specifically to our classification of smokers and nonsmokers on the basis of the CO breath sample. We did not conduct other direct measures of nicotine dependence or cigarette consumption, and this possibly resulted in a heterogeneous female smoking group composed of light and heavy smokers. Under this scenario, the smoking and nonsmoking groups may not have been adequately differentiated to observe a statistically significant difference; Ohmura et al. (2005) also observed nonsignificant differences between smokers and nonsmokers under similar circumstances (see also Johnson et al., 2007). Future work should make sure to include detailed estimates of nicotine consumption when the effect of smoking on temporal horizon is examined.

4.5. Summary

The results of the current study generally indicate that the interaction between smoking status and gender influences individuals' temporal horizons in the predicted negative direction. In addition, we found that assessments of FTP and delay discounting, can estimate the interaction between gender and smoking status. Both measures show that smoking status reduces temporal horizon. The effect for gender, however, depends on the assessment measure: for women who smoke, FTP extension scores indicate a shorter temporal horizon; for men who smoke, measures of delay discounting show a shorter temporal horizon. Thus, we suggest that neither FTP nor delay discounting measures alone provide a complete estimate of the effect of the interaction of gender and smoking status on temporal horizon. Instead, multiple measures that estimate future decision-making are required in order to understand the influence of temporal horizon on behavior. Moreover, the results that we describe support recent speculations that delay discounting should be considered an executive function along with cognitive flexibility and planning (Bickel and Yi, in press; cf. Bickel et al., 2007).

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Figure 1.

Mean ($\pm$ SEM) quantiles of FTP mean and extension for men and women by smoking (shaded) and non-smoking (unshaded) status. Means are evaluated at the average income, age, and education values. The left panel shows FTP mean and the right panel shows FTP extension.

Figure 2. Mean ($\pm$ SEM) quantiles of FTP Stories 1 and 2 for men and women by smoking status (shaded) and non-smoking (unshaded). Means are evaluated at the average income, age, and education values. The left panel shows FTP story 1 results and the right panel shows FTP story 2 results.

Figure 3.

Mean ($\pm$ SEM) discount rate (k) for hypothetical future gains of \$100 and \$1,000 for men and women by smoking (shaded) and non-smoking (unshaded) status. Means are evaluated at the average income, age, and education values. The left panel shows hypothetical future gains of \$100 and the right panel shows hypothetical future gains of \$1,000.

Table 1
Mean age, income, and years of education for women and men by smoking status.

	Women				Men			
	n	Years of Age	Monthly Income	Education (years)	n	Years of Age	Monthly Income	Education (years)
Smokers	36	42.3 (11.5)	1000 (414.50, 1700)	12.8 (1.6)	50	36.2 (11.5)	1150 (500, 1900)*	13.6 (2.7)
Nonsmokers	107	41.7 (14.4)	1375 (700, 2400)*	15.0 (2.1)	34	38.7 (14.9)	1500 (600, 2600)*	15.3 (2.7)
Combined across Smoking status	143	41.8 (13.7)	1200 (677, 2250)	14.4 (2.2)	84	37.3 (13.0)	1200 (500, 2250)	14.3 (2.9)

Table 2

Estimated regression slopes and 95% confidence intervals from ANCOVA analyses.

Family of measures	Income	Age	Education
FTP ($\times 10^{-4}$)	0.2 (−0.5, 1.0)	−59.2 (−140, 21.1)	316 (−121, 753)
Discounting ($\times 10^{-4}$)	−0.8 (−3.6, 2.1)	−68.6 (−367, 230)	−490 (−2086, 1106)

All p values testing slopes equal to 0 are > 0.26 . FTP, future time perspective.

Table 3

Estimated means and 95% confidence intervals for discounting rates and FTP results by group.

Measure	Smokers		Nonsmokers	
	Men	Women	Men	Women
Percentile of FTP extension	57.1 (44.3, 69.2)	35.1 (22.8, 49.1)	54.7 (40.3, 68.5)	49.2 (38.0, 60.4)
Percentile of FTP mean extension	53.5 (40.6, 66.0)	40.0 (26.9, 54.4)	54.3 (39.9, 68.2)	49.1 (38.0, 60.4)
Percentile of FTP story 1	43.8 (31.4, 56.9)	51.3 (36.9, 65.5)	40.7 (27.2, 55.4)	54.2 (42.9, 65.2)
Percentile of FTP story 2	38.6 (26.9, 51.5)	49.3 (35.0, 63.6)	52.7 (38.2, 66.7)	54.0 (42.7, 64.9)
k for \$100 ($\times 10^{-4}$)	117 (38.8, 353)	11.1 (3.5, 35.8)	7.3 (2.3, 23.7)	14.1 (4.5, 43.6)
k for \$1,000 ($\times 10^{-4}$)	69.8 (23.4, 208)	7.6 (2.4, 24.0)	6.0 (1.9, 18.8)	8.1 (2.6, 25.4)

Evaluated at the mean values of income (\$1,521.04/month), age (40.1 years), and years of education (14.4 years). k , discounting coefficient; FTP, future time perspective.