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Does delay discounting predict maladaptive health and financial behaviors in smokers?

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Abstract

Objective: Excessive delay discounting, the rapid devaluation of future rewards, is often demonstrated by individuals suffering from substance use disorders, including chronic cigarette smokers. This constricted temporal window not only produces increased valuation of immediate unhealthy rewards (e.g., cigarettes) but also a decreased valuation of both future healthy rewards (e.g., increased energy) and future consequences (e.g., lung cancer). Moreover, in addition to cigarettes, smokers tend to engage in other behaviors that elicit immediate rewards and negative future consequences such as over-consuming alcohol, unhealthy eating, physical inactivity, and/or irresponsible spending. The present study sought to determine whether smokers' discounting rate would predict the frequency of engagement in other poor health and financial behaviors, independent of cigarette smoking.

Methods: A total of 303 daily smokers were asked to complete a delay discounting task and then answer how frequently they typically engaged in health and finance related behaviors.

Results: A structural equation model was used to group the questions into highly significantly latent factors of "Drug Use", "Finances", "Fitness", "Food", "Health", "Household Savings", "Personal Development", and "Safe Driving". When regressed on the model, delay discounting significantly predicted engagement all of the factors, except "Safe Driving", independent of smoking status.

Conclusion: In sum, these findings highlight delay discounting as a useful metric for predicting whether individuals engagement in variety of healthy physical and financial behaviors, as a function of their temporal window.

Keywords

Delay Discounting; Health Behaviors; Financial Behaviors; Smokers; Structural Equation Modeling

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CONFLICT OF INTEREST

S.E.S. and W.K.B. report being Principals in BEAM Diagnostics, Inc. W.K.B. also reports being a Principal in HealthSim, LLC and NotifiUs LLC as well as a general partner in Red 5 Group LLC. W.B.D. and L.H.E. report no biomedical financial interests or potential conflicts of interests.

INTRODUCTION

Delay discounting is the process by which the value of a future reward loses its value as a function of increased delay to its receipt. This process may be conceptualized as the devaluation of a reward over an individual's temporal window (Bickel et al. 2010). That is, a short temporal window precludes valuation of a reward at longer delays. Excessive delay discounting, the rapid devaluation of future rewards, has been repeatedly demonstrated among individuals with substance use disorder (for meta-analyses see Amlung et al. 2016; MacKillop et al. 2011), including cigarette smokers (Bickel, Odum, and Madden 1999). In fact, delay discounting has been proposed as a candidate behavioral marker for substance use, abuse severity, and relapse (Bickel, Koffarnus, et al. 2014), and robustly predicts cigarette smoking relapse (Sheffer et al. 2014), suggesting its value as a prognostic tool.

Previous evidence also suggests that delay discounting is a trans-disease process wherein discounting rates predict engagement in other, non-drug, maladaptive behaviors (Bickel et al. 2012; Bickel and Mueller 2009). For example, excessive delay discounting is predictive of obesity, overeating, fast food consumption, infrequent exercise, prescription non-compliance, skipping breakfast, texting while driving, not wearing sunscreen, problem gambling, not completing medical screenings (e.g., cholesterol tests, mammograms, etc), and risky sexual behaviors (Amlung, Petker, Jackson, Balodis, & MacKillop, 2016; Axon, Bradford, & Egan, 2009; Bradford, 2010; Celio et al., 2016; Chabris, Laibson, Morris, Schuldt, & Taubinsky, 2008; Chesson et al., 2006; Daugherty & Brase, 2010; Garza, Ding, Owensby, & Zizza, 2016; Hayashi, Miller, Foreman, & Wirth, 2016; Petry, 2001), just to name a few. Moreover, not only is engagement in negative health behaviors related to lower socioeconomic status (Bickel, Moody, et al. 2014), but delay discounting rates are correlated with not saving money for the future and money mismanagement (Hamilton and Potenza 2012; Ersner-Hersfield et al. 2009). These findings suggest that the length of an individual's temporal window undergirds how individuals value a variety of delayed rewards such as long term health and drives their maladaptive behavior decisions.

Importantly, in addition to smoking, heavy cigarette smokers also tend to engage in other behaviors that elicit immediate rewards and negative future consequences such as over-consuming alcohol, unhealthy eating, and/or physical inactivity (Masood et al. 2015). From the perspective of the temporal window, these findings are consistent with a shortened time horizon in which immediately available rewards such as cigarettes are valued more than delayed health. This evidence highlights the need to examine co-morbid maladaptive behaviors by measuring a underlying mechanism (i.e., delay discounting rates). Moreover, while many reports have examined the relationship between delay discounting and individual behavior engagement, no report has yet compiled these individual behaviors into a larger theoretical framework.

Therefore, the present study expanded upon previous evidence and explored the relationship between delay discounting and a variety of health and financial behaviors in daily smokers. Structural equation modeling (SEM) was used to determine the predictive value of delay discounting on factors of "Drug Use", "Finances", "Fitness", "Food", "Health", "Household Savings", "Personal Development", and "Safe Driving". Excessive delay discounting rates

among daily smokers were hypothesized to predict reduced engagement in pro-health and financial behaviors and increased engagement in maladaptive behaviors, independent of smoking severity or history.

METHODS

Participants

A total of 303 daily cigarette smokers completed the single-session study. Daily smokers were required to provide written informed consent and be between the ages of 18–65. Exclusion criteria included evidence of a current significant medical illness, unmanaged psychiatric or neurological disorder, history or loss of consciousness of more than 10 minutes in the past year or loss of consciousness in a lifetime that required rehabilitation services (i.e., physical, occupational, speech), and/or (for females) not be pregnant or lactating. Of note, these exclusion criteria were included because these data were collected during a longer screening protocol used to allocate participants to on-going smoking studies being conducted in the laboratory. Demographic variables of the participants are presented in Table 1. The Virginia Tech Institutional Review Board reviewed and approved all procedures.

Procedure and Assessments

All participants completed a delay-discounting task followed by the Health Behaviors Questionnaire. Participants were also asked to answer a series of other questionnaires related to their drug and alcohol use severity as part of the larger study; results not presented here. In total, the consent and session assessments typically lasted approximately 2 hours to complete and participants were compensated for their time.

Delay Discounting Task

All participants completed an adjusting amount delay-discounting task. This task presented participants with a series of binary choices between a monetary reward available immediately and \$1000 available after a delay. For example, “Would you rather have \$500 now or \$1000 in 1 year?”. With each response, the task titrated the immediately available monetary reward up or down to settle on an indifference point, the point at which a participant is indifferent between the two choices. Participants answered 6 choice trials for each of 7 delays (1 day, 1 week, 1 month, 3 months, 1 year, 5 years, and 25 years) to obtain 7 indifference points (Du, Green, and Myerson 2002). These points were then used to generate a delay discounting curve using Mazur’s equation (Mazur 1987) and fit k . The natural log transformation of k was used for the SEM analyses.

Health Behaviors Questionnaire

The Health Behaviors Questionnaire was a series of 63 items asking participants to rate the relative frequency they engage in common health and financial behaviors categorized as “Drug Use”, “Finances”, “Fitness”, “Food”, “Health”, “Household Savings”, “Personal Development”, or “Safe Driving”. Some of these items were inspired by the health behaviors included in previous work (see Daugherty and Brase 2010), others were derived from commonly accepted health and financial behaviors among health and financial professionals

and personal development authorities. For example, “How often do you engage in the following activities: skip breakfast, use sunscreen, track your calorie intake, save money other than retirement, yoga or active stretching”. Answers most often ranged from “Never” to “Almost Always”. Some of the behaviors such as “get a flu shot” or “give to charity” had longer ranges between “Never” and “More than twice a Year”. Questions such as “How many times per week do you cook dinner at home on average” and “How many days per week do you drink alcohol”, asked participants to indicate the number of times they engaged in the health behavior with either a an answer choice or a fill in text box. The questions were arranged such that an increased frequency did not always indicate pro-health behaviors. Moreover, the questions were randomized such that categories of questions were not asked together. The full Health Behaviors Questionnaire is listed in Appendix A.

ANALYSES

In order to access the degree to which delay discounting predicted the large panel of health-related behaviors, structural equation modeling (SEM) was used (Hox, Moerbeek, and van de Schoot 2010). SEM was chosen over a correlation matrix because SEM controls for the shared error variance among measured variables, resulting in a more accurate description of the covariance between variables. Therefore, SEM models present an error-controlled accounting for how variables are related. SEM also allows for the grouping of measured variables into theoretically relevant latent factors which can then be predicted by other measured variables or latent factors. Predicting latent factors instead of individual variables allows for a more parsimonious investigation of many health behaviors. For the structural model, we grouped variables into their most face-valid factor and did not allow for cross-loadings or correlated residual errors. While not allowing for cross-loadings or correlated error variances worsened the overall model fit and decreased the amount of measured variable variance accounted for by the latent factors, it allowed for more interpretable regression equations. Also, because the comparisons of interest were between delay discounting and the latent factors, a mean structure SEM was not modeled to compare factor means. For the regression model, delay discounting, number of cigarettes smoked per day and number of years as a smoker were regressed onto the latent factors. Finally, because most of the variables were measured on ordinal likert scales, DWLS estimation was used.

In order to achieve model convergence and improve the quality of the latent factors, eight measured variables were removed from the final model. These variables were removed for either correlating too strongly with other measured variables of that same factor (e.g., $r^2 > 0.90$) or they did not significantly correlate (e.g., $r^2 < 0.10$) with any measured variables in the data set. The remaining fifty-five measured variables were included in the final SEM. For each latent factor, the reference variable was specifically chosen so that positive correlations with the latent factor and delay discounting would reflect more frequent engagement in risky or problematic behaviors and negative correlations with the latent factor and delay discounting would reflect more frequent engagement in health-positive behaviors. The factors were constructed this way because larger natural log transformed delay discounting values indicate greater delay discounting.

Two values for the correlation between factors are reported and discussed. The first value is the correlation between factors without the regression equations. This value represents the full correlation between the latent factors. The second value is the residual correlation which is the correlation between factors after the unique variance accounted for by the predictor variables (i.e., delay discounting) is accounted for.

RESULTS

Descriptive statistics of the Health Behaviors Questionnaire items are reported in Appendix A (Table 2A). Overall, the model fit the data well. Most model fit indices were below the recommended values (Hu and Bentler 1999) ($\chi^2(1543) = 883.364, p = 1.000$; $CFI = 1.000$; $TLI = 1.323$; $RMSEA = 0.000$; $SRMR = 0.090$). The complete model results including factor loadings, factor correlations with the regression paths and factor correlations without the regression paths are presented in Appendix B. Most factor loadings were statistically significant, demonstrating that the latent factors significantly predicted their corresponding measured variables (Figure 1). The R^2 values, which represent the total amount of variance accounted for in a measured variable by the latent factor, for each measured variable loading were modest ($mean R^2 = 0.300, SD = 0.213$).

The results for the regression paths are reported in Table 2 and Figure 2. Before the regression paths were added to the structural model, the correlations between the three predictive measures (delay discounting, cigarettes per day, and years of smoking) were investigated in order to avoid multicollinearity. No correlation between the three predictor variables was larger than 0.145. Delay discounting significantly predicted all the latent factors except for the “Safe Driving” factor. Delay discounting predicted the latent factors such that positive estimates indicate greater engagement in problematic behaviors and negative estimates indicate greater engagement in pro-health behaviors. The delay discounting regression estimates were all in the expected direction. The number of years a participant had smoked also predicted half of the latent factors.

The majority of the correlations between latent factors were statistically significant as were the residual factor correlations. This finding may suggest additional unidentified higher-order latent factors (e.g., risk taking). However, in this dataset, no pattern of latent factor correlations emerged to elucidate a higher-order structure. Additionally, several large measured variable residual errors were identified indicating that additional factors may be needed to fully describe the measured variable covariance structure.

Finally, delay discounting was positively correlated with income ($r = -0.269, p < .001$) and education ($r = -0.248, p < .001$) but not age ($r = -0.023, p = .712$) indicating that as delay discounting decreases, age and education increase. These variables were not included in the latent model because the model failed to converge when they were added to relevant factors. Additionally, the number years as a smoker was highly correlated with age ($r = 0.864, p < .001$). Such a strong correlation prevented age from being included in the model as a predictor variable for the latent factors because of high multicollinearity. An alternative model with age as a predictor variable of the latent factors instead of number of years as a smoker was conducted and revealed nearly identical results.

DISCUSSION

The present results demonstrate a replication of much of the previous work examining a relationship between delay discounting and engaging in maladaptive and/or risky health behaviors (Amlung et al., 2016; Axon et al., 2009; and see Bickel et al., 2017; Bradford, 2010; Celio et al., 2016; Chabris et al., 2008; Chesson et al., 2006; Daugherty & Brase, 2010; Garza et al., 2016; Hayashi et al., 2016; Petry, 2001) and expanded on these findings by including financial and household savings behaviors. Moreover, the present work developed a comprehensive model of related health and financial behaviors using SEM. Delay discounting significantly predicted engagement in the maladaptive health and financial behavior factors “Drug Use”, “Finances”, “Fitness”, “Food”, “Health”, “Household Savings”, and “Personal Development”, independent of two smoking status variables, cigarettes per day and number of years smoked.

The model structure was successful in accounting for a significant portion of the variance in all but two measured variables. These significant factor loadings establish the reliability and validity of the health-behavior questions, demonstrating that the questions were successful in measuring their targeted construct. A large portion of measured item variance was unaccounted for, suggesting that additional latent factors may be needed. However, upon investigating the measured variable residual error correlations, no clear pattern emerged that would result in the creation of additional theoretically meaningful factors. Therefore, we are confident that the latent factors (i.e., delay discounting and smoking status) well represent their labeled construct (e.g., a narrow temporal window).

Delay discounting significantly predicted seven of the eight latent factors. Importantly, the inclusion of the regression equations greatly improved the model fit (model fit without regressions: $X^2(1485) = 19,478$, $p < .001$; $CFI = 0.941$; $TLI = 0.938$; $RMSEA = 0.050$; $SRMR = 0.088$). The difference in X^2 values between the model presented and a model without the regression equations was very large ($\Delta = 18,596$). Therefore, the significant delay discounting regression coefficients support that delay discounting as an important predictor of many maladaptive behaviors and is a trans-disease process (Bickel et al. 2012), wherein a narrow temporal window (i.e., excessive delay discounting) potentially undergirds the decisions individuals make about engagement pro-health activities.

Delay discounting did not predict the “Safe Driving” factor. Previous research has demonstrated that delay discounting is related to safe driving practices such as seatbelt use (Daugherty and Brase 2010) or texting while driving (Hayashi, Russo, and Wirth 2015; Hayashi et al. 2016). Upon further evaluation, we found the correlations between delay discounting and the individual measured variables composing “Safe Driving” were all below 0.15 ($p > 0.05$). Therefore, while the standardized factor loadings for the “Safe Driving” factor were among the highest for the eight factors, delay discounting was, unexpectedly, not predictive of any safe driving behavior in the sample. Methodological differences as well as evidence of small effect sizes for the relationship between safe driving behaviors and delay discounting may provide some explanation (Daugherty and Brase 2010). Alternatively, Hayashi and colleagues (2015; 2016) found that the relationship between delay discounting and texting was domain dependent meaning that the significant relationship between texting

and delay discounting was found when participants were asked about the likelihood that they would respond to a text immediately versus after a delay. However, consistent with the present study, the participants' reported frequency of texting and driving and monetary delay discounting were not related. Future research should seek to better understanding the relationship of delay discounting and driving behaviors.

The two smoking predictors were less successful at predicting the latent factors. The number of years a participant had smoked significantly predicted four of the eight latent factors and the number of cigarettes smoked per day only predicted the only the "Fitness" factor. These predictions are expected given that heavy smokers eat less healthy foods, exercise less, and binge drink more often, compared to never, ex, and light smokers (Masood et al. 2015). However, the lack of strong prediction of the other latent factors by cigarette smoking behaviors may have resulted from the limited variability in the reported smoking behaviors. That is, the inclusion criteria for the present study (daily smokers) may have limited the variability of range of cigarettes per day within in the sample (i.e., average of $20 \pm 0.6\text{SEM}$ cigarettes per day), subsequently limiting the range to find a significant correlation with delay discounting and other factors. While this limitation does not preclude or diminish the conclusions drawn from the current study about heavy daily smokers, future research should also investigate differences in the SEM results between smokers and non-smokers.

A limitation of this SEM analysis (and SEM analyses in general) is that while the model accounts for a significant portion of the covariance between the measured variables, it does not necessarily reflect the "true" nature of the relationship between both the measured variables that compose the latent factors or their relationship to the predictive measured variables. Additional latent factors may be unaccounted for by this model, as indicated by the *SRMR* value and the modest R^2 values for both the measured variables and regression coefficients. Also, other combinations of latent factor structures may produce similarly fitting models. Moreover, in addition to the predictive variables, other processes are involved in maladaptive decision-making in general. For example, Stahl and colleagues (2014) found evidence for five divergent components of impulsivity with delay discounting representing only one component. Other processes may account for the correlation between specific factors as well as the individual variance of specific factors. One example, probability discounting, which is frequently demonstrated to be unrelated to delay discounting (Green and Myerson 2013), is also related to problematic behaviors such as cigarette smoking (Reynolds et al. 2004). However, the goal of this analyses was not to identify the most statistically predictive factors (e.g., exploratory factor analyses) or find all of the possible predictive variables but to create a theoretically viable model that could then be predicted by delay discounting and cigarette smoking. Importantly, a well-fitting and informative model was produced using questions that were developed based on face validity despite not optimizing the model fit by allow for cross-loadings or allowing the residual errors between measured variables to correlate. These findings further support the power of delay discounting as a predictor of a wide gamut of maladaptive health and finance behaviors. Future research will seek to refine these questions based on the model results in order to develop a stronger panel of questions that result in more comprehensive factors and stronger prediction by delay discounting.

Some additional limitations of the sample population that may have impacted the present results must be acknowledged. That is, the average annual income (approximately 12k/year) was lower than the regional and US average annual income. Lower socioeconomic status is related to negative health behaviors and delay discounting rates (Bickel, Moody, et al. 2014), however, when included in the model, income was not a significantly correlated and made the model fit worse, suggesting that income did not affect the results or conclusions. Pregnant and lactating women were not included due to the restrictions of the screening protocol. Exclusion of this subset of participants may have impacted the results slightly (e.g., pregnant women may have been more health conscious). Future studies would strive to include a normative sample of the smoking population. Finally, although directly collecting engagement in health and financial behaviors may have been ideal, the scope of this study's behaviors precluded such an endeavor. Therefore, the present study relied on participant self-report which may have been skewed, however participants were not cued or incentivized for their answers, diminishing the probability of demand characteristics.

While these data are cross-sectional precluding implications about how delay discounting may causally affect engagement in health and/or financial behaviors, the results suggest that delay discounting is a significantly related variable that should be investigated further. If delay discounting is indeed an underlying characteristic of multiple health behaviors for smokers, one may predict that if delay discounting is changed, via an intervention, then the related factors may also be altered proportional to the strength of their relationship with discounting. For example, a change in delay discounting rate may make financial decisions more self-controlled but will likely not alter safe driving behaviors.

Conclusions

The results of the SEM analyses further support the claim of delay discounting as a trans-disease process (Bickel et al., 2012). That is, delay discounting is a process which undergirds the decision to engage in maladaptive health and financial behaviors, likely caused by a narrow temporal window. These results have broadened the scope of the relationship between delay discounting and maladaptive health behaviors for the field and, importantly, these results indicate that delay discounting could serve as a diagnostic and predictive tool in a variety of settings (eg., financial education, diet and exercise, substance use, etc). Though previous research has demonstrated that delay discounting predicts specific health-behaviors, this is the first time that a large body of health-behaviors have been investigated within the same data set using SEM. In cigarette smokers, the relationship of delay discounting and maladaptive behaviors appears to be robust, regardless of smoking severity.

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Appendix A

Table 1A.

Health Behaviors Questions

Factor	Question Number	Text	Scale
Drug Use			
	DU1	How many cups of coffee or caffeinated beverages do you consume per day on average?	Continuous
	DU2	Use illegal drugs?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	DU3	How many days per week do you drink alcohol on average?	Continuous
	DU4	When you drink alcohol, how many drinks do you normally consume?	None (1), 1–2 drinks (2), 3–4 drinks (3), 5–7 drinks (4), 8–12 drinks (5), More than 13 drinks (6)
	DUR1 *	How many years of your life have you smoked cigarettes?	Continuous
	DUR2 *	How many cigarettes do you smoke per day?	Continuous
Finances			
	FIN1	Give to charity?	Never (1), Less than once a year (2), Once a year (3), Twice a year (4), More than twice a year (5)
	FIN2	Pay for your own health insurance?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	FIN3	Are charged late fees?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	FIN4	Pay all bills in full?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	FIN5	Gamble?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FIN6	Save money other than retirement savings?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FIN7	Pay off your credit card balance every month?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	FIN8	Overuse credit card?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
Fitness			
	FIT1	Take the stairs instead of the elevator?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FIT2	Maintain consistent diet/exercise habits?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FIT3	Drink more than 8 glasses of water a day?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)

Factor	Question Number	Text	Scale
Food	FIT4	How many hours of sleep do you get per night on average?	Continuous
	FIT5	Strenuous or high intensity exercise?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FIT6	Yoga or active stretching	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FIT7	How many times per week do you exercise [for a minimum of 20 mins]?	0 times (1), 1 time (2), 2 times (3), 3 times (4), 4 times (5), 5 or more times (6)
	FO1	Skip breakfast?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO2	Track your calorie intake?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO3	Drink soda with sugar?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO4	Drink soda with sweetener (other than sugar)?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO5	Drink energy drinks?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO6	Eat fast food?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO7	Eat out to avoid cooking?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO8	Eat heavy meals before bed?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
Health	FO9	Plan your meals ahead of time?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO10	Plan food shopping in advance?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	FO11	How many times per week do you cook dinner at home on average?	0 times (1), 1 time (2), 2 times (3), 3 times (4), 4 times (5), 5 times (6), 6 times (7), 7 times (8)
	FO12	How many snacks do you eat per day on average?	Continuous
	H1	Floss your teeth?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	H2	Visit the dentist?	Never (1), Less than once a year (2), Once a year (3), Twice a year (4), More than twice a year (5)
	H3	Get a flu shot?	Never (1), Less than once a year (2), Once a year (3),

Factor	Question Number	Text	Scale
			Twice a year (4), More than twice a year (5)
	H4	Get a cholesterol test?	Never (1), Less than once a year (2), Once a year (3), Twice a year (4), More than twice a year (5)
	H5	Get concerned about your health?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	H6	Use sunscreen?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	H7	Check your blood pressure?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	H8	Follow a doctor's treatment plans?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	H9	Go to the doctor for care when you are sick?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	H10	Take prescription medicine as prescribed?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	H11	Unprotected casual sex?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
Household Savings			
	HS1	Keep air conditioning running often during summer?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	HS2	Try to use less electricity than average?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	HS3	Keep heat low during winter to reduce heating bill?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	HS4	Program your thermostat to turn on/off at specific times of day?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	HS5	Keep home well-insulated?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	HS6	Use energy efficient lighting (fluorescent bulbs)?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
Personal Development			
	PD1	Set personal goals?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	PD2	Socialize with friends?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	PD3	Spend time with family?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	PD4	Hold grudges?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)

Factor	Question Number	Text	Scale
Safe Driving	PD5	How stressed do you feel in your life currently?	Sliding scale: 0–10. “0 being no stress, 10 being very high stress”
	PD6	How well do you feel you manage your stress daily?	Sliding scale: 0–10. “0 being not managed, 10 being managed very well”
	PD7	How many hours of TV do you watch per day on average?	Continuous
	SD1	Initiate a text conversation while driving?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	SD2	Reply to a text while driving?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	SD3	Read a text while driving?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	SD4	Wear a seatbelt?	Never (1), Rarely (2), Sometimes (3), Almost Always (4)
	SD5	Maintain your vehicle (oil changes, etc.)?	Never (1), Less than once a year (2), Once a year (3), Twice a year (4), More than twice a year (5)
	SD6	Drive at high speeds?	Never (1), Rarely (2), sometimes (3), Almost Always (4), Not applicable (5)
	SD7	How dangerous would you consider texting while driving?	Not very dangerous at all (1), Slightly dangerous (2), Moderately dangerous (3), Very dangerous (4), Extremely dangerous (5)

* Indicates questions used as predictors in the regression equations, not as measured variables loaded onto a latent factor.

Table 2A

Variable	Mean	SD	Variable	Mean	SD	Variable	Mean	SD	Variable	Mean	SD
Ink	−3753	2.802	SD1	1.762	0.839	H4	1.699	0.967	HS2	3.268	0.78
Age	39.388	12.215	SD2	1.87	0.9	H5	2.778	0.832	HS3	3.189	0.972
Income	\$1024	\$1296	SD3	2.168	6.878	H6	1.927	0.999	HS4	2.834	1.557
Education (years)	11886	1.981	SD4	3.457	6.883	H7	2.053	0.861	HS5	3.745	1.077
Gender (% Female)	50.8		SD5	4.378	0.895	H8	2.897	1.129	HS6	3.235	1.025
FO1	3.156	0.85	SD6	2.216	0.838	H9	2.864	0.936	PD1	2.964	0.775
FO2	1.407	0.736	SD7	4.57	0.729	H10	3.363	1.031	PD2	3.175	0.764
FO3	3.04	0.977	FIT1	2.672	0.836	H11	1.842	1.078	PD3	3.212	0.852
FO4	1.93	1.014	FIT2	2.252	0.956	FIN1	2.98	1.498	PD4	2.189	0.84
FO5	1.934	0.983	FIT3	2.54	0.959	FIN2	2.162	1.33	PD5	5.159	2.406
FO6	1811	0.673	FIT4	6.431	1.445	FIN3	2.247	0.94	PD6	6.623	2.529
FO7	2.487	0.772	FIT5	2.023	0.887	FIN4	3.241	0.923	PD7	3.344	2.853
FO8	2.54	0.837	FIT6	1.682	0.903	FIN5	1.709	0.89	DU2	2.215	1.125
FO9	2.646	0.917	FIT7	2.881	1.776	FIN6	2.02	0.907	DUR1	21.454	11532

Variable	Mean	SD	Variable	Mean	SD	Variable	Mean	SD	Variable	Mean	SD
FO10	2.904	0.961	H1	2.54	1.01	FIN7	3.248	1.712	DUR2	20.642	11.064
FO11	5.162	1.883	H2	2.47	1.128	FIN8	3.248	1.671	DU3	1.689	2.284
FO12	2.545	1.982	H3	1.801	0.93	HS1	3.513	0.858	DU4	2.705	1.224

Appendix B

Table 1B.

Complete Structural Equation Model Results

Latent Factor	Measured Variable	Estimate	Standardized Factor Loading	R ²
Drug Use	DU2	1.000	0.779	0.607
	DU3	0.429	0.345 *	0.119
	DU4	0.697	0.554 *	0.307
Finances	FIN1	1.000	0.420	0.176
	FIN2	1.024	0.430 ***	0.185
	FIN3	-0.967	-0.407 *	0.166
	FIN4	1.055	0.442 *	0.195
	FIN5	-0.738	-0.313 *	0.098
	FIN6	1.219	0.507 **	0.257
	FIN7	0.571	0.244 *	0.060
Fitness	FIT1	1.000	0.467	0.218
	FIT2	1.882	0.855 ***	0.731
	FIT3	0.785	0.368 **	0.135
	FIT5	1.387	0.641 ***	0.411
	FIT6	1.522	0.701 ***	0.491
	FIT7	1.476	0.680 ***	0.462
Food	FO1	1.000	0.238	0.057
	FO2	-2.174	-0.630 *	0.397
	FO3	1.370	0.324 *	0.105
	FO5	1.089	0.259 *	0.067
	FO6	2.486	0.580 *	0.336
	FO7	2.268	0.531 *	0.282
	FO8	1.634	0.386 *	0.149
	FO9	-3.188	-0.733 *	0.537
	FO10	-3.355	-0.769 *	0.591
	FO11	-2.364	-0.552 *	0.305
	FO12	2.974	0.370 *	0.137
Health				

Latent Factor	Measured Variable	Estimate	Standardized Factor Loading	R ²
	H1	1.000	0.418	0.175
	H2	1.119	0.467 ***	0.218
	H3	0.744	0.312 **	0.097
	H4	1.560	0.642 ***	0.412
	H5	0.869	0.375 ***	0.141
	H6	1.306	0.542 ***	0.294
	H7	1.476	0.609 ***	0.371
	H8	1.614	0.664 ***	0.441
	H9	1.230	0.511 ***	0.261
	H10	1.296	0.538 *	0.289
	H11	-1.050	-0.438 ***	0.192
Household Savings				
	HS2	1.000	0.516	0.266
	HS3	0.905	0.467 *	0.218
	HS4	0.933	0.482 *	0.232
	HS5	0.932	0.481	0.231
	HS6	1.504	0.772 *	0.596
Personal Development				
	PD1	1.000	0.627	0.393
	PD2	0.581	0.367 *	0.135
	PD3	0.463	0.293 *	0.086
	PD4	-0.591	-0.373 *	0.139
	PD5	-0.434	-0.275	0.076
	PD7	-1.868	-0.423 *	0.179
Safe Driving				
	SD1	1.000	0.867	0.752
	SD2	1.155	0.986 ***	0.972
	SD3	1.111	0.953 ***	0.908
	SD4	-0.609	-0.544 **	0.296
	SD6	0.524	0.471 ***	0.222
	SD7	-0.661	-0.589 ***	0.347
Regressions	Measured Variable	Estimate	Standardized Regression Coefficient	R ²
Drug Use				
	Delay Discounting	0.064	0.221 **	0.049
	Years of smoking	-0.018	-0.261 **	0.068
	Cigarettes per day	0.001	0.001	0.000
Finances				
	Delay Discounting	-0.075	-0.491 ***	0.241
	Years of smoking	0.002	0.041	0.002
	Cigarettes per day	0.000	-0.001	0.000
Fitness				
	Delay Discounting	-0.042	-0.252 *	0.064

Latent Factor	Measured Variable	Estimate	Standardized Factor Loading	R ²
Food	Years of smoking	0.000	-0.006	0.000
	Cigarettes per day	-0.007	-0.166 *	0.028
	Delay Discounting	0.019	0.226 *	0.051
Health	Years of smoking	-0.005	-0.232 *	0.054
	Cigarettes per day	0.003	0.152	0.023
	Delay Discounting	-0.026	-0.171 *	0.029
Household Savings	Years of smoking	0.011	0.294 ***	0.086
	Cigarettes per day	-0.003	-0.088	0.008
	Delay Discounting	-0.030	-0.160 *	0.026
Personal Development	Years of smoking	0.000	-0.001	0.000
	Cigarettes per day	0.004	0.083	0.007
	Delay Discounting	-0.040	-0.178 *	0.032
Safe Driving	Years of smoking	-0.008	-0.142	0.020
	Cigarettes per day	-0.001	-0.013	0.000
	Delay Discounting	0.034	0.104	0.011
	Years of smoking	-0.025	-0.316 *	0.100
	Cigarettes per day	0.012	0.146	0.021
Factor Correlations With Regressions	Latent Factor	Covariance Estimate	Residual Correlation	
Drug Use	Finances	-0.102	-0.388 **	
	Fitness	-0.064	-0.189	
	Food	0.059	0.352 *	
	Health	-0.142	-0.471 ***	
	Household Savings	-0.073	-0.188	
	Personal Development	-0.127	-0.270 *	
	Safe Driving	0.194	0.300	
Finances	Fitness	0.104	0.623 **	
	Food	-0.054	-0.651 *	
	Health	0.08	0.543 **	
	Household Savings	0.049	0.258	
	Personal Development	0.156	0.679 **	
	Safe Driving	-0.179	-0.564 *	
Fitness	Food	-0.055	-0.548 *	
	Health	0.070	0.397 **	

Latent Factor	Measured Variable	Estimate	Standardized Factor Loading	R ²
Food	Household Savings	0.083	0.363	
	Personal Development	0.165	0.597 ***	
	Safe Driving	-0.085	-0.223 *	
	Health	-0.045	-0.509 *	
	Household Savings	-0.026	-0.229	
	Personal Development	-0.076	-0.552 *	
Health	Safe Driving	0.090	0.475 *	
	Household Savings	0.023	0.116	
	Personal Development	0.103	0.423 **	
Household Savings	Safe Driving	-0.105	-0.312	
	Personal Development	0.122	0.388	
	Safe Driving	-0.106	-0.243	
Personal Development	Safe Driving	-0.214	-0.407 **	
	Safe Driving	-0.214	-0.407 **	
Factor Correlations Without Regressions	Latent Factor	Covariance Estimate	Factor Correlation	
Drug Use	Finances	-0.102	-0.388 **	
	Fitness	-0.065	-0.216 **	
	Food	0.062	0.431 *	
	Health	-0.152	-0.515 ***	
	Household Savings	-0.093	-0.195 *	
	Personal Development	-0.133	-0.342 **	
	Safe Driving	0.189	0.301 **	
Finances	Fitness	0.105	0.594 ***	
	Food	-0.052	-0.622 **	
	Health	0.089	0.516 ***	
	Household Savings	0.077	0.277 **	
	Personal Development	0.151	0.665 ***	
	Safe Driving	-0.222	-0.606 ***	
Fitness	Food	-0.050	-0.593 **	
	Health	0.075	0.431 ***	
	Household Savings	0.087	0.310 **	
	Personal Development	0.167	0.733 ***	
	Safe Driving	-0.079	-0.215 *	
Food	Health	-0.045	-0.55 **	

Latent Factor	Measured Variable	Estimate	Standardized Factor Loading	R ²
Health	Household Savings	−0.030	−0.231 *	
	Personal Development	−0.066	−0.616 *	
	Safe Driving	0.092	0.531 **	
Household Savings	Household Savings	0.026	0.095	
	Personal Development	0.087	0.393 ***	
	Safe Driving	−0.152	−0.423 ***	
Personal Development	Household Savings	0.115	0.321 **	
	Safe Driving	−0.126	−0.219 **	
	Safe Driving	−0.155	−0.329 ***	

*

$p < 0.05$

**

$p < 0.01$

$p < 0.001$

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Figure 1.

Standardized loadings for each latent factor with standard error bars. Bars with black outlines represent non-significant loadings.

Figure 2.

Regression paths with standardized regression coefficients. The measured variable DD represents delay discounting.

Table 1.

Participant demographics. Gender and Race presented as percentages. Age (years), Education (years), Month Income (\$), Cigarettes per day, and calculated $\ln(k)$ values are presented as participant means ($\pm$ Standard Error of Mean).

% Male	% Caucasian	Age	Education	Monthly Income	Cigs per day	$\ln(k)$
50.8	73.6	39.3 yrs (0.7)	12.9 yrs (0.1)	\$1024 (74.8)	20.7 (0.6)	-3.7 (0.2)

Table 2.

SEM model regression results for each latent factor. The standardized regression coefficient is the correlation between the latent factor and the predictive measured variable. The R^2 value is the amount of variability in the latent factor accounted for by the predictive measured variable.

Latent Factor	Measured Variable	Estimate	Standardized Regression Coefficient	R^2
Drug Use	Delay Discounting	0.064	0.221 **	0.049
	Years of smoking	-0.018	-0.261 **	0.068
	Cigarettes per day	0.001	0.001	0.000
Finances	Delay Discounting	-0.075	-0.491 ***	0.241
	Years of smoking	0.002	0.041	0.002
	Cigarettes per day	0.000	-0.001	0.000
Fitness	Delay Discounting	-0.042	-0.252 *	0.064
	Years of smoking	0.000	-0.006	0.000
	Cigarettes per day	-0.007	-0.166 *	0.028
Food	Delay Discounting	0.019	0.226 *	0.051
	Years of smoking	-0.005	-0.232 *	0.054
	Cigarettes per day	0.003	0.152	0.023
Health	Delay Discounting	-0.026	-0.171 *	0.029
	Years of smoking	0.011	0.294 ***	0.086
	Cigarettes per day	-0.003	-0.088	0.008
Household Savings	Delay Discounting	-0.030	-0.160 *	0.026
	Years of smoking	0.000	-0.001	0.000
	Cigarettes per day	0.004	0.083	0.007
Personal Development	Delay Discounting	-0.040	-0.178 *	0.032
	Years of smoking	-0.008	-0.142	0.020
	Cigarettes per day	-0.001	-0.013	0.000
Safe Driving	Delay Discounting	0.034	0.104	0.011
	Years of smoking	-0.025	-0.316 *	0.100
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