HHS Public Access

Author manuscript

Pers Individ Dif. Author manuscript; available in PMC 2021 January 01.

Published in final edited form as:

Pers Individ Dif. 2020 January 1; 152: . doi:10.1016/j.paid.2019.109564.

The Influence of Harm Avoidance and Impulsivity on Delay Discounting Rates

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Abstract

High rates of delay discounting are associated with a range of disorders characterized by behavioral disinhibition, such as substance abuse and childhood behavioral problems. The current study extends the research of the personality correlates of delay discounting by examining its association with two domains of disinhibited personality, impulsivity and low harm avoidance. Trait measures of impulsivity and harm avoidance as well as a delay discounting task were administered to 669 young adult subjects (350 male, 319 female). The primary hypothesis was that a combination of high impulsivity and low harm avoidance would be associated with the highest delay discounting rates. Delay discounting rates were significantly associated with high levels of impulsivity. Counterintuitively, the highest rates of delay discounting were associated with high rates of impulsivity and high rates of harm avoidance. Results suggest that those high in impulsivity *and* harm avoidance are more sensitive to immediate rewards. These results are novel and suggest more complex processes involved when considering a choice between an immediate and a delayed reward that may require longer waiting periods, which itself may be anxiety providing and perceived as potentially harmful.

Keywords

impulsivity; harm avoidance; delay discounting; disinhibited personality

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Declaration of Interests

The authors of this paper declare no competing interests.

Ethical Statement

This paper and the data reported in this paper have not been published and are not under consideration for publication elsewhere. This study was reviewed and approved by the Institutional Review Board at Indiana University – Bloomington. The guidelines for the ethical treatment of human subjects involved in research outlined in the Code of Ethics for the World Medical Association have been followed. Due care also has been exercised by the authors to ensure the integrity of this work, as outlined by the American Psychological Association. The authors do not have any financial or personal conflicts of interest relating to the research project.

1. Introduction

High rates of discounting delayed rewards are associated with a range of disinhibitory disorders, such as substance abuse and childhood behavioral disorders (Finn, Gunn, & Gerst 2015; Bobova et al., 2009; Endres et al 2011, de Wit, 2009) that are characterized by poor self-control and disinhibited personality traits (Bobova et al., 2009). Delay discounting refers to a general tendency for individuals not to inhibit a choice for an immediate reward when faced with a choice between a smaller immediate reward and a larger delayed reward (Bobova et al 2009; Bicken & Marsch, 2001; Finn, 2002). While high delay discounting rates reflect poor behavioral inhibition and difficulties delaying gratification it is typically taken as an indicator of impulsive choice (Bickel & Marsh 2001, de Wit et al., 2007; MacKillop et al., 2007). Similarly, studies of the personality correlates of delay discounting focus on its association with trait impulsivity (de Wit et. al., 2007; Kirby et al., 1999) without considering its potential association with other domains of disinhibited personality, such as low harm avoidance (high risk taking). These studies uniformly report significant associations between delay discounting rates and trait measures of impulsivity (Bickel & Marsch 2001; de Wit, Flory, Acheson, McCloskey & Manuck, 2007; Kirby et al., 1999; Odum, 2011; Ohmura, Takahashi & Kitamura 2005).

Trait impulsivity is thought to reflect strong approach (Behavioral Activation System) activity (Finn, 2002; Fowles, 1987; Swan et al., 2002) manifested as a general preference for immediate reward, difficulties delaying gratification, and a tendency to act quickly without reflection (Finn, 2002; Gunn et al., 2013). On the other hand, harm avoidance is thought to reflect increased Behavioral Inhibition System activity (Fowles, 1987; Lykken, 1995). Low harm avoidance reflects weak behavioral inhibition in the face of potentially aversive outcomes and increased risk taking. Low harm avoidance also has been associated with a range of disinhibited, externalizing behaviors, such as substance abuse, childhood conduct problems, and adult antisocial behavior (Finn, 2002). Low levels of harm avoidance is characterized by failing to inhibit behavior that might result in aversive consequences in favor of obtaining immediate rewarding outcomes (Finn, 2002; Finn et al., 2002; Waller, Lilienfeld, Tellegen, & Lykken, 1991). Subjects with low harm avoidance have difficulties learning to avoid aversive outcomes (such as electric shock) when seeking immediate monetary rewards (Finn et al., 2002). From a delay discounting perspective, low harm avoidance reflects a tendency to discount future aversive outcomes, when seeking out immediate rewards. Thus, low harm avoidance may also be associated with high rates of delay discounting.

The current study investigated the association between delay discounting rates and trait measures of impulsivity and harm avoidance, and their interaction. Because theory suggests that a combination of high behavioral activation – impulsivity - and low behavioral inhibition - low harm avoidance (Finn, 2002; Fowles, 1987; Gray, 1982) reflects the greatest behavioral disinhibition, we hypothesize that the high levels of trait impulsivity combined with low levels of harm avoidance will be associated with the highest rates of delay discounting. Very few studies have examined similar interactions in terms of discounting and harm avoidance. Malesza and Ostazweski (2013) assessed the role of impulsivity and harm avoidance on effort discounting and found that individuals high in harm avoidance prefer to

accept smaller rewards without any effort compared to work for a larger reward; we extend this research by focusing solely on delay discounting and constructs of disinhibited personality. This paper extends the literature on the personality basis for delay discounting by studying the association between delay discounting rate and both impulsivity, harm avoidance, and their interaction on delay discounting rates. Knowledge about the personality correlates of delay discounting can enhance our understanding of the psychological processes that contribute to delay discounting as well as further elucidate the characteristics associated with specific personality dimensions. Furthermore, better understanding about delay discounting rates can further our knowledge on various problems associated with high discounting rates, such substance use disorders, pathological gambling, tobacco use, and obesity (Heil et al., 2006; Yi et al., 2008; Weller et al., 2008).

2. Materials and methods

2.1 Participants

2.1.1 Sample Characteristics—The entire study sample consisted of 669 young adults, 350 male and 319 female, ages 18–30 with a range of substance use problems. Table 1 presents information on the basic sample demographics. The sample was 79.2% White, 7.3% African American, 5.1% Hispanic/Latino, 5.8% Asian, Indian, or Middle Eastern, and 0.7% Native American, as well as 1.3% endorsing multiple minorities.

2.1.2 Recruitment and telephone screening—Participants were recruited using flyers placed around the community and the local university campus. All flyers and postings were designed utilizing the approach used by Finn and colleagues to prompt responses from individuals that endorse variations in levels of alcohol use, levels of impulsivity and other disinhibited traits (Bobova et al., 2009; Finn et al., 2015; Bailey, Gerst & Finn, 2018). Participants were recruited based on recruitment in earlier studies to represent a range of externalizing and impulse control problems, including alcohol use and antisocial problems (Finn et al., 2015), such that 25% would have low externalizing problems, 50% with moderate levels of externalizing problems, and 25% with high levels of externalizing problems (Bogg & Finn, 2010; Finn et al., 2009; Finn et al., 2015). The flyers and postings advertised for *“adventurous, daring”* individuals, *“heavy drinkers”, “impulsive individuals”, “social drinkers”, “more reserved and introverted type person”*, persons who *“got in a lot of trouble as a child”* or *“have trouble with the law and authority”,* those who *“drink modest amounts of alcohol”*, and persons with *“drinking problems”.*

Advertisement responders were screened via telephone to determine whether they met the basic study inclusion criteria. The study inclusion criteria included education level of sixth grade of higher, no reported history of severe head injuries, no reported history of psychosis, reported history of alcohol use at least one time in their life, and fell within the age range of 18 to 30 years. Qualifying participants were informed that they are unable to participate unless they abstained from consuming alcohol and other drugs at least 12 hours before study sessions. Participants in this study were involved in a larger study consisting of four sessions for a maximum of 12 hours. This study included a battery of questionnaires, personality measures, cognitive tasks, decision making tasks and a diagnostic interview. Participants

were compensated at a rate of $10 per hour along with bonuses for showing up to sessions on time.

2.1.3 Session exclusion criteria—To participate in study sessions, subjects had to meet specific criteria on the day of testing. These criteria being (a) have no self-reported use of drugs or alcohol within the past 12 hours prior to testing, (b) at least 6 hr of sleep the previous night (c) not be experiencing symptoms of withdrawal or of any illness and (d) have a breath alcohol level of 0.0% (tested with an AlcoSenor IV, Intoximeters Inc., St. Louis, MO). Subjects were excluded from study sessions if they did not meet these criteria.

2.2 Measures

2.2.1 Personality Assessment—Impulsivity (IMP) was assessed using the Eysenck Impulsivity Questionnaire [EIV] (Eysenck, Pearson, Easting, & Allsop, 1985). Impulsivity is a multifaceted construct involving many specific processes (Dalley, Everitt, & Robbins, 2011; Mitchell, 1999). The Eysenck impulsivity scale was chosen because it assesses all key facets of the multidimensional nature of impulsivity in one scale. This scale assesses impulsivity in terms of being carried away by impulses, not thinking about the consequences of actions, lack of self-control, poor motor control, and acting quickly on ideas. The EIV impulsivity scale has been associated with higher delay discounting (Bobova et al., 2009) and poor behavioral inhibition on reward incentive tasks (Finn et al., 2002).

The Harm avoidance (HA) latent variable was assessed using 28-item harm avoidance subscale (Harm) of the Multidimensional Personality Questionnaire [MPQ] (Tellegen, 1982; Tellegen & Waller 1992). This scale assesses high risk taking and low harm avoidant tendencies including a preference to engage in dangerous activities and difficulties inhibiting behavior to avoid potential harm. The HA scale has been associated with antisocial behavior (Finn, 2002), engaging in risky behaviors (Finn, 2002; Tellegen & Waller, 1992; Waller et al., 1991), difficulties inhibiting behavior to avoid aversive consequences, such as electric shock (Finn et al., 2002), and decreased potentiation of startle in the presence of aversive stimuli (Justus & Finn, 2007).

2.2.2 Delay Discounting Tasks—Participants chose between a hypothetical amount of money “NOW” or $50 “LATER” at one of six time delays (i.e., 1 week, 2 weeks, 1 month, 3 months, 6 months, 1 year). The NOW amount varied from $2.50 to $47.50 in $2.50 increments. At least delay the choices were presented with the NOW amounts in both ascending and descending trial sequences.

2.2.3 Estimation of Discounting Rate—A single parameter hyperbolic function was used to estimate discounting rate in the delay discounting task (Mazur, 1987). The following equation represents the estimation: $Vp = V/(1 + k \times dt)$. Vp represents the present (discounted/subjective) value which is calculated as the average of the switch points for ascending and descending trials at a particular time delay. The constant V represents the amount of the delayed reward ($50), dt represents the length of time the reward is delayed in days, and k represents the discounting rate. The estimated k value of each participant was $\log_{10}$ transformed and this transformed k was used in the subsequent analyses. The use of

this hyperbolic model is a commonly-used approach to quantifying discounting rates in humans after being found to account for significantly more variance than exponential function models (Bickel & Marsch, 2001).

2.3 Data Analysis

Final analysis included 669 (350 males, 319 females) participants after excluding those with missing personality or delay discounting data. The delay discounting data ($\log_{10}$ transformed *k* value) were analyzed using a multiple regression (SPSS version 24), where the main effects of impulsivity (IMP) and harm avoidance (HA), as well as their interaction, were regressed on delay discounting rates ($\log_{10} k$). In the equation, harm avoidance and impulsivity scores were centered (on the mean).

3. Results

A significant regression equation was found for the interaction ($F(3,665) = 16.74$, $p < .001$) with an R^2 of .070. The regression revealed significant main effects of both IMP ($\beta = .260$, $p < .00001$) and HA ($\beta = .096$, $p = .02$), and a significant IMP by HA interaction ($\beta = .103$, $p = .006$). IMP was significantly correlated with higher delay discounting rates, ($r = .229$, $p < .001$). While the regression indicated a main effect of HA, HA was not significantly correlated with discounting rates ($r = -.009$, $p = .810$), suggesting a role for IMP in the IMP by HA interaction in this effect. IMP was moderately negatively correlated with HA ($r = -.378$, $p < .0001$). Figure 1 displays the interaction results using the average delay discounting rates and Figure 2 displays the scatterplots with the correlation coefficients of the study variables for the entire sample.

Simple main effects analyses of the IMP by HA interaction revealed that HA was predictive of delay discounting rates for those with high IMP (mean IMP = 4.64) ($F(1,303)=6.21$, $\beta = .14$, $p = .013$; $r = .142$, $p = .013$), but not for those low in IMP (mean IMP = −3.88) ($F(1,362)=.098$, $\beta = -.016$, $p = .754$; $r = -.016$, $p = .754$). However, IMP was significantly associated with discounting rate for those low in HA (mean HA= −5.45) ($F(1,305)=9.030$, $\beta = .17$, $p = .003$; $r = .170$, $p = .003$) and those high in HA (mean HA= 4.62) ($F(1,360)=37.304$, $\beta = .306$, $p < .00001$; $r = .306$, $p < .00001$). Scatterplots along with the correlation coefficients of the high and low groups are displayed in Figure 3. Thus, contrary to our hypothesis, the interaction revealed that harm avoidance was positively associated with discounting rates for those high in impulsivity. The highest discounting rates were observed for those high in HA and high in IMP. Table 2 displays the regression results based on the average delay discounting rates for each group.

4. Discussion

The purpose of this study was to test the hypothesis that the combination of high levels of impulsivity and low levels of harm avoidance would be associated with the highest elevations in delay discounting rates. Consistent with earlier research, we found that high levels of trait impulsivity was significantly associated with higher rates of discounting delayed rewards. We also observed a significant impulsivity by harm avoidance interaction. However, contrary to our hypothesis, the highest rates of delay discounting were observed in

those high both in impulsivity and harm avoidance. These results are counterintuitive from the theoretical perspective that high delay discounting rates reflect general increases in disinhibition, however they make sense in that waiting may be stressful for those with generally high levels of harm avoidance and perhaps one would be inclined to avoid the delay. However, the results point to some interesting characteristics about delay discounting and personality traits. Our results suggest that for highly impulsive and harm avoidant individuals waiting for a delayed reward may appear riskier, and may be more anxiety provoking, than choosing to take the immediate reward. This could explain what lead these individuals with high harm avoidance to discount the future reward at a higher rate, even though we would expect the highest delay discounting rates to be shown in those with high impulsivity and low harm avoidance. In previous studies, high rates of discounting delayed rewards have been associated with elevated levels of trait impulsivity (Bobova et al., 2009; de Wit, Flory, Acheson, McCloskey & Manuck, 2007; Kirby et al., 1999). Increased delay discounting reflects a bias to choose a smaller immediate reward, rather than waiting to receive a larger delayed reward. In fact, delay discounting tasks are considered by many as a task that assesses impulsive choice (Bickel & Marsh 2001; Heil et al 2006; Kirby et al., 1999). While delay discounting tasks are thought to reflect impulsivity by measuring the subjective value of an immediate versus delayed reward, other proposed traits of disinhibited personality had not been assessed in the context of delay discounting. Harm avoidance, for example, is thought to reflect problems inhibiting approach behavior in contexts where an aversive outcome is possible (Finn, 2002; Lykken, 1995). Harm avoidance can be construed, in part, as a tendency to discount (devalue) a future negative consequence when faced with an opportunity to enjoy an immediate reward. However, studies have not investigated the association between harm avoidance and delay discounting.

The current study was designed to address this limitation by assessing the effects of both harm avoidance and impulsivity, and their interaction, on delay discounting rates. Theory suggests that the combination of high levels of impulsivity and low levels of harm avoidance is associated with the highest levels of behavioral disinhibition (Finn, 2002; Fowles, 1987). Impulsivity is thought to involve strong approach, or behavioral activation, tendencies and difficulties delaying gratification (Finn, 2002; Fowles, 1987). Harm avoidance is thought to reflect increased behavioral inhibition and (Finn, 2002; Waller et al., 1991). Thus, the combination of both strong approach and weak inhibition should be associated with the greatest levels of behavioral disinhibition. Insofar as increased delay discounting underlies high behavioral disinhibition (Finn et al., 2015) the combination of high impulsivity and low harm avoidance should be associated with the highest rates of delay discounting of rewards. Consistent with previous research we found that trait impulsivity was associated with higher delay discounting rates. However, while the analyses revealed a significant impulsivity by harm avoidance interaction, the results were actually in the opposite direction to our hypotheses. Specifically, the combination of high levels of impulsivity and high levels of harm avoidance were associated with the highest rates of delay discounting.

While somewhat counter intuitive, these results are quite interesting. First, people who are high in both impulsivity and harm avoidance are typically not studied. Because these two traits are typically negatively correlated, it seems to be assumed that most impulsive individuals have low levels of harm avoidance (Finn, 2002). However, while these two traits

are significantly correlated, they are only moderately correlated (−0.378, see Figure 2c), indicating that there are individuals who likely have high levels of both traits and individuals who have low levels of each trait. A person who has high levels of impulsivity would have difficulty inhibiting approach (to reward) behaviors (Finn 2002; Gunn et al., 2013; Swann et al., 2002), but would have no difficulty avoiding potentially threatening or aversive outcomes (Finn 2002). Second, the results suggest that high harm avoidance, in the presence of high impulsivity, is associated with perceiving delayed rewards as more risky. In fact, we speculate that waiting for a delayed reward does have some risk; if one opts for a delayed monetary reward, there could be a degree of uncertainty and about financial need during the delay, or anxiety about the possibility of never receiving the rewards, or anxiety about the reward decreasing in actual value over the delay (Gray, 1972; Fowles 1987). Whatever the case, our results suggest that when an impulsive individual is harm avoidant as well, waiting for too long for a reward may be viewed as potentially “harmful”, and leading the individual to be that much more likely to choose the immediate smaller reward over the delayed reward. Additionally, it is possible that anxiety plays an influential role in the choice of such an individual (Gray, 1976; Gray 1982; Swann et al., 2002). It also could be that for such an individual waiting for a delayed reward may cause increased anxiety, since high BIS activity is thought to reflect a tendency to experience anxiety (Gray 1976; Fowles 1987) when confronted with a fear of nonreward.

This study should be interpreted in light of its limitations. First, the sample consists of mostly those with an AUD diagnosis and a wide range of symptom severity. It is possible that the high rates of externalizing problems in the sample could contribute to the high rates of impulsivity and individual differences found here. Second, impulsivity is a multifaceted construct (Dalley, Everitt, & Robbins, 2011; Mitchell, 1999) and the measure used in this study broadly measures trait impulsivity and does not measure specific subdomains of impulsivity, such as motor control and planning aspects. This study cannot tease apart which specific subdomains of impulsivity are associated with increased delayed discounting in our sample. Additionally, the sample in this study was predominately young (ages 18 to 30) Caucasian students recruited from a large university which may limit generalizability to the population as a whole. Further work should be done assessing these findings in other populations with varying levels of externalizing problems as well as other age and race demographics, outside of a university setting. Finally, this study focused on delay discounting of rewards and did not examine the association between delay discounting of losses and both impulsivity and harm avoidance. Recent studies suggest the importance of understanding delay discounting of both losses and rewards (Bailey, Gerst, & Finn, 2018; Gerst, Gunn, & Finn, 2017; Ohmura et al., 2005). Future work should examine the interaction between impulsivity, harm avoidance, and other disinhibited personality traits on delay discounting of losses as well to better understand the role of harm avoidance in both delay discounting tasks.

In conclusion, these results provide information about the interaction of disinhibited personality traits and their impact on discounting rates. Specifically, the interaction between high harm avoidance and high impulsivity on delay discounting rates, while counterintuitive, shed some light on how individual differences in approach and avoidance tendencies may be associated with delay discounting. The elevated delay discounting rates of this specific,

typically under-identified group of high impulsive and high harm avoidant individuals underlines the fact that there is some risk in waiting for a delayed reward and suggests a role of fear or anxiety of non-reward that can influences risk assessment and approach behaviors on a delay discounting task.

Acknowledgements

This research was supported by National Institutes of Alcohol Abuse on Alcoholism (NIAAA) grant R01 AA13650 to Peter R. Finn.

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Highlights

- Increased delay discounting is significantly associated with high impulsivity.
- Harm avoidance alone is not associated with increased delay discounting.
- Results revealed an impulsivity by harm avoidance interaction.
- Impulsivity *and* high harm avoidance are associated with the highest discounting.
- Results suggest complexities and individual differences in disinhibited personality.

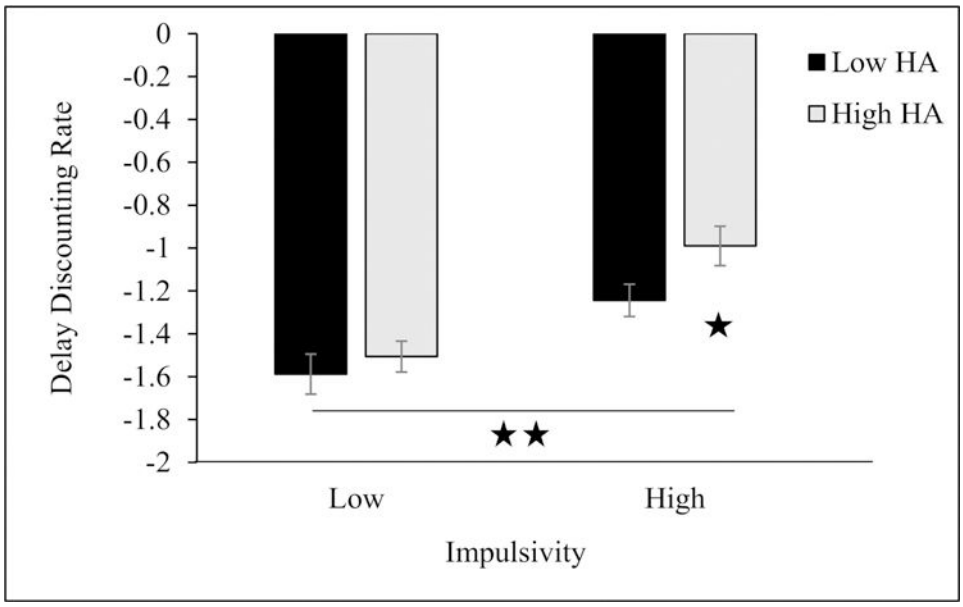

Figure 1. Delay discounting rate by Harm Avoidance and Impulsivity

HA=harm avoidance; Delay discounting rate ($log_{10}k$) by HA divided in to high and low HA using median split to display data. * = p<.05 significance of the high HA high IMP group. ** = p<.0001 significance of the main effect of IMP.

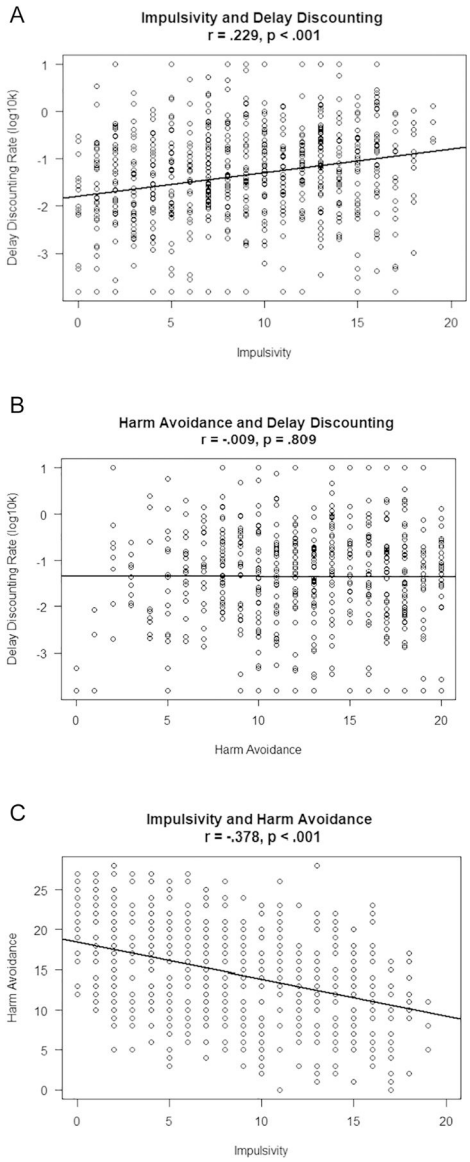

Figure 2.

Scatterplots depicting correlations between study variables for entire sample. Figure 2a. Impulsivity by $\log_{10}$K delay discounting for entire sample. Figure 2b. Harm avoidance by $\log_{10}$k delay discounting for entire sample.Figure 2c. Impulsivity by Harm Avoidance for entire sample.

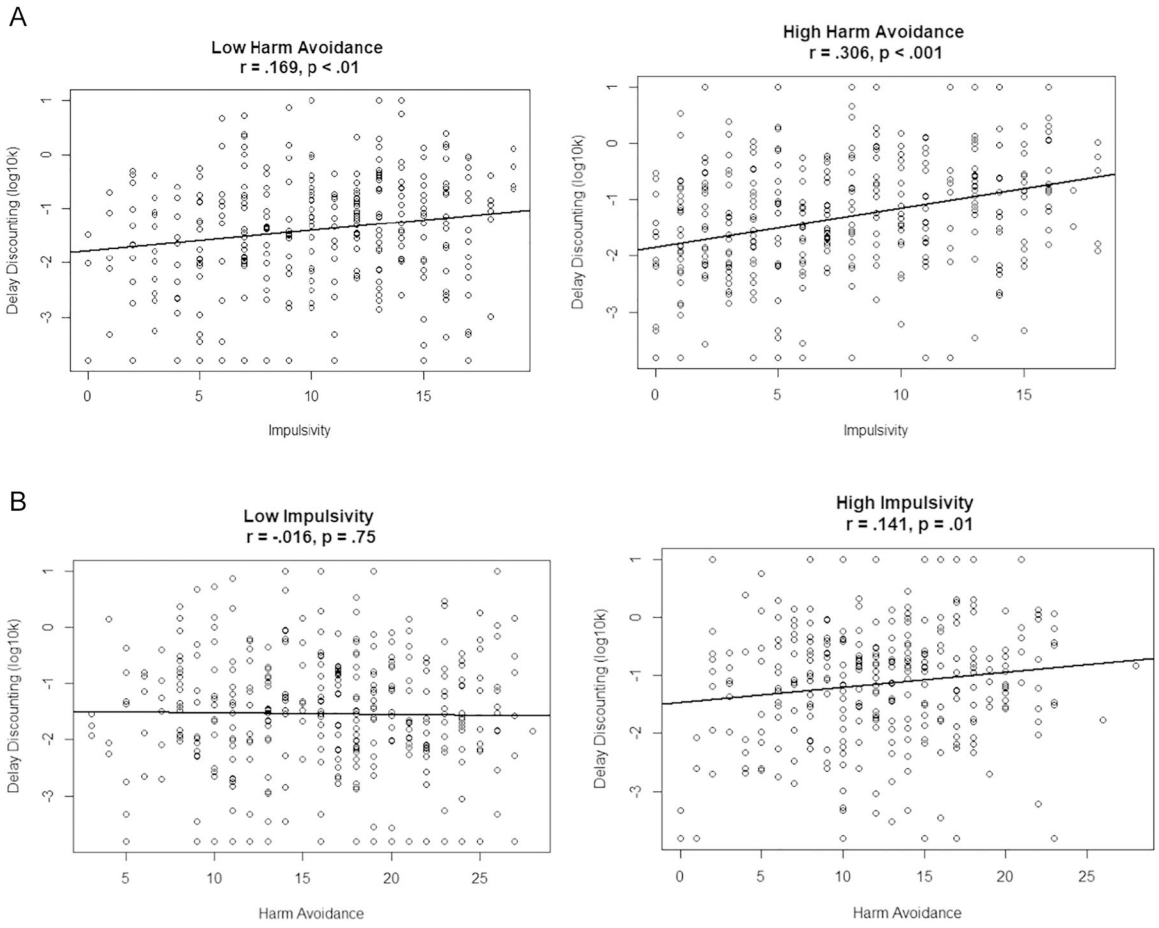

Figure 3.

Scatterplots depicting correlations between $\log_{10}$k (Delay Discounting Rate), Impulsivity, and Harm Avoidance divided into high and low groups. Figure 3a. Impulsivity by $\log_{10}$k delay discounting for those low and high in Harm Avoidance. Figure 3b. Harm Avoidance by $\log_{10}$k delay discounting for those low and high in Impulsivity.

Table 1.

Sample Characteristics

	Mean	SD
N	669	-
Age	21.19	2.514
% Female	47.7	-
Years of education	13.92	1.714
Impulsivity	8.75	0.192
Harm Avoidance	14.44	0.234
Delay Discounting Rate	−1.35	0.0415

Table 2.

Multiple Regression Results

	F (df)	Standard Beta	P-value
Main effect model	16.739 (3,665)		
IMP	41.3 (1,665)	0.260	**.000**
HA	6.65 (1,665)	0.096	**.018**
IMP by HA	7.58 (1,665)	0.103	**.006**
Simple main effects			
HA within low IMP	0.098 (1,362)	−0.016	.754
HA within high IMP	6.209 (1,303)	0.142	**.013**
IMP within low HA	9.030 (1,305)	0.170	**.003**
IMP within high HA	37.304 (1,360)	0.306	**.000**

IMP = impulsivity, HA = Harm Avoidance. High and low IMP or HA groups established using median split.