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The Behavioral Economics of Drunk Driving

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Abstract

This study investigates whether drinker-drivers attributes are associated with imperfect rationality or irrationality. Using data from eight U.S. cities, we determine whether drinker-drivers differ from other drinkers in cognitive ability, ignorance of driving while intoxicated (DWI) laws, have higher rates of time preference, are time inconsistent, and lack self-control on other measures. We find that drinker-drivers are relatively knowledgeable about DWI laws and do not differ on two of three study measures of cognitive ability from other drinkers. Drinker-drivers are less prone to plan events involving drinking, e.g., selecting a designated driver in advance of drinking, and are more impulsive. Furthermore, we find evidence in support of hyperbolic discounting. In particular, relative to non-drinker-drivers, the difference between short- and long-term discount rates is much higher for drinker-drivers than for other drinkers. Implications of our findings for public policy, including incapacitation, treatment, and educational interventions, are discussed.

Keywords

alcohol consumption; drinking and driving; time inconsistency; consumer ignorance; cognitive ability; impulsivity

I. Introduction

There is no consensus about which conceptual framework should be used to explain why some people drive while intoxicated (DWI). On the one hand, there is a model of crime in which rational agents weigh expected gains and losses when deciding to violate the law (Becker, 1968). Such persons may engage in criminal behavior because they value the gain more and/or the loss less highly (Fehr and Gächter, 1998). Certain behaviors are consistent with rationality; for example, being selfish, i.e., not considering the negative effect of one's behavior on others, being risk tolerant, or having a high rate of time preference. More altruistic persons may be more cautious drivers because they internalize the consequences of

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harming others on the road. More risk tolerant and more present-oriented individuals may be more likely to engage in behaviors that others would avoid.

The behavioral economics literature has focused on deviations from pure rationality in decision making, including: cognitive limits on decision-making; reliance on heuristics' utility of outcomes reflecting a person's well being relative to others; "reference points" (Mas, 2006); lack of self-control (Bettman et al., 1998; Slovic et al., 1977); social pressure to conform (DellaVigna, 2009); and emotions affecting decision making (Loewenstein, 1996). A substantial amount of economic research lends empirical support to the behavioral economics critique (see e.g., McFadden, 1999). The boundary between standard and behavioral economics is not well defined (see e.g., Jolls et al., 1998; Posner, 1998). Nor is it necessary to draw a precise line between the two views of behavior. Behavioral economics offers particular advice for public policy interventions, including legal interventions that might be worth following to the extent that there is empirical support for the behavioral economics critique.

On its face, DWI seems like a prototypical case of non-rational decision making. The activity leads to bad outcomes downstream. If anything, alcohol addiction and emotions in various combinations would seem to play a large role in the decision to become intoxicated and once intoxicated the decision to drive is anything but a rational calculation.

An alternative to the rational view is that people may commit illegal acts because they are imperfectly rational (Cawley, 2008). They are rational in the sense that they consider the future consequences of their actions, but they may have time inconsistent preferences. They may have biased beliefs about the probabilities of adverse consequences of their actions, seeing ahead only a few periods at a time (Jehiel and Lilico, 2010). Further, they may have difficulty thinking about utility in a state in which adverse outcomes are realized, or in remembering heuristics based on previously-determined algorithms for responding to common life situations, e.g., actions to be taken before or after consuming alcoholic beverages.

An even further departure from pure rationality are irrational actors.[1] Their decisions may be totally influenced by emotions, including visceral urges provoked by external cues rather than an objective assessment of benefit versus cost. Major cognitive limitations and/or psychiatric disorders, which are more common among substance abusers, may lead to irrational decision-making.

There are several alternative, albeit non-mutually exclusive approaches, for dealing with DWI. At one end of the spectrum is imposition of criminal penalties. Such penalties involve a combination of disincentives to violate the law and incapacitation, the former more likely to be effective if drivers make rational calculations with incapacitation most clearly appropriate when individuals do not respond to disincentives to violate criminal sanctions embodied in criminal statutes. In the context of DWI, incapacitation takes the forms of

[1]There are no fine dividing lines between these categories. For example, Hoch and Loewenstein (1991) describe some decision making a tug of war between desire and willpower. The relative strength of desire and willpower presumably determines where a particular choice is classified in the above scheme.

incarceration, routine blood tests, ignition interlock which restricts the ability of an intoxicated individual to drive a vehicle, and Secure Continuous Remote Alcohol Monitoring (SCRAM) devices, bracelets attached to the person's ankle that monitor the presence of alcohol in perspiration. Non-response to disincentives may reflect that the disincentives are insufficiently high to deter or that some individuals do not rationally weigh long-term benefits versus costs of DWI. Penalties for DWI are rarely imposed in that the probability of arrest conditional on drinking and driving is so low. According to our survey findings, the probability of arrest for DWI, conditional on driving after having had too much to drink is 0.008. Considering the probability of prosecution and conviction for DWI, the probability of a DWI conviction given a drinking and driving episode is about 0.006.[2]

Empirical evidence may not only yield information on the effectiveness of criminal penalties but also affect their design. For example, evidence on high rates of time preference would imply that punishment following a DWI violation should be swift.

Two other general approaches for reducing rates of DWI are education campaigns and therapies. The rationale for education campaigns at a macro, e.g., messages on billboards, or micro level, e.g., private provision of information by physicians to individual patients, about the harms of DWI[,] is that people lack relevant knowledge in particular and/or suffer from cognitive limitations more generally. Underlying the case for therapy are the notions that DWI stems from dependence on and/or abuse of alcohol and drugs. Conditional on being dependence or abusing these substances, DWI is plausibly not the result of a rational calculation. At a minimum, judgment is likely to be impaired. Empirical evidence on drinker preferences can inform the design of therapy to the extent that DWI reflects alcohol dependence/abuse versus other attributes of the individual, e.g., impulsiveness and impatience in contexts other than in situations involving alcohol consumption. Some individual characteristics, such as lack of self-control, may itself be the cause of alcohol dependence/abuse, as well as drinking and driving. If so, just treating the alcohol problems may be ineffective in reducing rates of DWI in that the basic issue underlying decisions remains unaffected.

This study investigates whether or not persons who engage in drinking and driving tend to possess some attributes that are importantly associated with imperfect rationality or irrationality. Using data collected for this study, we address these specific issues. First, does the cognitive ability of persons who report that they drank and drove in the past year differ from those who did not? Perhaps drinking and driving is a byproduct of cognitive deficits. Second, is such behavior attributable to lack of knowledge of DWI laws? One reason for lack of knowledge is that the cost of acquiring the requisite information may be higher for some individuals in part because of lower cognitive ability. Third, do drinker drivers lack self-control, as indicated by a lower propensity to plan for the future and by greater overall impulsivity? Time inconsistency reflects lack of self-control. A fourth possibility is that drinker drivers have time-inconsistent preferences, which implies that rather than use a

[2]The probability of conviction for DWI given a DWI arrest based on arrest data from North Carolina is 0.74. This calculation is based on our own analysis of DWI arrest data for this state. Hoch and Loewenstein (1991) reported a 0.82 DWI conviction rate for Maryland. Another study reported an even lower probability of arrest conditional on drinking and driving, i.e., 0.001 (Beitel et al., 2000).

constant discount rate for evaluating present and future costs of benefits and costs of current decisions, persons apply a higher discount rate to benefits and costs accruing in the short-term than they do for benefits and costs accruing later. As a long-term goal, they would like to quit their bad habit, but they postpone doing this because the near-term benefit of quitting is discounted at a relatively high rate.

We find first that persons who engage most often in drinking and driving are relatively knowledgeable about DWI laws, and second, drinker drivers do not differ on two of the three study measures of cognitive ability from persons who consume some alcohol but do not drive. Drinker drivers are less prone to plan events involving drinking, e.g., selecting a designated driver in advance of the drinking episode, and are more impulsive as measured by a scale not specifically designed to measure alcohol consumption and related behaviors. Drinker drivers do tend to have higher rates of time preference, which the framework based on Becker and Murphy's (1988) rational addiction model envisions. Furthermore, we do find evidence in support of hyperbolic discounting. In particular, relative to non-drinker drivers, the difference between short- and long-term discount rates is much higher for drinker drivers than for other drinkers. To our knowledge, this is the first study of differences in cognitive status and ignorance of laws among persons who do or do not engage in a harmful behavior such as drinking and driving and provides the strongest empirical evidence in support of hyperbolic discounting on the part of a segment of the U.S. adult population.

Section II provides background on the issues raised by our study questions. Section III describes the data and empirical specification, which is followed by a discussion of empirical findings in Section IV. A final section reviews and discusses implications of our findings and relates them to previous findings in the behavioral economics literature.

II. Background

A. Cognitive Limitations

Research that has been conducted on the relationship between cognitive status and decision-making stems from the path-breaking work by Simon (1955, 1979) on "bounded rationality." However, although DWI is a "bad" decision from a social perspective, in general, the fact that decision making patterns differ on average according to the individual's cognitive status does not necessarily mean that more cognitively able individuals make better choices, only that they often differ (Frederick, 2005). Mechanisms underlying these differences in decision-making processes are not well understood.

Cognitive ability affects a range of economic and social outcomes, including earnings and occupational attainment (e.g., Heckman et al., 2006). It relates to an individual's ability to learn, process information, and to make decisions. Lower cognitive ability has been linked to higher risk aversion and to higher impatience (Dohmen et al., 2010; Hinson et al., 2003), higher impulsivity (de Wit et al., 2007), and a lower propensity to save (Ballinger et al., 2011) or invest in stocks, the latter in part due to more information-intensive nature of such assets as compared to fixed income securities (Christelis et al., 2010).

Given their high number, many decisions are unconscious, occur automatically, and are based on heuristics (Kahneman, 2003). People rely on memory to know how they have handled past decisions of particular types, and use this information to make current decisions. While alcohol use has been linked to neurocognitive deficits, evidence on the relationship between driving under the influence and such deficits is mixed (Kasar et al., 2010).

B. Ignorance of the Law

A related possibility is that drinker drivers violate the law because they lack knowledge of the relevant laws. While knowledge may be acquired by experience and search, perhaps the cost of search and knowledge retention is higher for law violators.[3] Alternatively, law violators may learn from experience after they have been penalized, which is the causal mechanism under specific deterrence (Gray and Scholz, 1993).

C. Lack of Self-Control

Individuals who lack self-control may be less likely to engage in long-term planning and/or be more subject to temptations causing deviations from plans in the short-term. Planning is a general process of making choices about the future. Discounting is part of the planning process.[4] Recent research suggests that the propensity to plan for the future may be important in determining choices, like the decision to quit an addictive behavior or a bad habit, that involve immediate costs and delayed rewards.

Ameriks et al. (2003) argued that lack of financial planning may reflect a general lack of self-control (or impulsivity) and skills required to carry out plans. In their empirical analysis, they regressed an individual's wealth holdings on a measure of time spent making financial plans to estimate the effect of planning on asset accumulation. The problems of reverse causation (someone with more wealth may have an added incentive to make plans) and omitted variables (those who plan may have unobserved characteristics correlated with wealth) were addressed by instrumenting for financial planning with, most importantly, a measure of time spent planning vacations. The authors found that financial planning has an economically important association with wealth levels, and can explain variation in wealth that leading theories cannot. Khwaja et al. (2007b) obtained similar results for financial and vacation planning, but time spent thinking and planning about smoking was not associated with differences in financial and vacation planning. However, in another study, the authors did find that smokers had shorter financial planning horizons than others did (Khwaja et al., 2006).

Planning is only a first step in sound decision-making. Actually carrying plans through is another. Social psychological studies have investigated implementation of plans to alter behavior over time, e.g., implementing plans to eat healthier foods (Adriaanse et al., 2011). Visceral urges can affect plan implementation by increasing the marginal utility of an

[3]Posner (1998) suggested law violators may be a selected group. Law-abiding persons decide to follow the law after evaluating the benefits versus costs of doing so. This leaves others who violate the law because they do not rationally weigh benefits versus costs.
[4]For example, in planning for retirement, discounting affects the timing of retirement and the amount of resources placed aside for consumption during retirement (Diamond and Köszegi, 2003; Holmes, 2010).

immediate reward; also, an immediate reward can activate appetite states (Frederick et al., 2002; Loewenstein et al., 2001a). Irrational decisions are influenced by emotions experienced at the moment of decision-making. Emotional reactions to risky situations often diverge from objective assessments of risks, and when a divergence occurs between affect and choices based on objective evaluation of risk versus benefit, emotional reactions often dominate.[5] There is some empirical evidence from social psychology that people often overestimate their capacity for impulse control, thus overexposing themselves to various temptations (see e.g., Nordgren et al., 2009).

Such visceral urges apply to consumption of addictive goods (Loewenstein, 1999) in which there may be struggle between two forces, desire and willpower (Hoch and Loewenstein, 1991). Use of addictive substances and associated behaviors such as DWI may be triggered by external cues (Bernheim and Rangel, 2004). Impulsivity may make an individual more responsive to such cues.[6] In Wickens et al. (2008), impulsivity predicted driving violations.

Impulsivity can be viewed as a state at a moment in time, or as a personality characteristic that evolves slowly over time or is time invariant. Presumably persons with these characteristics are more responsive to cues when they appear. Oberlin and Grahame (2009) reviewed literature demonstrating an association between impulsivity, alcoholism, abuse of cocaine, heroin, methamphetamine, and nicotine.[7] To measure impulsivity as a personality characteristic, Khwaja et al. (2007b) used an index of impulsivity developed by Loewenstein et al. (2001b), also used in our study.[8] Khwaja et al. (2007b) found that smokers tend to be more impulsive on average than non-smokers are.

D. Time-Inconsistent Behavior

Under hyperbolic discounting (Ainslie, 1975, 1992, 1999), the discount rate becomes higher as the time for implementing the change becomes closer. Discounting is exponential for decisions occurring in the future but not for immediate decisions for which the discount rate is higher. O'Donoghue and Rabin (1999) and Gruber and Köszegi (2001) modeled the decision-maker as a sequence of present-biased distinct agents. Time-inconsistent agents can be sophisticated in that decision-makers recognize their time inconsistent and self-control problems and place barriers in the way of carrying out time inconsistent actions ("sophisticates") or not recognize their time inconsistency problems ("naïfs").[9]

[5]Recent neurobiological research as questioned the notion of competition between a cold rational far-sighted rational decision-making system and a hot short-sighted emotional system expressed in behavioral economics papers (see e.g., Seymour and Dolan, 2008).

[6]Loewenstein (1996) argued that hyperbolic discounting cannot explain responses to situations such as cues from smell or proximity, which are commonly associated with impulsivity, other than to time delays. In the context of this paper, an example would be seeing people in front of bar having a good time as a stimulus for stopping and entering the bar.

[7]To further study the association, focusing on alcohol use, the authors conducted an experiment with high-alcohol preferring and low-alcohol preferring mice, varying the time of rewards to gauge the extent to which rewards were discounted. They found evidence that the high-alcohol preferring mice were more impulsive than the mice in the comparison group were.

[8]To measure impulsivity, we used impulsivity questions developed by (Loewenstein et al., 2001b). To conserve time, the SAD used a condensed version of the Lowenstein et al. scale; their instrument includes 22 questions. In the SAD, respondents were asked at wave 1 to respond on a 5-point scale to 12 statements designed to measure impulsivity.

[9]Theoretical studies have incorporated the concept of temptation. In Gul and Pesendorfer's (2001, 2004) framework, temptation creates a preference for commitment. More recently, Noor (2011) argues that opportunities that lead to tempting consumption may be tempting themselves and hence preferred to a menu of choices that forecloses future temptation.

The initial surge in popularity of the concept of time inconsistency was that it seems to explain important anomalies in decision-making. Results of empirical tests have not all provided rigorous support of time inconsistency. For example, following a literature review, Read et al. (2012) presented results indicating no evidence of hyperbolic discounting in a longitudinal study involving choices of money.

Time inconsistency seems highly applicable to high levels of consumption of an addictive good. It may be particularly applicable to drinking and driving in that such decisions are often made in a social context. There is some empirical evidence that a positive emotional status leads to increased risk taking (Kuhnen and Knutson, 2011; VanDellen and Hoyle, 2010). There may be considerable heterogeneity in how emotional factors affect the decision to drink and drive. For example, some persons may be regular patrons of bars and hence the good feeling from an evening with friends at the bar may frequently impair the individual's judgment as to whether or not to drive him- or herself home from the bar. On the other hand, some regular drinkers may rarely be in a position to drink and drive since most alcohol consumption occurs at home. But the emotion from drinking at a holiday party leads to a poor decision to drive oneself home. Since this is a rare occasion, the latter type of individual may have little experience with how alcohol affects the person's driving ability.[10] In the latter type of case, the individual is unable to effectively calculate the risk and potential loss associated with drinking and driving.

The important implication of this kind of model is, unlike perfectly rational addicts, choices made in the present probably will not be viewed by the individual as optimal later. To the extent that the imperfect rationality agent accurately describes consumption of addictive goods, the role for government intervention is much broader than under rational addiction. In particular, some imperfectly rational persons may know that they will not carry out their plans to quit consumption in the future. Thus, they rely on self-control devices to aid them in implementing their plans (Gruber and Köszegi, 2004).

A review of the literature on hyperbolic discounting largely based on the psychological, psychopharmacological, and neuroscience literatures concludes that hyperbolic discounting is more common among addicts (Peters and Büchel, 2011). Several studies have examined time inconsistent decision-making as it applies to alcohol use. The studies are deficient in relying on student subjects, an inexpensive alternative, but not necessarily representative of the population the investigators seek to study, and in having very small samples or methodological deficiencies.

A highly cited study by Vuchinich and Simpson (1998) used data from a survey of students at Auburn University in which they compared the goodness of fit of data from various drinker types between an exponential discounting function and a hyperbolic discounting function. Rewards were pecuniary, but subjects differed in terms of their alcohol use. Problem drinkers exhibited more evidence of hyperbolic discounting than light drinkers, but there were no cognitive differences between the two groups of drinkers. Richards et al. (1999) focused on the effects of alcohol consumption on the discounting process and found

[10]See Silver (2012) for a discussion of this point.

that 24 young adults discounted differently depending on the level of alcohol consumed in a laboratory setting. The authors also found that the data fit the hyperbolic better than the exponential function.

Moore and Cusens (2010) investigated whether the discount rates of social drinkers changed as their blood alcohol content levels increased. Forty-six males received breathalyzer tests on entry to a bar and again when they left. Higher rates of discounting of future rewards were detected after the men left the bar. Also, persons with higher discount rate at entry into the bar demonstrated that a higher increase intoxication by the end of their visit. This is not a direct test of hyperbolic discounting.

Loughran et al. (2012) collected data from 478 university students who were asked for responses to a hypothetical scenario about drinking and driving. Gains and losses from DWI were delayed at five different intervals ranging from “tonight” to “10 years from now.” The students were asked about the probability of arrest if they were to drink and drive and about the probability that they would engage in such activity. They found evidence consistent with hyperbolic discounting. For example, when the benefit of DWI was delayed by a week, the probability of DWI rose by about 10 percent, but when the delay was extended to a month, this probability only rose by four percent.

There is more empirical evidence with regard to time preference and time-inconsistent behavior of smokers (Bickel et al., 1999) than on alcohol consumption.[11] The fact that people have trouble carrying out their plans to quit smoking seems indicative of time-inconsistent behavior. Khwaja et al. (2007a) used the same type of questions we use in this study of drinking and driving, but a different equation specification, to test for hyperbolic discounting among smokers. They found no empirical evidence in support of hyperbolic discounting for smokers.

III. Data

Battelle Memorial Institute conducted a three-wave survey of drinkers and drivers, called the Survey of Alcohol and Driving, or the SAD, on our behalf in eight U.S. cities in four states during 2010–2012. When possible the questionnaire design was guided by questions asked in prior surveys, albeit not all asked in the same instrument. The first wave was administered by telephone and contained questions on: demographic characteristics/income; alcohol consumption/problems/ dependence/abuse; health and health behaviors; planning; cognition; impulsivity; motor vehicle insurance; accident/traffic violation history; and altruism. The second wave was administered by computer about a month after the first wave and requested information for which visual displays were likely to be helpful. This study’s data on hyperbolic discounting come from this wave.[12] The third wave consisted of computer-assisted interviews administered a year after the first wave.[13] This study relies on data from the first two waves.

[11]On drug dependence and discounting, see Bickel and Marsch (2001).
[12]The third wave consisted of follow-up questions to allow analysis of accuracy of respondents’ predictions of future behaviors and outcomes.
[13]Survey instruments can be found at (http://dialog.econ.duke.edu/dapstudy).

Since the study focus was on DWI, eligibility for the survey required respondents to have driven a car and consumed alcohol during the last month, residence within one of eight study cities, and be age 18 or older. The eight cities were: Raleigh, North Carolina (NC) and Hickory, NC; Philadelphia, Pennsylvania (PA) and Wilkes-Barre, PA; Seattle, Washington (WA) and Yakima, WA; and Milwaukee, Wisconsin (WI) and La Crosse, WI. They represented a broad geographic spread of large and small cities. While data from eight cities are not representative of the U.S., the four study states in which the cities are located varied in severity of their DWI problems, e.g., in per capita consumption of ethanol in gallons in 2007—NC (2.0), PA (2.2), WA (2.4), and WI (3.0) (National Institute on Alcohol Abuse and Alcoholism, 2009). Arrest to population ratios varied from 0.25% (WA) to 0.67% (WI) in 2009 (our calculation from data on individual arrests we obtained from each state). The four states also differed in their DWI prevention laws and demographic composition.

The participant recruitment process was designed to oversample persons who consumed large amounts of alcohol and were prone to DWI in order to study decision-making and other behaviors of such individuals in detail. Having had an arrest for DWI was not a prerequisite for participation in the survey. However, questions were asked about prior DWI arrests and convictions, drinking and driving behavior, citations for other traffic offenses, and the resulting penalties. Institutional Review Boards at both Duke University and Battelle approved the survey design, data collection methods, questionnaires, and participant recruitment methods.

We employed several innovative recruitment techniques to elicit survey participation resulting in 1,634 completed responses to wave 1. Recruitment methods, with number of respondents in parenthesis, were: random digit dial (592); court records (7); study flyers in bars and full-service restaurants (17); newspaper advertisements (198); email invitations to participate (703); and individuals who called Battelle to participate after seeing advertisement or being referred by another person (117).

In total, 40 respondents reported they had been arrested for DWI in the last three years. This number is far fewer than the number of respondents that reported having driven after drinking in the past year (695, 42.5% of respondents). A financial incentive of up to $90 was offered to all individuals, regardless of recruitment method, for participating in the study. The most effective recruiting method was an emailed invitation to participate based on a random draw of email addresses in the eight cities. The message described eligibility criteria, mentioned the financial incentive, and referred the individual directly to our study website, which listed the study objectives and responsibilities of study participants. The website specified how potential participants could volunteer.

In some specifications, we test for whether or not inclusion of binary variables for sampling source affects coefficients on covariates of interest. Changes in coefficients were minimal with compared to without inclusion of binary variables for sampling source.

IV. Empirical Specification

A. Dependent Variables

To measure cognitive ability, the SAD asked three alternative sets of questions, all based on the questions asked in the Health and Retirement Study (HRS). On memory, SAD asked by telephone (the SAD, Wave 1): “How would you rate your memory at the present time? Would you say it is excellent, very good, good, fair, or poor?” Questions on numeracy were “If the chance of getting a disease is 10%, how many people out of 1,000 would be expected to get the disease?” “If 5 people all have the winning numbers in the lottery and the prize is two million dollars, how much will each of them get?” “Let’s say you have $200 in your savings account. The account earns 10 percent interest per year. How much would you have in the account at the end of one year?” A third set of cognitive questions come from the Telephone Interview for Cognitive Status (TICS), a brief standardized test of cognitive functioning developed for use in situations in which cognitive screening in person is impractical (www4.parinc.com, accessed 10/15/12) and used in the HRS. The SAD included questions from or similar to the TICS on object naming (e.g., “What do you call the kind of prickly plant that grows in the desert?”) and current affairs information (e.g., “Who is the Governor of (your state) right now?”) The SAD also included responses to a serial 7’s subtraction test and a question about today’s date. Separately, the SAD asked respondents to count backwards from a number, which was set at 20. Counting backwards is designed to capture fluid intelligence; object naming is designed to measure crystallized intelligence, and naming time, orientation in time. Higher numeracy by the SAD has been positively associated to the quality of household financial decisions (Smith et al., 2010).

The SAD did not include the TICS questions asked in the HRS on immediate and delayed word recall designed to measure working memory to conserve time on the telephone interview (Rodgers et al., 2003). However, separately, as noted above, the SAD did include a measure of self-assessed memory. Values for the TICS-based cognition scale in our study vary from 0 to 13.

The SAD used several questions designed to elicit respondent knowledge of the law. The dependent variable for our analysis of knowledge of the law is a count of incorrect answers to each of the five knowledge questions described below. An incorrect analysis can be a wrong answer, a missing value, a refusal to answer, or a “don’t know.” The five questions for our analysis of legal knowledge were: (1) “To the best of your knowledge, what percentage of alcohol in the blood is required before a person can be considered ‘legally drunk’ in your state? Use a range of 0.01% to 0.20%. Enter a percentage of 0.01 to 0.20_____.” As with the other questions, respondents would give answers of “refused” and “don’t know” or leave the field blank. (2) “Can a person be convicted of drunk driving just for exceeding a certain blood alcohol limit or does the court require proof of impaired driving, such as weaving all over the road?” Options for answers were: “Exceeding a blood alcohol content is enough.” “Must show impaired driving.” (3) “Suppose that a driver were convicted for driving with a fairly high blood alcohol level—say about 0.15%. According to the laws in your state, can this driver’s license be suspended for a first offense conviction of drunk driving?” Answers were “yes” or “no.” (4) “What is the fine for a first DWI

conviction in your state?" _____dollars. The last question in this set was, (5) "Can this same driver be required to serve some time in jail for a first offense?" The answers to the first two questions do not vary by state. There is state variation in answers to the third through five questions. We obtain the laws from various sources to judge whether or not respondents' answers are correct.[14]

On planning, the SAD first asked about drink planning. There were three questions: (1) "In your entire life, did you ever have an episode when you ended up drinking more than you meant to?" (2) "In your entire life, did you ever have an episode or period when you kept on drinking for longer than you had intended?" and (3) "When you are going someplace where you plan to drink, do you arrange for someone else to drive after your have been drinking?" "Refused" and "don't know" responses to the first two questions are coded as "yes" and to the third "no." The variable drink planner is coded on a scale of 1–4 and takes lower values when the person's responses demonstrate poorer drink planning and higher values when drinking is better planned. If respondents said "yes" to the first two questions and "no" to the third, drinking planning is set to 1. Drink planning is set to 2 when the respondent reported one of the following combinations: (a) does not use designated driver, has drank *more* than intended but never *longer*, (b) does not use designated driver, has drank *longer* than intended but never *more*, or (3) uses a designated driver and has drunk both more and longer than intended. Drink planning takes a value of 3 when: (a) the respondent uses a designated driver and has drank *more* than intended but never *longer*, (b) uses a designated driver, and drank *longer* than intended but never *more*, or (c) s/he does not use a designated driver and s/he has never drunk more or longer than expected. If the respondents said "no" to the first two and "yes" to the third question, drinking planning is set to 4.

The statement on financial planning was: "I have spent a great deal of time developing a financial plan." Possible responses ranged from "disagree strongly" to "agree strongly" on a seven-point scale. "Refused" or "don't know" are coded as a 2, "disagree." This scale varies from 1 to 7. The question to elicit an estimate of the respondent's financial planning horizon read: "In planning your savings and spending, which of the following time periods is most important to you and your household?" Response options ranged from "the next few months" to "longer than 10 years." There were five "don't know" and no "refused" responses to financial planning horizon questions. The "don't knows" are coded as 2's (=one year).

We measure impulsivity from responses to 12 questions from the SAD. Respondents were asked to respond on a 5-point scale to 12 questions ranging from "strongly agree" with the statement to "strongly disagree": "I rarely make hasty decisions;" "I never seem to be able to get organized; I fly off the handle;" "There are so many little jobs that need to be done that I sometimes just ignore them all;" "I control my temper;" "I do things on impulse that I later regret;" "I often worry about things that might go wrong;" "I always consider the consequences before I take action;" "I am not a worrier;" "I plan for the future;" "I often do things on the spur of the moment;" "I finish what I start; I act on impulse."[15]

[14]Washington: Rev. Code Wash. (ARCW) § 46.61.5055; North Carolina: N.C. Gen. Stat. § 20-179; Pennsylvania: 75 Pa. C.S. § 3804; Wisconsin: Wis. Stat. §346.65.

Respondents were asked to agree or disagree with the above statements. They were phrased alternatively in ways that agreement that signified impulsivity and conversely. There were five response categories ranging from “disagree strongly” to “agree strongly.” None of the statements referred to alcohol or other substance use or to DWI. In our empirical analysis, the impulsivity index varies from 12 to 60 with high values being more impulsive. The actual range of scores is 13 to 54.

The SAD measured time preference in the financial domain with four questions. “Would you rather win $1,000 now or $1,500 a year from now?” “Would you rather win $20 now or $30 a year from now?” “Would you rather lose $1,000 now or $1,500 a year from now?” “Would you rather lose $20 now or $30 a year from now?” We form a panel by respondent based on answers to each of the four questions. The dependent variable is 1 if the person selected the present as opposed to the future alternative. The analysis of time preference includes explanatory variables to identify the question to which the response referred. The omitted reference group is “Win $1,000 now or $1,500 a year from now?”

The questions on hyperbolic discounting in the SAD referred to the respondent’s willingness to undergo an endoscopy. The SAD described endoscopy with the aid of a short informational video.[16] Following the video administered in wave 2, the SAD elicited the respondent’s perceived life expectancy (N). If the person did not answer, there was a probe with specific age categories. Then the SAD asked three questions about the payoff in terms of added life expectancy required for the respondent to be willing to undergo an endoscopy. The first question was: “Suppose you were told that by having the endoscopy from N (response to the previous question), your life expectancy would increase to $N + X_1$, where X_1 was drawn at random between 0.5 to five years). If the X_1 draw was either 0.5 or five years, this was taken as the final value. We exclude such observations from our analysis. Otherwise, the SAD implemented a procedure for refining the increase in life expectancy the respondent required to have the endoscopy. More specifically, if the answer to the initial question was “yes,” the value of increased life expectancy asked in the next question is $(X_1 + 0.5)/2$. If the answer was “yes” again, the person was asked whether s/he would have an endoscopy if the increase in life expectancy were $[(X_1 + 0.5)/2 + 0.5]/2$. If the person answered “yes” again, this was taken as the respondent’s final value. Otherwise, the response to the previous question was taken as the final value. Similar procedures were employed for other combinations of answers.

To describe the underlying theory and our empirical approach, let c be the instantaneous disutility of having an endoscopy, and $V(N - t)$ be the utility of expected remaining life

[15]For a statistical analysis of properties of this impulsivity scale, see Loewenstein et al. (2001b). The Cronbach alpha in our data is 0.73, which is in the “acceptable” range (George and Mallery, 2003).

[16]An endoscopy is a procedure enabling the physician to examine the esophagus, stomach, and duodenum, using a thin, flexible tube through which the lining of the esophagus, stomach, and duodenum can be seen using a television monitor. To ensure that the stomach is empty, the patient should not eat or drink six hours prior to the procedure. The patient is given a numbing solution and generally is sedated for the procedure. Patients may experience a mild sore throat or feeling of distention, but these aftereffects are transitory. Minor adverse side effects include reactions to the sedative or exacerbation of pre-existing conditions. Rarely, more major complications occur such a perforation of esophagus, stomach, or duodenum, which require surgical repair. Although excess alcohol use may lead to esophageal cancer Loewenstein et al. (2001b), endoscopies are also performed to detect non-malignancies. Alcohol use is only one of many potential causes of such cancer. Except through the channel of alcohol use, there is no link between drinking and driving and use of endoscopy.

years at time *t*. With an annual discount rate of γ + ρ for the first year, and ρ over subsequent years, then the individual is indifferent between having an endoscopy and receiving X_1 additional life years of life according to:

$$V_{\mathrm{i}}(N_{\mathrm{it}}-t)=-c_{\mathrm{i}}+V_{\mathrm{i}}(N_{\mathrm{it}}-t)+\mathrm{e}^{-\gamma_i-\rho_i(\mathrm{N_{it}-t})}\alpha_{\mathrm{i}}X_{1\mathrm{i}}.$$

The months of life added at the end of the person's current life expectancy to achieve indifference with not having the endoscopy ($X_{1\mathrm{i}}$) is discounted by $\mathrm{e}^{-\gamma_{\mathrm{i}}-\rho_{\mathrm{i}}(\mathrm{N_{it}-t})}$. The parameter α_{i} is the individual-specific, time invariant value of an extra month of life. This indifference equation implies that

$$c_{\mathrm{i}}=\mathrm{e}^{-\gamma_i-\rho_i(\mathrm{N_{it}-t})}\alpha_{\mathrm{i}}X_{1\mathrm{i}}. \quad (1)$$

This series of questions was followed by a series of questions designed to elicit the value of life extension (equals the non-pecuniary cost to the individual) required for the person to have an endoscopy a year from now. The non-pecuniary cost of undergoing an endoscopy was reduced in proportion to the discount rate the person applied to deferring the non-pecuniary cost by a year. At the lower non-pecuniary cost, the time-inconsistent individual reasons that s/he is more likely to undergo the endoscopy in a year. "Suppose you were told by having the endoscopy a year from now, you could extend your life expectancy from *N* to $N + X_2$ years, would you be willing to have the procedure a year from now?" The pattern of follow-up questions was the same as those for having the endoscopy now.

Using the same reasoning as above, a second indifference equation implies

$$\mathrm{e}^{-\rho_i}c_{\mathrm{i}}=\mathrm{e}^{-\rho_i(\mathrm{N_{it}-t})}\alpha_{\mathrm{i}}X_{2\mathrm{i}}. \quad (2)$$

Eqs. (1) and (2) yield

$$\mathrm{e}^{-\rho_i(\mathrm{N_{it}-t})}\alpha_{\mathrm{i}}X_2=\mathrm{e}^{-\gamma_i-\rho_i(\mathrm{N_{it}-t+1})}\alpha_{\mathrm{i}}X_{1\mathrm{i}}\text{or}\ \ \ln(X_{1\mathrm{i}}/X_{2\mathrm{i}})=\gamma_{\mathrm{i}}+\rho_{\mathrm{i}}. \quad (2')$$

The next step was to ask the respondent about the life extension required if the respondent had a life expectancy of a year longer than the one s/he thought she had and to determine what increase in life expectancy would be required to have the endoscopy a year from now. This question was designed to measure the individual's long-term and presumably lower discount rate. "Now suppose that your life expectancy was extended a year from the life expectancy you gave me earlier and suppose you were told by having a endoscopy a year from now, you could extend your life expectancy from *N* +1 to *N*+1+ X_3, would you be willing to have the procedure a year from now?" Again the SAD included follow-up questions to refine the estimate of life extension required under these circumstances. The SAD included a third question that delayed the benefits from the endoscopy. This question added a year to the individual's subjective life expectancy (*N*+12), and then asked what the added months of life expectancy would have to be for the person to have an endoscopy a year from now ($X_{3\mathrm{i}}$). Responses to this question imply an indifference equation

$$e^{-\rho_i} c_i = e^{-\rho_i (N_{it} - t + 1)} \alpha_i X_{3i}. \quad (3)$$

Eqs. (2) and (3) yield

$$e^{-\rho_i (N_{it} - t + 1)} \alpha_i X_{3i} = e^{-\rho_i (N_{it} - t)} \alpha_i X_{2i} \text{ or } \ln(X_{3i}/X_{2i}) = \rho_i. \quad (3')$$

Hence,

$$\ln(X_{1i}/X_{3i}) = \gamma_i. \quad (4)$$

To determine the difference between the short- (2') and long-run rates (4), we subtract eq. (4) from eq. (2') to recover values of ρ and to investigate whether there is (quasi) hyperbolic time discounting and whether there are differences in average discounting by the number of drinking and driving episodes each respondent reported.

B. Explanatory Variables

Overview—The key explanatory variables are for number of drinking and driving episodes in the past year reported at the first SAD interview. We present results from three specifications. The first ("limited specification") only contains covariates for drinking and driving episodes. The third ("full specification") includes covariates that may also explain behaviors captured by our dependent variables. The full specification contains covariates for addiction to alcohol and other substances, demographic characteristics, household income, and except for the cognition analysis, cognitive status. The second specification ("intermediate specification") excludes the binary variables for drinking and driving and our measure of alcohol dependence/abuse.

Number of Drinking and Driving Episodes in Past Year—To elicit frequency of drinking and driving episodes, the SAD asked "In the last 12 months, have you driven a car or other motor vehicle such as a motorcycle when you were slightly intoxicated (e.g., felt a little tipsy)?" If the respondent answered affirmatively, s/he was asked an identical question but asked about how many times this occurred with response categories being once, twice, 3–4 times, and more than 4 times. We base explanatory variables for drink and driving behavior on binary variables for drink and drive 1–4 times and drink and drive 5 or more times, with the omitted reference group being 0 times in the past year (i.e., drinkers who did not drink and drive).

Alcohol Dependence/Abuse—We measure alcohol dependence/abuse by the CAGE index, which has been shown to be a reliable predictor of alcohol dependence and abuse (Ewing, 1984). One study reported that CAGE test scores of 2 or more had a specificity of 76% and a sensitivity of 93% for the identification of excessive drinking and a specificity of 77% and a sensitivity of 91% for the identification of alcoholism (Bernadt et al., 1982). This index is based on affirmative answers to four questions. "In your life, did you more than once want to stop or cut down (C) on your drinking?" Also asked for lifetime: "Have people annoyed (A) you by criticizing your drinking?" "Have you ever felt bad or guilty (G) about

your drinking?" "Have you had a drink first thing in the morning to steady your nerves or to get rid of a hangover (eye-opener, E)?" Values range from 0 to a maximum of 4.

Full Specification—In the full specification, we also include explanatory variables for other factors that plausibly affect drinking and driving.

To measure use of other substances, we include covariates for being a current smoker, having consumed marijuana at least 100 times in one's life, and a binary variable for hard drug user—using licit psychotropic drugs without a prescription and using illicit drugs--having used psychedelics, such as LSD, PCP, mescaline, peyote, or angel dust, cocaine, heroin, or other narcotics in the past year

Demographic variables are: educational attainment in years; currently married; household under age 18.[17] We also include covariates for household income[18] and impulsivity.

Our factor analysis of responses to the 12 questions on impulsivity yields five retained factors. The first accounts for 64 percent of the variance and had positive factor loadings of 11 or the 12 questions, the exception being "I am not a worrier." This factor is interpretable as a general index of impulsivity. We interpret the second, third, fourth, and fifth factors as disorganized /rash, easily angered, disregard for consequences of one's actions, and "I am not a worrier," respectively. We include factor loadings on the first four factors as explanatory variables in some specifications.

C. Estimation

Our basic specification for the analysis of cognition, knowledge, time preference, and planning, is the following:

$$Y_i=\gamma_0+\gamma_1 DD5+x_i+\gamma_2 DD1-4x_i+\gamma_3 CAGE_i+\gamma_4 z_i+\zeta_i \quad (5)$$

where Y is the dependent variable, $DD\ 5+x$ and $DD\ 4+x$ stand for 5+ and 1 to 4 drinking and driving episodes in the past year, respectively, CAGE for the CAGE index, z for other covariates, and ζ. We present alternative specifications to gauge the robustness of our findings. One such specification is limited to covariates for drinking and driving; another is limited to the z_i covariates. The latter specification allows us to gauge the importance of standard socio-demographic covariates and income absent the covariates for drinking and driving and alcohol dependence/abuse. We use ordered logit for this analysis. Ordered logit imposes consistent proportional odds for the probabilities it estimates. We test the validity of this assumption.

To measure hyperbolic discounting, we specify equations for the short- and long-term discount rates, respectively. These equations are:

[17]The SAD asked for educational attainment in categories. To develop continuous variables for educational attainment, we translate descriptions of highest grade or year of school completed into years. For example, we assume that "less than a high school graduate" is 11 years and a "graduate education" is 18 years.

[18]For income, we take the mid-point of each category. The open-ended category for income was $250,000+. We set income of persons in such households at $350,000.

$$\ln(X_{1i})/\ln(X_{2i})=\alpha_{01}+\alpha_{11}DD5+x_i+\alpha_{21}DD5+x_i+\alpha_{31}DD1-4x_i+\alpha_{41}CAGE_i+\alpha_{51}z_i+\varepsilon_{1i} \quad (6)$$

for the short-term rate and

$$\ln(X_{3i})/\ln(X_{2i})=\alpha_{02}+\alpha_{12}DD5+x_i+\alpha_{22}DD5+x_i+\alpha_{32}DD1-4x_i+\alpha_{42}CAGE_i+\alpha_{52}z_i+\varepsilon_{2i} \quad (7)$$

for the long-term rate.

Subtracting eq. (7) from eq. (6) yields the equation we estimate

$$\begin{aligned}&\ln(X_{1i})/\ln(X_{2i})\\&\quad-\ln(X_{3i})/\ln(X_{2i})\\&\quad=(\alpha_{01}-\alpha_{02})+(\alpha_{11}-\alpha_{12})DD5\\&\quad+x_i+(\alpha_{21}-\alpha_{22})DD5\\&\quad+x_i+(\alpha_{31}-\alpha_{32})DD1\\&\quad-4x_i+(\alpha_{41}-\alpha_{42})CAGE_i\\&\quad+(\alpha_{51}-\alpha_{52})z_i+\varepsilon_{2i}\end{aligned} \quad (8)$$

We use ordinary least squares to estimate eq. (8) in our analysis of hyperbolic discounting.

The number of observations used in the regression analysis is generally 1.567. In the hyperbolic discount rate analysis, there are 1,089 due to missing values on the hyperbolic discounting questions. In the analysis of financial tradeoffs in which there are up to four observations per respondent, there are 6,115 to 6,247 observations.

V. Results

A. Descriptive Statistics

Drinking and Driving—Almost 12 percent of respondents (11.7%) reported that they drove when they were “slightly intoxicated” 5+ times during the previous year (Table 1). Another 31.3 percent did so 1–4 times. The majority of respondents (57.0%) said that they did not drink and drive during the past year. All respondents consumed some alcohol in the 30 days before wave 1.

Use of Alcohol, Tobacco, and Illicit Substances—On average, respondents gave slightly more than one affirmative answer to the four CAGE questions. Almost a fifth of respondents smoked (19.0%); a quarter had consumed marijuana 100+ times in their lifetimes (24.4%), and almost a sixth of respondents consumed hard drugs (15.6%).

Cognitive Status, Hyperbolic Discounting, Planning, and Impulsivity—The mean self-evaluated memory score is 3.6 (std. dev. 0.95), roughly in the middle of the range between the worse to the best self-evaluated memory (range: 1–5). The mean numeracy score is near to the highest of the possible values (3), 2.4 (std. dev. 0.80) as is the abbreviated TICS, 11.9 out of a minimum of 5 and a maximum of 13 (std. dev. 1.4).[19] Mean

[19]TICS as modified in the SAD.

educational attainment is 15.5 years, which is almost the time required to complete a college degree.

The mean of drink planning is 2.2 (std. dev. 0.86), about mid-range between the minimum and maximum values for drink planning. Financial planning has a range of 1–7, with the mean, 4.9, close to “somewhat agree” to the financial planning question. The mean financial planning horizon is 6.0 years (std. dev. 7.0), indicating a moderate financial planning horizon with substantial heterogeneity in responses. The mean for the impulsivity scale is 29.5 (std. dev. 6.4), almost mid-way between the range of possible values, 12 to 60. Forty-six percent of respondents selected the present over the future alternative. On average, in the analysis of hyperbolic discounting, the short-term discount rate exceeded the long-term rate by 0.015 on average, but with a large standard deviation, 0.548.

High percentages of respondents reported 5+ episodes (11.7%) of having driven after having had too much to drink in the past year and about three times as many reported having had 1–4 episodes during the past year (31.3%), leaving nearly 57 percent of respondents saying that they did not drink and drive. By contrast, using data from the Behavioral Risk Factor Surveillance System, Bergen et al. (2012) reported that 2.2 percent of respondents 18+ reported drinking and driving in the past month. If we multiply the 2.2 percent estimate times 12, the resulting product is about equal to the number of drinker drivers from SAD. But clearly, this is an overestimate from BRFSS because our calculation assumes no duplicates. The SAD contains more drinker drivers since we limited the sample to persons who consumed some alcohol during the month before the screener interview, undoubtedly resulting in its obtaining respondents for whom alcohol consumption is more salient.

The mean CAGE score is 1.2 out of a possible score of 4. About a fifth of the sample are smokers, marijuana, and hard drug users. The mean age is 42.6 years. Almost half of respondents are currently married (46.1%), and slightly over half are female (52.5%); 70.5 percent have children under age 18 in their households. Mean household income is $76,800 with a standard deviation of $63,700.

B. Cognitive Status

Persons with alcohol dependence/abuse have worse self-reported memory than others. Each additional affirmative answer to the CAGE questions reduces the odds of having good memory by 18 percent (Table 2, col. 1, odds ratio (OR) = 0.82; 95% confidence interval (CI): 0.76–0.89). Holding the influence of CAGE constant, the odds of having good memory is lower for persons who drank and drove 1–4 times in the past year (OR=0.70; 95% CI: 0.57–0.86) and even lower for those who drank and drove 5+ times (OR=0.64; 95% CI: 0.47–0.87).

In the intermediate specification (col. 2), higher educational attainment (OR=1.18; 95% CI: 1.12–1.24) and household income (OR=1.25; 95% CI: 1.06–1.47) increase the odds of having better memory; being older (OR=0.99; 95% CI: 0.98–0.99) and black (OR=0.66; 95% CI: 0.49–0.88) reduce these odds. Increasing educational attainment by a year has almost the same effect on memory as a $72,000 increase in annual household income. A two-year reduction in educational attainment is about equal in impact to the reduction in the

odds of good memory between black and white races. Comparing results from the limited with those for the full specification (col. 3), results for drinking and driving episodes and alcohol dependence/abuse are robust to changes in specification.

Drinking and driving has no statistical effect on numeracy in either the limited (col. 4) or full specifications (col. 6). Persons with higher CAGE scores are less likely to perform well on the numeracy test in the limited specification (OR=0.90; 95% CI: 0.83–0.97), but there is no statistical difference once the other covariates are added.

Other results are plausible. In particular, numeracy rises appreciably with increased educational attainment (OR=1.35; 95% CI: 1.27–1.42, col. 5). There are no statistical differences in the TICS scores by drinking and driving status (cols. 7, 9). In the limited specification (col. 7), persons with higher CAGE scores have higher abbreviated TICS scores (OR=0.92; 95% CI: 0.85–0.99), but in the full specification, statistical significance is lacking. Persons with higher educational attainment perform better (OR=1.23; 95% CI: 1.17–1.30, col. 8). Each additional year of age increases the odds of having higher abbreviated TICS score by almost 0.01 (OR=1.009; 95% CI=1.001–1.017).

B. Ignorance of Laws

In the limited specification, drivers with 5+ previous episodes of drinking and driving have better knowledge of the five laws than do non-drinker drivers (Table 3, col. 1, OR=0.67; 95% CI: 0.49–0.91).[20] There are no statistical differences for the 1–4 episode group or for alcohol dependence/abuse.

Other results lend support to our use of the questions to measure knowledge. In the intermediate specification, more highly educated persons are less likely to lack knowledge as are older persons, and persons with higher values on the abbreviated TICS. Blacks are more likely to be ignorant of the law, cet. par. Odds ratios on these covariates are robust to addition of covariates in the full specification. In the full specification (col. 4), 5+ drinker drivers remain less likely to be ignorant of DWI laws. The odds ratio is almost the same as in the limited specification.

We add a fourth specification to gauge the relationship between cognition and ignorance of the law. In this specification (col. 2), persons with higher numeracy and higher scores on the abbreviated TICS are less likely to lack knowledge.

C. Lack of Self-Control

Persons reporting 5+ episodes of drinking and driving have much lower odds of engaging in drink planning than do those who did not drink and drive in the limited specification (OR=0.44; 95% CI: 0.32–0.61, Table 4, col. 1). The difference between the 1–4 episode group and the omitted reference group (0 episodes) is almost as large (OR= 0.55; 95% CI: 0.44–0.68). In the full specification (col. 3), the odds ratios for 5+ and 1–4 episode drinker drivers are similar but closer to one than in the limited specification. As with the limited specification, the 5+ episode group engaged in less drink planning on average than did the

[20]The dependent variable refers to lack of knowledge of laws.

1–4 group. Persons with higher CAGE scores engage in less drink planning in both the limited and full specifications (limited: OR=0.69: 95% CI: 0.63–0.74 and full: OR: 0.70; 95% CI: 0.64–0.76).

Drinker drivers are less likely to engage in financial planning, although the differences between drinker drivers and non-drinker drivers are much less than for drink planning. The 5+ episode drinker driver group also is less likely to engage in financial planning in the limited specification (OR=0.73; 95% CI: 0.55–0.98, col. 4). The difference in financial planning between 1–4 episode drinker drivers and non-drinker drivers is slightly lower (OR= 0.80; 95% CI: 0.66–0.98). Persons with high CAGE scores are also less likely to engage in financial planning in the limited specification (OR=0.90; 95% CI: 0.83–0.97). This odds ratio implies a difference in the odds of financial planning of about 40 percent comparing a person with four affirmative answers to the CAGE questions with a person with no affirmative answers to these questions.

More highly educated, married (col. 5 only), and more affluent persons are more likely to engage in financial planning. Older persons were less likely to do so.

Measured in terms of financial planning horizons, in the limited specification, 5+ episode drinker drivers have shorter planning horizons on average (OR=0.73; 95% CI: 0.55–0.99, col. 7) as do persons with higher CAGE scores (OR=0.84; 95% CI: 0.78–0.91). The significant result for 5+ drinker drivers disappears in the full specification, but the odds ratio for CAGE remains statistically significant and slightly higher in magnitude, implying a lesser differential between planning horizons on the basis of alcohol dependence/abuse.

As with financial planning, but not drink planning, more highly educated persons tend to have longer financial planning horizons. Married, older, and more affluent persons have longer financial planning horizons on average. Blacks tend to have shorter financial planning horizons. By contrast, we find no difference in financial planning by black versus white race and blacks tend to engage in more drink planning than whites. Results for age also differ between the financial planning and the financial planning horizon analysis. Older persons would plausibly have a short financial planning horizon, but the difference could reflect different goals of such planning, e.g., planning for financing college for younger and financing retirement for older persons.

Persons who admitted drinking and driving 5+ times during the past year answered affirmatively to 3.20 more impulsivity questions on average than did persons who said that they had no such episodes (Table 5, col. 1). In the full specification, the difference is about half as large (1.68, col. 4). The difference between 1–4 episode drinker drivers and non-drinker drivers is 1.46 (col. 1). This difference also is about half as large in the full specification (col. 4). Persons reporting alcohol dependence/abuse are more impulsive on average. In the full specification, each affirmative response to a CAGE question raises the impulsivity score by 0.86 on average. In the full specification, smokers, and marijuana and hard drug users tend to be more impulsive. More highly educated persons and those with better self-reported memory tend to be less impulsive.

D. Time Preference

Persons who reported drinking and driving 5+ times in the past year were 55 percent more likely to be impatient than were those who reported no drinking and driving during this time period (Table 6, col. 1, OR=1.55; 95% CI: 1.31–1.84). Those who reported 1–4 episodes are 24 percent more likely to be likely to be impatient (OR=1.24; 95% CI: 1.10–1.40). Each additional affirmative answer to the CAGE questions increases the probability of being impatient by nine percent (OR= 1.086; 95% CI: 1.039–1.14). In the full specification (col. 3), the odds ratios for the drinking and driving variables fall to 1.31 and 1.15, respectively, but remain statistically significant at conventional levels. However, the CAGE variable is no longer statistically significant.

In the full specification, smokers, marijuana users, blacks, older persons, and persons with higher cognitive ability (modified TICS) were more likely to be impatient. Persons with higher numeracy and those with higher income are less likely to be impatient. With the exception of the cognitive ability variable, inclusion of the drinking and driving and CAGE variables do not affect direction of effect and statistical significance. The abbreviated TICS variables lose statistical significance in the specification without the alcohol-related covariates.

Finally, judging from the odds ratios on the factors for impulsivity, more impulsive individuals are clearly more impatient. However, the odds ratios do not differ among the factors.

The difference in short- and long-term discount rates is statistically significant for drinker drivers in the full specification (Table 7, col. 3), which implies that such persons are hyperbolic discounters. More specifically, short-term discount rates are 0.124 higher than long-run rates for 5+ episode drinker drivers than for persons who did not engage in drinking and driving. Comparing persons who said that they had 1 to 4 drinking and driving episodes in the past year, the short- versus long-term discount differential is 0.083 higher for 1–4 than for non-drinker drivers. The parameter estimate on our measure for alcohol dependence/abuse is not statistically significant at conventional levels in any of the specifications reported in Table 7. In a specification that does not control for other covariates (col. 1), the parameter estimates are smaller, 0.090 and 0.064, respectively, implying smaller differences, and statistical significance is only better than the at the 0.10 level.

VI. Sensitivity Analysis

Alternative Drinker-Driver Categories

The majority of persons (56.9%) reported no drinking and driving episodes during the past year. 31.3 percent of persons fell in the 1–4 drinking and driving episode category with the remaining 11.7 percent of persons reporting 5+ drinking and driving episodes in the past year. In sensitivity analysis, we split the 1–4 episode group into two categories, 1–2 and 3–4. While there are statistical differences in observed characteristics between the 0 and 1–2 episode drinker driver category (Appendix A), there are few statistical differences between attributes of 1–2 and 3–4 episode drinker drivers. The values presented are the values for the

lower drinking and driving category in the pairwise comparison. Furthermore, there are few statistical differences between attributes of 3–4 and 5+ episode drinker drivers. There are more statistically significant differences between the 5+ and 1–4 episode drinker driver than between the 3–4 and 5+ groups. In part, this reflects greater statistical power to detect differences. We conclude that there is no advantage into splitting the 1–4 group into two groups.

Tests of Consistent Odds Ratio Property

Ordered logit analysis requires an assumption that the odds ratios on covariates are constant, i.e., do not vary according to the value of the dependent variable. To test this assumption, we group the dependent variables into alternative 0–1 categories and use logit to estimate coefficients and odds ratios/confidence intervals (Appendix B). This consistent odds ratio property holds for cognition variables--self-evaluated memory, numeracy, abbreviated TICS with one exception. While higher CAGE significantly decreases the abbreviated TICS in Table 2, col. 7, none of the corresponding results for CAGE are statistically significant in sensitivity analysis.

Persons who reported 5+ drinking and driving episodes are substantially more knowledgeable about DWI laws in ordered logit analysis (Table 3). We obtain consistent results on this covariate when the dependent variable is 1 for 1 to 5 correct answers and 0 for no correct answers. We do not find such differences with other breakdowns on the dependent variable (combining responses ranging from 0 to 5 into one category). With ordered logit, persons reporting 1–4 drinking and driving episodes are not more knowledgeable of the law than persons with no such episodes. In the sensitivity analysis, in one specification, persons with 1–4 episodes are more knowledgeable of the laws than non-drinker drivers. The results for drink planning in the sensitivity analysis are consistent with those from ordered logit.

In general, in the financing planning analysis, the drinking and driving episode and CAGE covariates lose statistical significance in the limited specifications when the dependent variables are converted into a binary variable. Results for the full specification are consistent with the ordered logit results. In the limited specification, when the horizon is converted to a binary variable, statistical significance is lost.

In sum, in most cases, the consistent odds ratio property of ordered logit analysis holds.

City and Source of Referral Fixed Effects

The results presented in the text exclude city fixed effects. When city fixed effects are included, the results are virtually the same as those presented. Respondents were recruited by SAD from various sources as explained above. Results from specifications including fixed effects for source of referral are also virtually the same as results we present.

VII. Discussion

Our study yields these key findings. Adult drinker drivers do not differ from other adult drinkers on two of the three measures of cognitive ability, the exception being self-reported

memory. If anything, drinker drivers understand the fundamentals of DWI law better than others.

On average, drinker drivers are poorer planners in both drinking and financial domains, and they exhibit greater impulsivity. However, the SAD did not capture how greater impulsively specifically translates into greater responsiveness to situations or cues.

Drinker drivers, especially those who reported drinking and driving at least five times in the year before the first interview, have a higher rate of time preference on average. Furthermore, our research provides empirical support for the notion that drinker drivers, especially those reporting 5+ such episodes in the past year, exhibit time-inconsistent preferences. Results for alcohol dependence/abuse do not reveal that dependence/abuse per se is associated with time inconsistent preferences. Differences between short- and long-term rates for drinker drivers, especially those in the 5+ episode/year category are sizeable.

In the full specification results reported above, we control for educational attainment and income. Mean educational attainment is lower for persons in both drinker driver groups, especially persons reporting 5+ such episodes in the past year. Excluding these covariates, the odds ratios on the binary variable for 5+ drinking and driving episodes rise to above 1 in the analysis of numeracy and abbreviated TICS and are statistically significant at conventional levels. This evidence supports the conclusion that, especially in combination with our results for knowledge of the law, persons who frequently drink and drive do not typically engage in this behavior because of cognitive limitations. On the contrary, these persons know what they are doing and understand the legal consequences of their behavior. In contrast to our study results, past literature on CAGE has reported that addiction to alcohol is associated with cognitive deficits (Sullivan et al., 2000).

In a study conducted over two decades ago, Kenkel (1991) found that lack of knowledge was a factor in heavy and binge drinking and other unhealthy behaviors, but he concluded that much unexplained variation remained in drinking and other unhealthy behaviors remained after accounting for health knowledge and educational attainment, finding supported more recently by Cutler and Lleras-Muney (2010). Our study contains a more direct measure of knowledge about the legal consequences of drinking and driving, and we find, if anything, that frequent DWI violators are more knowledgeable about the law. Lack of knowledge may be more of an issue for first time drinkers and drivers. Our results may not generalize to other contexts and health behaviors, e.g., food consumption and obesity (see e.g., Kan and Tsai, 2004).[21]

Much of the economic empirical literature on time-inconsistent preferences relies on qualitative evidence, such as the consistency of contract terms with an underlying assumption that people are time inconsistent (DellaVigna and Malmendier, 2004; Heidhues and Köszegi, 2010). Our survey seeks to avoid the context of alcohol use and drinking and driving by posing a choice about whether or not to have an endoscopy. We infer time preferences of persons based on their prior drinking and driving behaviors. It is possible that

[21]There is some evidence that people have different discount rates for different goods (Giordano et al., 2002; McClure et al., 2007; Thaler, 1981; Thaler and Shefrin, 1981).

responses would have differed if sample persons had been confronted with a choice about drinking and driving.

Adult outcomes reflect non-cognitive as well as cognitive abilities (Heckman, 2008; Heckman et al., 2006). Among the former are the ability to plan for the future and to exercise self-control.[22] In these aspects of non-cognitive abilities, as well as having higher exponential rates of time preference, drinker drivers clearly do not perform as well as others. Our regressions are descriptive in that we find that DWI is associated with these behaviors rather than establishing causation. It seems highly implausible that drinking and driving per se causes higher discount rates, shorter financial planning horizons, or less time devoted to planning more generally. Rather it is likely that the persons with these attributes are more likely to drink and drive. An implication is that programs to treat persons convicted of drinking and driving should stress broader personality factors rather than limit the focus to alcohol use and abuse, as at least some do.[23]

Our results have important implications for the design of programs to reduce DWI. First, our findings provide no empirical support for educational interventions. Admonitions not to drink and drive may be effective in convincing occasional drinker drivers to avoid situations that may lead to drinking and driving, but when asked in a non-emotional context about the consequences of drinking and driving, respondents to our survey were knowledgeable overall.

Other findings lead to a more complex set of implications. The lack of self-control and forward-looking thinking among drinker drivers provides a positive case for various forms of incapacitation. Incarceration is highly costly, and current statutes do not provide for long periods of incarceration, except for repeat offenders. Use of ignition interlock and SCRAM devices may be appropriate. However, the empirical literature provides mixed support for these strategies (Barnett et al., 2011; McCartt et al., 2013; Voas et al., 2013). Their effectiveness is limited by partial coverage and short duration of coverage. Persons are incapacitated for a time, often for months, but rarely for more than a few years.

The high discount rates and time-inconsistency of drinker drivers imply that swiftness of punishment is important. One form is for DWI arrestees to spend the night in jail immediately following the arrest. Others are to assess high amounts of bail and to impose high excise tax rates on alcoholic beverages.

The main implication for treatment is that there appear to be innate preference differences between drinker drivers and other adults. Viewing DWI as simply a manifestation of alcohol dependence is an oversimplification. Whether the differences in preferences stem from genetic or environmental factors, including those early in the life course, being less likely to plan and exhibit impulsiveness is clearly associated with being a drinker driver. That the difference between the short- and long-term discount rates is high for frequent drinker drivers and absent for persons who exhibit alcohol dependence/abuse and who do not drink and drive *suggests* that causality runs from the personality attributes to drinking and driving

[22]Nagin and Pogarsky (2004) found that violent crime reflected visceral factors/poor impulse control as well as present-biasedness,
[23]See e.g. the literature review by Larimer and Cronce (2007).

rather than the reverse. It seems implausible that drinking and driving per se would *cause* a person to be impulsive and impatient in other domains. There has been some experimentation with the use of voucher-based incentives to encourage abstinence and attendance in treatment (Higgins et al., 2002). Our results suggest that incentives be offered immediately rather than be deferred.

Overall, our results provide empirical support for incapacitation programs designed along the lines of South Dakota's 24/7 Sobriety Program. This program allows persons convicted of a DWI offense to remain in the community in lieu of incarceration if they totally abstain from alcohol and drugs. Monitoring includes twice a day breath testing, use of ankle bracelet testing, drug patch testing, and urine testing (Loudenburg et al., 2012).

Our study has several important strengths. The SAD measured many personal characteristics of individuals pertinent to the choice of drinking and driving, to the extent feasible using measures and scales that have been employed in past surveys. The SAD oversampled drinkers and drivers, given the analysis sufficient statistical power to detect differences. The survey was conducted in several geographically dispersed areas throughout the U.S. rather than in a single locality. We employ a rigorous empirical test of hyperbolic discounting. Rather than simply relate state laws to alcohol-related outcomes such as rates of motor vehicle fatalities and binge drinking, this study probes the "black box" of decision making about drinking and driving.

We also acknowledge some weaknesses. It is difficult to measure cognitive ability accurately in a multipurpose survey, although we do find that our cognitive measures have plausible relationships with variables we would expect them to have. Even though we have stressed the potential importance of emotions, cues, and context in the drinking and driving decision, the survey did not observe persons in actual situations in which they would be likely to decide to drink and drive. Rather responses were obtained over the telephone and by computer when respondents were presumably in "cold" states. Furthermore, the SAD did not document the precise sequence of events leading to particular drinking and driving episodes. For example, if the person drives to a bar with a car full of strangers, key steps leading to DWI are made even before the first drink is consumed. If a person goes to a party, and impulsively consumes "one too many," particular strategies for DWI control may be appropriate, such as social host liability (Stout et al., 2000) in which the host is made responsible for curbing the impulsivity of the guests. The SAD measured cognitive ability when the person was presumably not under the influence of alcohol. But cognition at the point at which the individual is deciding whether or not to drive home after drinking is presumably compromised by intoxication.

Finally, the SAD obtained sensitive information, such as the number of times the person drank and drove and arrests for DWI from self-reports. Not only is admitting to drinking and driving and prior arrests for DWI potentially embarrassing, but recalling events over the period of a year or even more so over a three-year period may have been cognitively demanding. Given these issues, it is interesting that respondents admitted to as many mishaps as they did.

Future research should focus on additional personality attributes that may explain drinking and driving behavior, such as hostility, lack of respect for the law, and sensation-seeking (MacDonald and Mann, 1996). Unfortunately, while economic theory provides a path to studying the link between time preference and behaviors, it provides little guidance about which of these other attributes to select for analysis. While our study has shown that impulsive persons are more likely to drink and drive, we are missing the situations that elicit such behavior among impulsive persons. Studies that follow the path from impulsivity as a personal characteristic to the choice to drink and drive (or not) are likely to be fruitful.

The notion that pure rationality does not apply universally has become more widely accepted by economists. This has led to investigations relatively well linked to economic concepts such as time inconsistency. Rather than group all other personal attributes into "omitted heterogeneity," to gain an understanding of why people engage in personally destructive behaviors such as driving while intoxicated, economists will need to focus on influences that fall under the omitted heterogeneity heading.

Although by several indicators, persons who drink and drive tend to appear to take a shorter-run perspective in decision-making than others do, they do not generally differ in cognitive ability, and if anything, have a better understanding of the legal consequences of a DWI.

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Appendix A

Alternative Drinker-Driver Categories

Variables	Variable Means: Three Drinker-Driver (DD) Categories		
	Zero DD	1–2x DD	3–4x
Edu. Attainment (yrs.) (0–18)	15.770**	15.264	15.304*
Married (0–1)	0.536**	0.414	0.348
Female (0–1)	0.577	0.526*	0.411
Black (0–1)	0.114	0.135	0.101
Other race (0–1)	0.055*	0.024	0.025
Age (18–100)	44.166**	41.285	40.437
Household Income (0–3.5; '00000s)	0.814	0.752	0.69
# of children <18 (0–10)	0.722	0.823*	0.576
CAGE (0–4)	0.937**	1.387*	1.696*
Impulsivity (12–60)	28.135**	30.301	30.278*
N	1225	491	342

** p<0.01,

* p<0.05

Example: The first column shows the means of the never DD group, and the stars represent significant differences in mean with

Appendix B

Tests of Consistent Odds Ratio Property

Variable	Self Eval. Memory 1–3 = 0; 4–5 =1		Self Eval. Memory 1–2=0; 3–5=1	
DD5+x	0.689* (0.495 – 0.961)	0.748 (0.523 – 1.070)	0.502** (0.327 – 0.772)	0.515** (0.321 – 0.827)
DD1−4x	0.731** (0.582 – 0.918)	0.749* (0.590 – 0.951)	0.683* (0.488 – 0.956)	0.693* (0.486 – 0.987)
CAGE	0.845** (0.776 – 0.919)	0.875** (0.799 – 0.957)	0.742** (0.659 – 0.835)	0.808** (0.712 – 0.916)
	Numeracy 0–2=0; 3=1		**Numeracy 0–1=0; 2–3=1**	
DD5+x	0.906 (0.649 – 1.265)	1.063 (0.728 – 1.550)	0.885 (0.542 – 1.446)	0.97 (0.552 – 1.704)
DD1−4x	0.891 (0.709 – 1.120)	0.972 (0.756 – 1.250)	0.787 (0.561 – 1.102)	0.806 (0.555 – 1.172)
CAGE	0.901* (0.828 – 0.981)	0.961 (0.874 – 1.056)	0.883* (0.780 – 0.999)	1.001 (0.871 – 1.151)

	Abbreviated TICS 0–12= 0; 13=1		**Abbreviated TICS 0–11=0; 12–13=1**		**Abbreviated TICS 0–10=0; 11=13=1**	
DD5+x	0.766 (0.548 – 1.073)	0.97 (0.667 – 1.411)	0.941 (0.653 – 1.358)	1.198 (0.796 – 1.804)	0.742 (0.469 – 1.174)	0.844 (0.502 – 1.417)
DD1−4x	0.879 (0.701 – 1.103)	0.963 (0.754 – 1.229)	0.831 (0.648 – 1.066)	0.913 (0.697 – 1.196)	0.885 (0.633 – 1.238)	0.933 (0.649 – 1.343)
CAGE	0.928 (0.852 – 1.010)	1.001 (0.912 – 1.098)	0.921 (0.840 – 1.010)	1.011 (0.913 – 1.119)	0.936 (0.829 – 1.058)	1.085 (0.948 – 1.241)
	Ignorance of Law 0–4=0; 5=1		**Ignorance of Law 0–1= 0; 2–5=1**		**Ignorance of Law 0=0; 1–5=1**	
DD5+x	1.12 (0.733 – 1.713)	0.812 (0.510 – 1.292)	0.862 (0.613 – 1.213)	0.787 (0.543 – 1.141)	0.489** (0.348 – 0.687)	0.514** (0.355 – 0.744)
DD1−4x	0.847 (0.621 – 1.156)	0.703* (0.506 – 0.976)	1.008 (0.801 – 1.269)	0.953 (0.748 – 1.214)	0.841 (0.657 – 1.076)	0.841 (0.649 – 1.089)
CAGE	1.036 (0.926 – 1.158)	0.944 (0.838 – 1.064)	0.969 (0.889 – 1.056)	0.912 (0.832 – 1.000)	0.958 (0.875 – 1.049)	0.934 (0.848 – 1.030)
	Drink Planner 1–2=0; 3–4=1		**Drink Planner 1–3=0; 4=1**			
DD5+x	0.369** (0.231 – 0.591)	0.455** (0.276 – 0.750)	0.123** (0.030 – 0.508)	0.140** (0.033 – 0.594)		
DD1−4x	0.497** (0.379 – 0.650)	0.547** (0.413 – 0.726)	0.438** (0.275 – 0.695)	0.456** (0.281 – 0.740)		
CAGE	0.536** (0.477 – 0.603)	0.543** (0.481 – 0.614)	0.452** (0.358 – 0.569)	0.431** (0.338 – 0.549)		
	Financial Planner 1–5=0; 6–7=1		**Financial Planner 1–4=0; 5–7=1**			
DD5+x	0.775 (0.555 – 1.083)	0.927 (0.646 – 1.332)	0.718 (0.509 – 1.014)	1.028 (0.704 – 1.502)		
DD1−4x	0.801 (0.638 – 1.005)	0.86 (0.678 – 1.090)	0.825 (0.648 – 1.051)	0.958 (0.741 – 1.239)		
CAGE	0.938 (0.862 – 1.021)	0.993 (0.908 – 1.087)	0.911* (0.833 – 0.996)	1.012 (0.920 – 1.115)		
	Financial Planning Horizon 0.5–7.5=0; 20=1		**Financial Planning Horizon 0.5–1=0; 2.5–20=1**			
DD5+x	0.822 (0.518 – 1.306)	1.019 (0.618 – 1.681)	0.806 (0.577 – 1.126)	1.142 (0.786 – 1.657)		
DD1−4x	0.951 (0.707 – 1.280)	1.046 (0.765 – 1.430)	0.891 (0.706 – 1.124)	1.061 (0.826 – 1.362)		
CAGE	0.870* (0.775 – 0.976)	0.908 (0.803 – 1.027)	0.859** (0.788 – 0.936)	0.944 (0.859 – 1.036)		

Appendix C

Impulsivity Factor Analysis, factor loadings and unique variances

	Factor1: General	Factor2: Future Oriented	Factor3: Steady	Factor4: Planner	Factor5
I do things I later regret	0.6700	−0.2324	0.003	−0.0792	−0.0517
I act on impulse	0.6711	−0.3930	0.0791	−0.0537	−0.0028
I do not finish what I start	0.4895	0.3432	0.1746	0.0426	0.0190
Do things on spur of moment	0.4179	−0.3210	0.1427	−0.0804	0.0907
I do not plan for the future	0.4714	0.2296	0.1629	0.1962	0.0171
I am not a worrier	−0.1536	−0.0961	0.2225	0.0952	0.1246
I do not consider consequences	0.5361	−0.0869	−0.0074	0.2245	−0.0385
I do not control my angry feelings	0.4458	0.1248	−0.4754	0.0666	0.0293
I ignore little jobs	0.4909	0.2870	0.1400	−0.1769	−0.0028
I fly off the handle	0.4788	0.0908	−0.4340	−0.0645	0.0641
I never get organized	0.4638	0.3239	0.2120	−0.0851	−0.0136
I often make hasty decisions	0.3513	−0.2305	0.0394	0.0886	−0.0429

Highlights

- We use data from a three-wave survey in eight US cities, conducted for this study.
- Drinker drivers do not differ for most measures of cognitive ability.
- Drinker drivers are more knowledgeable about the fundamentals of DWI law.
- Drinker drivers have shorter planning horizons and are more impulsive.
- We find evidence of hyperbolic discounting on the part of drinker-drivers.

Table 1

Descriptive Statistics

Variables	N	Mean	Std. dev.
Dependent Variables			
Cognition			
Self-evaluated memory (1–5)	1567	3.570	0.951
Numeracy (0–3)	1567	2.433	0.796
Modified TICS (0–13)	1567	11.927	1.356
Ignorance of the law (0–5)	1567	1.664	1.728
Planning			
Drink planner (1–4)	1567	2.212	0.855
Financial planner (1–7)	1567	4.894	1.782
Financial plan horizon (0.5–20)	1567	6.014	6.957
Impulsivity (12–60)	1558	29.340	6.375
Present preferred over future	6247	0.456	0.498
Difference in discount rates	4356	0.015	0.548
Explanatory Variables			
Drinking and driving episodes (DD)			
DD 5+x (0–1)	1567	0.117	0.322
DD 1−4x (0–1)	1567	0.313	0.464
DD 0 (0–1)	1567	0.569	0.495
Addiction			
CAGE (0–4)	1567	1.232	1.239
Smoker (0–1)	1567	0.190	0.393
Marijuana>100 (0–1)	1567	0.244	0.430
Hard drug user (0–1)	1567	0.156	0.363
Demographic characteristics			
Edu. attainment (yrs.) (0–18)	1567	15.497	1.987
Married (0–1)	1567	0.461	0.499
Female (0–1)	1567	0.525	0.500
Black (0–1)	1567	0.117	0.322
Other race (0–1)	1567	0.040	0.197
Age (18+)	1567	42.633	12.549
Household income (0–3.5; '00000s)	1567	0.768	0.637
# of children<18 (0–10)	1567	0.705	1.053

Possible range in parentheses

N = number of observations used in analysis

Table 2

Cognitive Limitations (Ordered Logit)

Variables	Self-evaluated memory			Numeracy			Modified TICS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DD 5+x	0.641** (0.472 – 0.872)	-	0.677* (0.489 – 0.939)	0.901 (0.654 – 1.241)	-	1.037 (0.725 – 1.482)	0.820 (0.609 – 1.105)	-	1.043 (0.755 – 1.441)
DD 1−4x	0.701** (0.571 – 0.860)	-	0.711** (0.575 – 0.878)	0.868 (0.696 – 1.083)	-	0.929 (0.732 – 1.179)	0.861 (0.700 – 1.058)	-	0.941 (0.758 – 1.168)
CAGE	0.818** (0.757 – 0.884)	-	0.844** (0.778 – 0.915)	0.897** (0.826 – 0.973)	-	0.966 (0.883 – 1.055)	0.921* (0.853 – 0.995)	-	1.000 (0.922 – 1.086)
Smoker		-	1.076 (0.823 – 1.406)		-	0.855 (0.646 – 1.132)		-	0.623** (0.479 – 0.809)
Marijuana>100x		-	0.908 (0.714 – 1.154)		-	1.186 (0.906 – 1.551)		-	1.017 (0.798 – 1.296)
Hard drug user		-	0.833 (0.624 – 1.113)		-	0.788 (0.580 – 1.070)		-	0.971 (0.731 – 1.291)
Edu. attainment (yrs.)		1.178** (1.121 – 1.238)	1.155** (1.096 – 1.218)		1.345** (1.271 – 1.423)	1.330** (1.254 – 1.411)		1.232** (1.171 – 1.297)	1.198** (1.136 – 1.264)
Married		1.125 (0.900 – 1.406)	0.994 (0.791 – 1.248)		1.235 (0.964 – 1.582)	1.192 (0.925 – 1.536)		1.107 (0.878 – 1.394)	1.046 (0.827 – 1.324)
Female		0.925 (0.768 – 1.114)	0.801* (0.660 – 0.971)		0.606** (0.491 – 0.747)	0.605** (0.486 – 0.753)		0.749** (0.619 – 0.906)	0.756** (0.621 – 0.921)
Black		0.656** (0.489 – 0.881)	0.647** (0.481 – 0.870)		0.261** (0.191 – 0.355)	0.262** (0.192 – 0.358)		0.547** (0.407 – 0.736)	0.563** (0.418 – 0.759)
Other race		1.036 (0.634 – 1.693)	0.966 (0.587 – 1.590)		0.578* (0.351 – 0.950)	0.587* (0.355 – 0.970)		0.589* (0.375 – 0.925)	0.570* (0.362 – 0.898)
Age		0.986** (0.979 – 0.994)	0.983** (0.975 – 0.991)		0.999 (0.990 – 1.007)	0.998 (0.989 – 1.006)		1.009* (1.001 – 1.017)	1.009* (1.001 – 1.017)
Household income		1.246** (1.059 – 1.466)	1.219* (1.035 – 1.437)		1.120 (0.921 – 1.362)	1.117 (0.917 – 1.359)		1.496** (1.241 – 1.804)	1.467** (1.216 – 1.769)
# of children<18		0.950 (0.863 – 1.047)	0.956 (0.868 – 1.053)		0.973 (0.875 – 1.083)	0.975 (0.876 – 1.085)		1.048 (0.949 – 1.157)	1.055 (0.955 – 1.165)
N	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567

Variables	Self-evaluated memory			Numeracy			Modified TICS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pseudo R-squared	0.013	0.021	0.032	0.003	0.085	0.088	0.002	0.045	0.048

Confidence interval in parentheses;

** p<0.01,

* p<0.05

Table 3

Ignorance of the Law (Ordered Logit)

Variables	(1)	(2)	(3)	(4)
DD 5+x	0.669* (0.490 – 0.914)	-	-	0.637** (0.456 – 0.888)
DD 1−4x	0.914 (0.748 – 1.117)	-	-	0.869 (0.706 – 1.068)
CAGE	0.977 (0.906 – 1.054)	-	-	0.934 (0.862 – 1.012)
Smoker		-	-	0.961 (0.737 – 1.253)
Marijuana>100x		-	-	0.956 (0.752 – 1.215)
Hard drug user		-	-	1.225 (0.921 – 1.629)
Edu. attainment (yrs.)		-	0.934** (0.887 – 0.983)	0.924** (0.876 – 0.975)
Married		-	1.163 (0.936 – 1.445)	1.118 (0.896 – 1.394)
Female		-	0.966 (0.803 – 1.161)	0.900 (0.745 – 1.089)
Black		-	1.646** (1.234 – 2.195)	1.640** (1.227 – 2.192)
Other race		-	1.387 (0.879 – 2.189)	1.267 (0.800 – 2.007)
Age		-	1.009* (1.001 – 1.016)	1.008 (1.000 – 1.016)
Household income		-	0.971 (0.824 – 1.145)	0.960 (0.813 – 1.132)
# of children<18		-	1.088 (0.992 – 1.192)	1.089 (0.993 – 1.194)
Self-evaluated memory		0.924 (0.839 – 1.017)	0.955 (0.866 – 1.054)	0.931 (0.843 – 1.028)
Numeracy		0.817** (0.722 – 0.925)	0.881 (0.772 – 1.005)	0.879 (0.770 – 1.003)
Modified TICS		0.919* (0.854 – 0.988)	0.926* (0.859 – 0.998)	0.927* (0.860 – 0.999)
N	1,567	1,567	1,567	1,567
Pseudo R-squared	0.002	0.007	0.013	0.016

Confidence interval in parentheses;

** p<0.01,

* p<0.05

Table 4

Planning (Ordered Logit)

Variables	Drink planner			Financial planner			Financial planning horizon		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DD5+x	0.444** (0.325 – 0.607)	-	0.515** (0.369 – 0.718)	0.734* (0.547 – 0.984)	-	0.974 (0.712 – 1.333)	0.734* (0.546 – 0.989)	-	1.007 (0.733 – 1.384)
DD1−4x	0.549** (0.442 – 0.681)	-	0.581** (0.466 – 0.726)	0.803* (0.659 – 0.980)	-	0.891 (0.726 – 1.094)	0.904 (0.741 – 1.104)	-	1.064 (0.864 – 1.310)
CAGE	0.688** (0.634 – 0.745)	-	0.701** (0.644 – 0.763)	0.896** (0.831 – 0.966)	-	0.962 (0.890 – 1.040)	0.840** (0.779 – 0.906)	-	0.907* (0.838 – 0.981)
Smoker		-	0.790 (0.602 – 1.037)		-	0.831 (0.643 – 1.074)		-	0.830 (0.638 – 1.080)
Marijuana>100x		-	0.912 (0.712 – 1.167)		-	0.736* (0.582 – 0.932)		-	0.875 (0.690 – 1.109)
Hard drug user		-	0.859 (0.641 – 1.152)		-	0.805 (0.610 – 1.062)		-	0.764 (0.577 – 1.013)
Edu. attainment (yrs.)		0.989 (0.940 – 1.041)	0.928** (0.879 – 0.980)		1.149** (1.095 – 1.206)	1.115** (1.059 – 1.173)		1.092** (1.041 – 1.146)	1.064* (1.011 – 1.118)
Married		1.598** (1.274 – 2.006)	1.273* (1.008 – 1.608)		1.293* (1.044 – 1.601)	1.158 (0.930 – 1.442)		1.461** (1.178 – 1.811)	1.340** (1.075 – 1.670)
Female		2.019** (1.662 – 2.453)	1.617** (1.322 – 1.977)		0.975 (0.815 – 1.167)	0.903 (0.750 – 1.088)		0.938 (0.782 – 1.124)	0.876 (0.726 – 1.056)
Black		1.387* (1.017 – 1.890)	1.479* (1.083 – 2.022)		1.017 (0.769 – 1.346)	1.002 (0.756 – 1.327)		0.665** (0.497 – 0.890)	0.668** (0.499 – 0.896)
Other race		1.722* (1.069 – 2.773)	1.530 (0.946 – 2.475)		0.976 (0.619 – 1.539)	0.966 (0.609 – 1.532)		0.993 (0.641 – 1.538)	1.004 (0.646 – 1.561)
Age		0.996 (0.988 – 1.004)	0.992 (0.984 – 1.000)		0.992* (0.984 – 0.999)	0.990* (0.983 – 0.998)		1.016** (1.009 – 1.024)	1.015** (1.007 – 1.023)
Household income		1.072 (0.910 – 1.261)	1.000 (0.847 – 1.180)		1.462** (1.245 – 1.717)	1.426** (1.213 – 1.677)		1.654** (1.409 – 1.942)	1.621** (1.379 – 1.905)
# of children<18		0.877** (0.796 – 0.966)	0.896* (0.812 – 0.988)		0.926 (0.846 – 1.013)	0.932 (0.851 – 1.020)		1.006 (0.918 – 1.103)	1.008 (0.918 – 1.106)
N	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567

Variables	Drink planner			Financial planner			Financial planning horizon		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Pseudo R-squared	0.0457	0.0193	0.0593	0.00383	0.0178	0.022	0.00663	0.0386	0.0427

Confidence interval in parentheses;

** p<0.01,

* p<0.05

Table 5

Impulsivity (OLS)

Variables	(1)	(2)	(3)	(4)
DD 5+x	3.207** (0.505)	-	-	1.681** (0.510)
DD 1−4x	1.459** (0.346)	-	-	0.773* (0.338)
CAGE	1.273** (0.129)	-	-	0.855** (0.128)
Smoker		-	-	1.735** (0.420)
Marijuana>100x		-	-	0.981* (0.383)
Hard drug user		-	-	0.982* (0.452)
Edu. attainment (yrs.)		-	−0.551** (0.086)	−0.323** (0.086)
Married		-	−1.462** (0.369)	−0.635 (0.360)
Female		-	−0.875** (0.311)	−0.126 (0.308)
Black		-	−0.622 (0.502)	−0.536 (0.481)
Other race		-	−0.103 (0.771)	0.246 (0.742)
Age		-	0.002 (0.013)	0.016 (0.013)
Household income		-	0.240 (0.269)	0.420 (0.258)
# of children<18		-	0.158 (0.157)	0.135 (0.150)
Self-evaluated memory		−1.839** (0.166)	−1.683** (0.165)	−1.378** (0.160)
Numeracy		−0.364 (0.216)	−0.124 (0.224)	−0.099 (0.214)
Modified TICS		−0.270* (0.128)	−0.120 (0.128)	−0.083 (0.123)
N	1,558	1,558	1,558	1,558
R-squared	0.115	0.090	0.133	0.212

Confidence interval in parentheses;

** p<0.01,

* p<0.05

Table 6

Financial Tradeoffs (Logit)

Variables	(1)	(2)	(3)
DD5+x	1.552** (1.305 – 1.844)		1.313** (1.086 – 1.587)
DD1−4x	1.242** (1.103 – 1.399)		1.149* (1.013 – 1.303)
CAGE	1.086** (1.039 – 1.135)		0.994 (0.947 – 1.043)
Smoker			1.187* (1.015 – 1.387)
Marijuana>100x			1.162* (1.010 – 1.338)
Hard drug user			1.009 (0.854 – 1.192)
Edu. attainment (yrs.)		0.971 (0.941 – 1.002)	0.987 (0.955 – 1.019)
Married		0.897 (0.785 – 1.025)	0.949 (0.829 – 1.087)
Female		0.930 (0.832 – 1.040)	0.974 (0.868 – 1.092)
Black		1.960** (1.635 – 2.349)	1.986** (1.654 – 2.385)
Other race		1.098 (0.844 – 1.429)	1.161 (0.889 – 1.517)
Age		1.009** (1.005 – 1.014)	1.010** (1.005 – 1.015)
Household income		0.763** (0.690 – 0.845)	0.772** (0.697 – 0.856)
# of children<18		1.021 (0.965 – 1.081)	1.021 (0.965 – 1.081)
Self-evaluated memory		1.038 (0.977 – 1.103)	1.046 (0.984 – 1.113)
Numeracy		0.905* (0.835 – 0.980)	0.901* (0.831 – 0.976)
Modified TICS		1.044 (0.997 – 1.092)	1.048* (1.001 – 1.098)
Scores for factor 1		1.204** (1.123 – 1.290)	1.162** (1.082 – 1.248)
Scores for factor 2		1.205** (1.118 – 1.299)	1.193** (1.106 – 1.286)
Scores for factor 3		1.177** (1.091 – 1.271)	1.163** (1.077 – 1.256)
Scores for factor 4		1.235** (1.089 – 1.401)	1.211** (1.067 – 1.374)
N	6,247	6,215	6,215
R-squared	0.0698	0.0983	0.101

Robust standard errors in parentheses;

** p<0.01,

* p<0.05

Results for control questions not shown

Table 7

Difference in Difference Analysis of Hyperbolic Discounting (OLS)

Variables	(1)	(2)	(3)	(4)
DD5+x	0.090 (0.055)		0.124* (0.060)	
DD1−4x	0.064 (0.038)		0.083* (0.039)	
CAGE	0.009 (0.014)	0.018 (0.014)	0.013 (0.015)	0.019 (0.015)
Constant	−0.027 (0.026)	−0.006 (0.024)	−0.103 (0.220)	−0.030 (0.219)
Other Covariates[a]	No	No	Yes	Yes
N	1,089	1,089	1,086	1,086
R-squared	0.006	0.002	0.024	0.018

Robust standard errors in parentheses;

** p<0.01,

* p<0.05

[a] Included but not shown: smoker, marijuana>100x, hard drug user,