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Male, but not Female, Alcohol-Dependent African Americans Discount Delayed Gains More Steeply than Propensity-Score Matched Controls

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Abstract

Rationale—Alcohol dependence is known to be associated with steep discounting of delayed rewards, but its relation to the discounting of delayed losses and probabilistic rewards is unclear. Moreover, patterns of alcohol consumption vary considerably between communities, but previous research has not examined the relation between discounting and alcohol dependence in low-income African Americans.

Objectives—The goal of the present study was to determine whether low-income, alcohol-dependent African Americans differ from controls in the degree to which they discount delayed rewards, delayed losses, or probabilistic rewards.

Methods—African American participants, both cases and controls, were recruited from the same low-income neighborhoods, and propensity-score matching was used to further control for demographic differences. Participants performed three tasks that assessed their discounting of hypothetical monetary outcomes: delayed rewards, delayed losses, and probabilistic rewards.

Results—Alcohol-dependent cases discounted delayed gains, but not delayed losses or probabilistic gains, more steeply than their matched controls. The difference in discounting of delayed gains was localized to the male cases, whose discounting was steeper than either the male controls or the female cases; no gender difference was observed between male and female controls.

Conclusions—The present results extend findings regarding discounting by substance abusers to a previously unstudied group, low-income African Americans, and suggest that in this group at least, alcohol dependence, particularly in males, may be more a reflection of choosing immediate rewards than of ignoring their delayed negative consequences.

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Keywords

alcohol dependence; African Americans; discounting; delayed gains; delayed losses; probabilistic gains; gender; income

Many everyday decisions involve tradeoffs, and the tradeoffs a person makes can be understood in terms of discounting. For example, one often has to choose between getting less than one really wants but getting it immediately, and getting more but only after a delay. So, too, one may have to choose between getting less, but being certain of getting it, and the possibility of getting more, although one might get nothing. Such choices pit smaller or less desirable, but immediate and certain, rewards against larger or more desirable rewards that are delayed or uncertain. When people choose the smaller less desirable reward in such cases, they are said to have "discounted" the value of the delayed or probabilistic option. More specifically, *delay discounting* refers to the decrease in the subjective value of an outcome as the time until its occurrence increases, and *probability discounting* refers to the decrease in subjective value as the likelihood of an outcome decreases (Rachlin 2006; Rachlin et al.1991).

Much of the current interest in discounting is due to its possible role in various problem behaviors. That is, some behavioral problems may reflect a tendency to make certain kinds of tradeoffs. For example, it has been hypothesized that steep discounting reflects impulsivity and is at the heart of impulse control problems such as substance abuse (e.g., Bickel and Marsch 2001; for a review focusing on impulsivity and alcohol use disorders, see Lejuez et al. 2010). From this perspective, choosing a smaller, more immediate reward is an impulsive choice, whereas choosing the larger, delayed alternative reflects self-control. Probability discounting also has been interpreted as a measure of impulsivity (e.g., Yi et al. 2010) in that those who take a chance on getting a larger reward are viewed as being more impulsive, in the sense of being more risk-taking. The issue is complicated, however, by findings suggesting that for the most part, delay discounting correlates only weakly with either probability discounting (Myerson et al. 2003) or psychometric tests of impulsiveness (Kirby and Finch 2010), consistent with the view that impulsivity is multi-dimensional in nature (Green et al. 2013a; Lejuez et al. 2010).

Although one cannot usually compare the degree to which substance abusers and controls discount delayed drug rewards, it is well established that, on average, individuals with substance abuse problems tend to discount delayed monetary rewards more steeply than controls (Bickel et al. 2014b; MacKillop and Kahler 2009). Indeed, the fact that people with substance abuse problems steeply discount even nondrug rewards is consistent with the idea that substance abuse reflects a general pattern of choosing immediate rewards over larger, delayed rewards. Moreover, there is evidence that steep delay discounting rates are a predictor, rather than an outcome, of substance abuse (Audrian-McGovern et al. 2009) as well as a predictor of drug relapse following treatment (Washio et al. 2011; Yoon et al. 2007). With respect to alcohol abuse in particular, MacKillop and colleagues observed in their meta-analytic review that, with few exceptions, studies have found that groups of

individuals with alcohol-abuse problems show steeper discounting of delayed rewards than control groups (MacKillop et al. 2011).

It is well known that patterns of alcohol consumption vary considerably across cultures and also between different communities in the same country. For example, although European Americans begin drinking at a younger age and report higher levels of alcohol consumption across age groups, when African Americans consume alcohol, they have comparable or higher risk of alcohol-related problems than European Americans and may begin to experience alcohol problems at lower levels of consumption (for a review, see Zapolski et al. 2014). Moreover, African Americans differ substantially by gender when it comes to drinking patterns. Whereas African American men are more likely to start earlier, using alcohol or other drugs for a thrill or as a means of enhancing their status in social situations, African American women generally use alcohol or drugs as a way to cope with stress (Zapolski et al. 2014). In addition, African American women tend to develop alcohol-use problems as they get older, whereas men tend to develop them when they are younger (Caetano and Clark 1998).

There also appears to be an important interaction between gender and income, in that one particular group of African Americans, low-income African American men, is at the highest risk for alcoholism and related problems (Ford et al. 2007). To date, however, the only study to examine delay discounting in relation to alcohol-related problems in African Americans focused on a sample of college students (Dennhardt and Murphy 2011). Clearly, there is a need for research that examines discounting and alcohol abuse in African Americans, focusing on those with lower incomes who have been shown to be the ones most susceptible to alcohol-related problems (Zapolski et al. 2014). Such research could shed light on the determinants of substance abuse in an under-studied and highly vulnerable group, and also provide a test of the generality of the association between delay discounting and alcoholism.

The observed risk for alcohol dependence in low-income African American men may be related to more general findings of gender differences in substance abuse (e.g., Cotto et al. 2010). Becker et al. (2012) proposed that males and females begin and continue consuming substances of abuse, including alcohol, for different reasons. More specifically, females are more likely than males to begin and continue consumption because of a substance's negative reinforcing effects. That is, they are more likely to consume in order to escape or reduce negative feelings such as stress or social isolation. In contrast, males are hypothesized to be more likely to initiate and continue consumption because of a substance's positive reinforcing effects, including social reinforcement such as feelings of inclusion.

Although Bobova et al. (2009) reported steeper discounting by males and by alcohol-dependent participants, no interaction of gender and alcohol dependence was reported for their predominantly Caucasian sample. In another study with a predominantly Caucasian sample, Weafer et al. (2015) observed no gender differences in delay discounting in either a group determined to be at-risk for alcohol-related problems or a non-risk group. The two studies to examine possible race and gender differences in discounting (Dennhardt and Murphy 2011; de Wit et al. 2007) both found that African American participants showed steeper discounting than European American participants, but no gender differences in

discounting were observed and no interactions between gender and race were reported. It is not known, however, whether these findings also describe African Americans with alcohol-related problems, particularly low-income individuals.

Accordingly, the present study compared discounting of delayed monetary gains in male and female low-income African American alcoholics and controls, and also examined the discounting of delayed losses and the discounting of probabilistic gains, two other fundamental decision-making tasks. Substance abuse has been hypothesized to reflect a general tendency toward impulsive decision making, regardless of whether decisions involve positive or negative consequences (for a review, see Yi et al. 2010). That is, delay discounting refers to decreases in the (absolute) subjective value of future outcomes as the delay increases, such that gains become less attractive and losses become less aversive, and therefore impulsivity is associated with steep discounting in both cases. However, the current evidence concerning whether discounting of delayed losses is related to substance abuse is mixed, as is the literature on the discounting of probabilistic outcomes (Bickel et al. 2014a), which is relevant because of the comorbidity of alcohol dependence and pathological gambling (Petry et al. 2005). The one study to examine the relation between the discounting of losses and alcohol consumption (Takahashi et al. 2009) found a significant correlation for delayed losses but not for probabilistic losses or for delayed or probabilistic gains. However, only one of the 33 participants in that study reported daily consumption of alcohol, and alcohol-related problems were not assessed. Given the negative personal, social, and health consequences of alcoholism, consequences that are frequently delayed, excessive discounting of delayed losses and gains are equally plausible mechanisms, although only the latter has received much attention in the literature.

Thus, the major goal of the current study is to shed light on three important issues concerning alcoholism, issues about which little is currently known: first, whether excessive discounting of delayed gains is associated with alcoholism in low-income African Americans; second, whether alcoholism is associated with excessive discounting of either delayed losses or probabilistic gains; and third, whether male and female alcohol-dependent African Americans differ in their discounting of gains and losses. To ensure that these issues were adequately addressed, the present study used a combination of epidemiological and behavioral economic techniques. We examined discounting in fairly large samples of alcoholics and controls recruited from the same low-income neighborhoods and used propensity scores to match cases and controls (Rosenbaum 2002; Rosenbaum and Rubin 1983). Propensity-score matching is a powerful statistical technique used to control for multiple potential confounds (e.g., age, education). Although it is commonly utilized in epidemiological studies and other areas of social science research (e.g., Apel and Sweeten 2010; Glynn 2006), propensity-score matching has not been applied previously to the problem of discounting and substance abuse.

Method

Participants

761 of the participants taking part in a larger study of the genetic determinants of alcohol dependence in African Americans were tested on three discounting tasks. To recruit African

American alcohol-dependent participants, interviewer teams visited 6 treatment facilities in the St. Louis area. Control subjects were recruited using a commercially available database, the Merlin cross-directory, which merges data on address, phone, household membership, and birth date from public records, credit headers, and marketing lists. This made it possible to search specific areas of the city for controls who were geographically matched to cases from the same census block group.

All participants were given a comprehensive psychiatric interview, and blood samples were taken and DNA stored for later genotyping. Eligibility criteria for inclusion in the current alcohol-dependent sample were a diagnosis of alcohol dependence for the preceding 12 months based on the criteria specified in the DSM-IV, and current or recent treatment for alcohol and alcohol consumption within the previous 30 days. Controls were required to have consumed more than a minimal amount of alcohol in their lifetime (i.e., at least 20 drinks) but not meet diagnostic criteria for past-year DSM-IV alcohol dependence. The alcohol consumption requirement for controls was intended to screen out individuals who might have high genetic liability for alcohol dependence, but who had not consumed alcohol in sufficient quantities for this liability to become manifest as dependence. Consistent with previous research, the alcohol-dependent cases and controls also differed in dependence on tobacco, marijuana, and cocaine (e.g., Anthony & Echeagaray-Wagner, 2000; Midanik, Tam & Weisner, 2007).

Only community-dwelling individuals who were judged to be without severe cognitive deficiencies, based on the results of the comprehensive psychiatric interview, and who had no more than two hospitalizations for mental health disorders qualified to be included in the initial samples. Screening based on the aforementioned criteria and elimination of participants with incomplete data resulted in initial samples (prior to propensity-score matching) of 222 alcohol-dependent African American participants and 304 African American controls recruited from the same census block groups. The average ages of the alcohol-dependent cases (59.9% male) and controls (32.6% male) were 39.3 (SD = 9.8) and 43.0 (SD = 9.0) years of age, respectively.

Procedure

Participants were tested using computerized discounting tasks (Du et al. 2002) that assessed (1) the discounting of delayed gains and (2) the discounting of delayed losses, as well as (3) the discounting of probabilistic gains. For all three discounting tasks, the immediate/certain amount was equally likely to be displayed to the left or the right of the delayed/probabilistic amount on the computer monitor, and participants indicated their choice between the two options by pressing one of two clearly marked computer keys.

On the task assessing discounting of delayed gains, participants chose between a hypothetical amount of money ($2,500) that could be received after a delay and smaller amount that could be received immediately. They made a series of 6 choices at each of 6 delays: 2 weeks, 1 month, 6 months, 1 year, 3 years, and 5 years. The first choice in each series was between $2,500 after a specified delay and an immediate $1,250. If the immediate amount was chosen, the amount of the immediate gain was decreased; if the delayed gain was chosen, the amount of the immediate reward was increased.

The size of the adjustment on subsequent choices was always half of the previous adjustment. For example, if a participant chose $1,250 now over $2,500 in 3 months, the next choice would be between $625 now and $2,500 in 3 months. If the participant then chose $2,500 in 3 months over $625 now, the next choice would be between $938 now (rounded up from $937.50) and $2,500 in 3 months; alternatively, if the participant chose $625 now over $2,500 in 3 months, the next choice would be between $313 now and $2,500 in 3 months. This procedure converges rapidly on an indifference point, that is, the amount of immediate gain that is subjectively equal in value to the delayed gain (for further details, see Du et al. 2002).

In the task assessing the discounting of delayed losses, participants chose between paying a hypothetical amount of money (again $2,500) after a delay and paying a smaller amount immediately. The procedure was directly analogous to that for delayed gains and converged on the amounts of immediate loss that were subjectively equal in value to losses after delays of 2 weeks, 1 month, 6 months, 1 year, 3 years, and 5 years.

The probability discounting task used a procedure similar to those used for the two delay discounting tasks. Participants made a series of 6 choices at each of 6 probabilities, with the amount of certain gain adjusted based on the participant's previous choice. The probabilities were presented as the percent chance (95, 80, 60, 40, 20, or 5%) of receiving a hypothetical amount of money ($2,500), and the procedure converged on the amounts of certain gain that were subjectively equal in value to each of the probabilistic gains.

Analysis

For each participant on each task, the area under the discounting curve (AuC) was calculated based on the obtained indifference points and used as the measure of the degree of discounting. Following Myerson, Green, and Warusawitharana (2001), AuCs were calculated based on the observed subjective values rather than by integrating a discounting function (e.g., a hyperbola) so as to obtain a measure that does not depend on assumptions regarding the form of the discounting curve, and were normalized so that an AuC could range between 0.00 and 1.00. An AuC of 1.00 would indicate that the subjective value of an outcome was judged equal to its actual value regardless of how long it was delayed or what its probability of occurrence was (i.e., no discounting), and an AuC of 0.00 would indicate that an outcome was judged of zero value if it was delayed at all or had less than 100% chance of occurrence (i.e., the value of a delayed or probabilistic outcome was discounted completely).

The samples of alcohol-dependent cases and controls differed significantly in age, education, gender, and income. Therefore, propensity-score matching (Rosenbaum 2002; Rosenbaum and Rubin 1983) was used to reduce biases that might contribute to differences in discounting between the alcohol-dependent and control samples so that any differences observed after matching could be more validly attributed to effects of alcohol dependence. A propensity score was calculated for each participant that represented the likelihood that a participant with that person's age, gender, and education and, for our first analysis, income, would be alcohol-dependent, and then these propensity scores were used to create matched

pairs of cases and controls who were similar on these potential confounders but who differed with respect to their dependence on alcohol.

The two samples also differed in both mental and physical health. However, because these attributes are themselves affected by alcohol dependence (Bouchery et al. 2011; Mullahy and Sindelar 1998), unlike age, gender, and (albeit to a lesser extent) education, using them to match samples could produce "over-matching" and lead to underestimation of any difference in discounting associated with alcohol dependence (e.g., Gissler and Hemminki 1996; Marsh et al. 2002). Although the same is true with respect to income, income is an especially important variable in the current investigation, and therefore, propensity-score matching was done both with and without income as a matching variable so that the role of income in the observed differences between male and female cases and controls could be assessed.

Propensity-score matching is commonly used in medical research to assess the effect of a treatment on disease symptoms in situations in which, in addition to the treatment, the symptoms may also be the result of other causes (confounds). In the present investigation, the "treatment" is alcohol dependence, the symptom is steep discounting, and some of the potential confounds are age, gender, education, and income. Although geographic matching (i.e., recruiting cases and controls who lived in the same neighborhood) presumably resulted in smaller differences in confounds such as income and education than would otherwise have been observed, at best it presents a partial solution to this problem. Therefore, matching based on propensity scores was used to further "correct" the estimation of treatment effects by controlling for the existence of confounding variables (Becker and Ichino 2002; Rosenbaum and Rubin 1983).

As defined by Rosenbaum and Rubin (1983), an individual's propensity score is the likelihood of that person being assigned to a particular treatment condition, given an observed vector of covariates (i.e., scores on the confounding variables). For the present investigation, we used the Stata® statistical software package (StatCorp LP) to first estimate propensity based on multiple probit regression and then perform nearest-neighbor matching without replacement. To determine whether matching reduced bias, we used several measures of balance between case and control groups before and after matching. These measures included a standardized percentage bias, which represents the difference between the means for the alcoholic and control groups as a percentage of the square root of the average of the variances for the two groups, as well as the ratio of the variances of each confounding variable for the two groups, which is equal to 1.0 if perfect balance is achieved. For the continuous variable of age, *t*-tests were used to compare cases and controls; for the ordinal variables of education, income, and health status, the Mann-Whitney Rank Sums test was used; for the percentage male and the dichotomous variable depression treatment, the Chi Square test was used.

Results

Propensity-score matching based on age, gender, education, and income reduced the bias (i.e., the standardized difference between cases and controls) with respect to these variables

to the extent that differences in the matching variable that had been statistically significant prior to matching were no longer significant after matching (see Table 1). Matching based on just age, gender, and education (see Table 2) eliminated group differences in two of the matching variables, age and education. Although the difference in the percentage of males for cases (53.2%) and controls (40.5%) was still statistically significant after matching, the bias was considerably reduced from what it had been in the unmatched samples, and a similar result was observed with respect to income.

The median income for the alcohol-dependent cases was between $7,000 and $10,000 both before and after matching on age, gender, and education, but whereas the controls had a median income between $30,000 and $40,000 before matching, after matching they had a median income between $20,000 and $30,000, which is the median for adults in the North St. Louis neighborhoods from which participants were recruited. The decreased difference in income between the unmatched and matched control samples was most likely because education was one of the matching variables; prior to matching, income was significantly correlated with education in the control sample ($rho = .447$, $p < .001$), although the correlation was much weaker in the alcohol dependent sample, perhaps due to restriction of range ($rho = .151$, $p < .05$).

Table 3 presents the mean AuCs for delayed gains, delayed losses, and probabilistic gains (as well as the corresponding SDs and the results of statistical tests) for alcohol-dependent cases and controls both before and after propensity-score matching. Prior to matching, significant differences were observed between cases and controls with respect to how steeply they discounted delayed outcomes, both gains and losses, whereas no significant difference was observed when the outcomes were probabilistic gains. Importantly, cases discounted delayed gains significantly more steeply than controls (i.e., cases had smaller AuCs) even after matching based on gender, age, education, and income, as well as after matching on the first three of these variables (see Figure 1). In contrast, the difference in discounting of delayed losses was not significant after matching even when the groups were allowed to differ in income. Interestingly, income was not correlated with the degree of discounting of delayed gains in either group following matching based on age, gender, and education (both rs < .13, both ps > .08).

Although the alcohol-dependent cases discounted delayed gains significantly more steeply than matched controls, in other respects their discounting (like that of the controls, who were also low-income African Americans) was similar to what has been observed in many studies of samples from other populations. For example, both cases and controls showed significantly steeper discounting of delayed gains than of delayed losses after matching based on age, gender, and education (both ts > 7.5, both ps < .001). Moreover, consistent with previous findings (Green et al. 2013b; Myerson et al. 2011; for a review, see Green and Myerson 2004), the decrease in subjective value of delayed and probabilistic outcomes was well described by the hyperboloid discounting model (Myerson and Green 1995), as indicated by the low root mean square error (RMSE) of the subjective values estimated by the model.

The RMSE was used to measure goodness of fit because the proportion of variance accounted for (R^2) can be misleading in certain cases (Johnson and Bickel 2008), such as when discounting data are accurately predicted but the observed indifference points occupy a narrow range (e.g., see the group mean subjective values for delayed losses in Figure 1). Examination of the RMSEs revealed that the hyperboloid model accurately described the group mean subjective values for both the alcohol-dependent cases and controls on all three tasks both before and after matching: (i.e., all RMSEs less than 3.4% of $2,500, the amount whose value was being discounted: M = 2.39%, SD = 0.49), and the model fits were comparable to those observed in previous studies, including those examining discounting by abusers of various substances (for examples, see Green and Myerson 2004).

Finally, because previous research suggests that relative to other African Americans, low-income males are at higher risk for alcohol dependence (Zapolski et al. 2014), statistical tests for potential gender differences in the discounting of delayed gains were conducted using the Holm-Sidak correction for multiple comparisons (Holm 1979). These planned comparisons localized the source of the difference between cases and controls matched on age, gender, and education in the alcohol-dependent males (see Figure 2). Although there was no significant difference between the female cases and the female controls ($t = 1.081$, $p = .281$), the alcohol-dependent males discounted delayed gains more steeply than both the female cases ($t = 4.59$, $p < .001$) and the male controls ($t = 2.59$, $p = .021$). Moreover, although a gender difference was observed in the cases, there was no significant difference between the male and female controls ($t < 1.0$). Notably, the gender difference in the cases' discounting was confined to delayed gains; no significant gender differences were observed in the discounting of delayed losses or probabilistic gains (ts < 1.0).

The observed pattern of differences in the discounting of delayed gains may be compared with that for household income. For example, the median income for the female cases ($4,000–6,999/year) was substantially less than that for the female controls ($20,000–29,999/year; $z = 6.80$, $p < .001$), despite the fact that they did not differ in discounting. Similarly, the median household income for the female controls was substantially less than that for the male controls ($30,000-$39,999/year; $z = 2.12$; $p = .034$) although they also did not differ in discounting. The median income for the male cases ($10,000-$19,999/year) was much less than that for the male controls (z = 5.45, p < .001. Notably, however, the income for the male cases was substantially more than that for the female cases, even though the male cases discounted significantly more steeply than the female cases ($z = 2.88$, $p = .004$), exactly the opposite of what would be expected if income differences were the cause of the observed difference in discounting.

Discussion

Low-income, alcohol-dependent African American cases and non-dependent controls performed three tasks that assessed the degree to which they discounted the value of delayed monetary gains, delayed monetary losses, and probabilistic monetary gains. For both samples, the subjective value of an outcome decreased as either the delay until its occurrence or the odds against its occurrence increased, and on all three tasks, the form of that decrease was well described by the hyperboloid discounting model (Myerson and Green 1995),

consistent with previous studies (for a review, see Green and Myerson 2004). Also consistent with previous studies (e.g., Estle et al. 2006; Murphy et al. 2011; Thaler 1981), both samples discounted delayed gains more steeply than delayed losses. These findings extend the generality of previous findings concerning discounting to a previously unstudied group, low-income African Americans. Importantly, DSM-IV alcohol dependence in this group was associated with a tendency to steeply discount delayed monetary gains but not delayed monetary losses. Although substance abuse is sometimes thought of as resulting, at least in part, from a general tendency toward impulsive decision making, regardless of whether decisions involve positive or negative consequences (for a review, see Yi et al. 2010), these results suggest that alcohol dependence is more a consequence of choosing immediate rewards, even when larger rewards could be had if one were willing to wait, than it is a result of ignoring the delayed negative outcomes of such behavior.

The difference between cases and controls with respect to their patterns of discounting was robust, in that it was still observed after propensity-score matching to control for differences in age, gender, education, and income: Treatment-seeking, alcohol-dependent individuals still discounted delayed monetary gains more steeply than matched controls, whereas no significant differences between cases and controls were observed in the discounting of delayed losses or probabilistic gains. Further analyses localized the difference in discounting of delayed gains to the male cases, whose discounting was steeper than either the male controls or the female cases; no difference was observed between male and female controls.

Previous studies have established that the degree to which people discount delayed gains differs by age, income, and education (Green et al. 1996; Reimers et al. 2009), and possibly also by race (Dennhardt and Murphy 2011). Individuals with similar demographic attributes tend to cluster together both socially and geographically and therefore share many similar experiences, including health outcomes such as alcoholism (Fesahazion et al. 2012). As a result, these attributes represent potential confounds in case-control studies unless they are shared by both cases and controls.

African Americans, for example, are exposed to unique stressors, such as restricted access to housing, education, and employment opportunities, which may increase their likelihood of experiencing poor mental health outcomes and problems with self-control (Haushofer and Fehr 2014; Martin et al. 2003). Despite this, African Americans, as a group, are much less likely to drink alcohol than European Americans (Hesselbrock et al. 2003), but discrimination and neighborhood deprivation can increase the likelihood of drinking and alcohol-related problems (Martin et al. 2003). The risk of such problems among African Americans has been attributed to being “place bound,” that is, when African Americans are low income and live in deprived neighborhoods, they are commonly more dependent on local resources – they have reduced access to transportation, less education, and lower incomes – and thus are more vulnerable to local drinking norms (Fesahazion et al. 2012). In addition, they are situated in neighborhoods that have many more alcohol outlets (LaVeist and Wallace 2000). Thus, it can be difficult to distinguish the role that discounting plays in alcohol dependence among African Americans from that played by poverty, lower levels of education, and neighborhood environment.

One strength of the present study is its effective combination of behavioral economic and epidemiological methods to address this issue. Within epidemiology, the term confounding has been used to characterize situations where group comparisons cannot distinguish between the effects of multiple causes. The measured effect, therefore, is likely to result from a combination of different causes beyond the one being studied. In observational studies such as this one, investigators do not have control over treatment assignment (i.e., case vs. control), and thus direct comparison of the alcohol-dependent cases with the nondependent controls could be misleading.

Although we used traditional methods of adjustment (i.e., we stratified on race, focusing on African Americans only, and used geographic matching to ensure that both cases and controls lived in the same neighborhoods), we were not able to adjust for differences in "place bound" vulnerabilities such as education and income using such methods. We also could not control for differences in other demographic variables related to alcoholism, like gender and age. Therefore, propensity scores were used to help control for these confounding variables (Becker and Ichino 2002), revealing that although alcohol-dependent cases discounted both delayed gains and losses more steeply than controls prior to matching, only the difference in the discounting of delayed gains was significant after matching and is therefore likely to be directly related to alcohol dependence.

The finding that cases and controls differed in discounting after controlling for the potentially confounding variables of gender, age, education, and income does not necessarily imply that these variables were not themselves directly related to the participants' discounting. The role played by these potentially confounding variables is a separate question, and because in the African American community, low-income males are at special risk for alcohol dependence, we conducted follow-up analyses examining the role of gender and its potential interaction with income. These analyses revealed that the relation between delay discounting and alcohol dependence was driven by the fact that the male cases, but not the female cases, discounted delayed gains more steeply than the controls of either sex. More specifically, whereas there was no difference in discounting between male and female controls, both the difference between male and female cases and the difference between male cases and male controls were medium size effects (Cohen's *d*s of .40 and .43, respectively).

Although the finding that the male cases discounted delayed gains more steeply than the male controls is consistent with what might have been expected based on previous studies examining the relation between income and discounting (e.g., Green et al. 1996; Reimers et al. 2009), the gender difference in discounting observed in the alcohol-dependent cases is not explainable in terms of income differences. More specifically, following matching based on age, gender, and education, the median income for the male cases was approximately $10,000 greater than that for the female cases, yet the males discounted significantly more steeply than the females. Further, no differences in discounting were observed between male and female controls although on average they, too, differed in income by approximately $10,000, suggesting that the observed gender difference in discounting is specific to alcohol-dependent cases.

Zapolski et al. (2014) theorized that the gender difference in alcohol consumption patterns in African Americans reflects the fact that African American men face special difficulties in fulfilling the basic needs of relatedness, competence, and autonomy, whereas many African American women may be better able to satisfy these needs through their role as mothers and/or caregivers. Zapolski et al. suggest further that men may be at greater risk because low-income African American women typically have better access than men to government programs that provide employment, education, housing, food, and financial benefits. Thus, it is possible that the steep discounting of low-income, alcohol-dependent men in the present study somehow may be a consequence of the special difficulties faced by low-income African American men.

It should be noted, however, that gender differences in the consumption of alcohol and other abused substances are observed in other populations as well, and that the differences observed here also may reflect these more general effects. For example, in the only large-scale study to look for possible gender differences in the relation between delay discounting and alcohol consumption, Rossow (2008) found that discount rate was more strongly associated with various alcohol-related measures in male than female teenagers. Notably, these measures included the frequency of alcohol consumption, intoxication, and severe intoxication, all potential precursors to alcohol-related problems.

Reviewing the literature, Becker et al. (2012) noted that in general, males are more likely than females to engage in risky behaviors that include drinking and experimenting with drugs, whereas females are more likely to begin drinking and taking drugs as self-medication to reduce stress or alleviate depression. They suggested further that there are neurobiological differences that may underlie these differences. Importantly, males take their first steps on the path to addiction and dependence because of the positively reinforcing effects of alcohol and other drugs, including the positive social reinforcement for engaging in such behaviors (e.g., higher level of social inclusion), and those who continue on that path may be those most susceptible to such effects. Indeed, the discounting of delayed gains may be thought of as a measure of this susceptibility, hence the consistent finding of steeper discounting by abusers of various substances (MacKillop et al. 2011).

In contrast, females tend to begin (and continue) consuming alcohol and other drugs because of their negatively reinforcing effects (i.e., in order to escape from or decrease negative feelings), yet no difference was observed in the discounting of delayed losses either between female and male cases or between female cases and female controls. The discounting of delayed losses has received relatively little attention in the literature despite its obvious relevance (cf. Takahashi et al. 2009; Woolverton et al. 2012), and further research exploring individual as well as gender differences in this regard is clearly needed.

Thus, although discounting may shed considerable light on alcohol dependence in low-income, African American men, our results so far have little to say about dependence in African American women, other than that it may have different roots than in their male peers. As Becker et al. (2012) and others have noted, gender differences in etiology and/or manifestation may have important implications for prevention and treatment, arguing strongly against a “one size fits all” approach. Future studies will be needed to determine

whether the present findings regarding gender differences in discounting and alcohol dependence generalize to other demographic groups, particularly other low-income populations, and to other abused substances. In addition, it will be extremely important to establish whether or not the differences in discounting observed here predict the development of alcohol dependence in low-income African Americans and whether they persist following treatment (Bickel et al. 2014b; MacKillop and Kahler 2009). For the present, however, several things seem clear: low-income African Americans with DSM-IV alcohol dependence discount delayed monetary gains significantly more steeply than those who are not alcohol dependent, yet they do not differ in their discounting of delayed losses or probabilistic gains, and further, it is the alcohol-dependent males who are the source of the difference between cases and controls. Taken together, these findings provide important new information about an understudied group at special risk for alcohol dependence.

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References

Anthony JC, Echeagaray-Wagner F. Epidemiologic analysis of alcohol and tobacco use. Alcohol Res Health. 2000; 24:201–208. [PubMed: 15986714]

Apel, RJ., Sweeten, G. Propensity score matching in criminology and criminal justice. In: Piquero, AR., Weisburd, D., editors. Handbook of quantitative criminology. Springer; New York: 2010. p. 543-562.

Audrian-McGovern J, Rodriguez D, Epstein LH, Cuevas J, Rodgers K, Wileyto EP. Does delay discounting play an etiological role in smoking or is it a consequence of smoking? Drug Alcohol Depend. 2009; 103:99–106. [PubMed: 19443136]

Becker JB, Perry AN, Westernbroek C. Sex differences in the neural mechanisms mediating addiction: A new synthesis and hypothesis. Biol Sex Differ. 2012; 3:1–35. [PubMed: 22214247]

Becker SO, Ichino A. Estimation of average treatment effects based on propensity scores. The Stata Journal. 2002; 2:358–377.

Bickel WK, Johnson MW, Koffarnus MN, MacKillop J, Murphy JG. The behavioral economics of substance use disorders: reinforcement pathologies and their repair. Annu Rev Clin Psychol. 2014a; 10:641–677. [PubMed: 24679180]

Bickel WK, Koffarnus MN, Moody L, Wilson AG. The behavioral- and neuro-economics process of temporal discounting: A candidate behavioral marker of addiction. Neuropharmacol. 2014b; 76:518–527.

Bickel WK, Marsch LA. Toward a behavioral economic understanding of drug dependence: delay discounting processes. Addict. 2001; 96:73–86.

Bobova L, Finn PR, Rickert ME, Lucas J. Disinhibitory psychopathology and delay discounting in alcohol dependence: Personality and cognitive correlates. Exp Clin Psychopharmacol. 2009; 17:51–61. [PubMed: 19186934]

Bouchery EE, Harwood HJ, Sacks JJ, Simon CJ, Brewer RD. Economic costs of excessive alcohol consumption in the US, 2006. Am J Prev Med. 2011; 41:516–524. [PubMed: 22011424]

Caetano R, Clark CL. Trends in alcohol-related problems among Whites, Blacks, and Hispanics. 1984–1995. Alcohol Clin Exp Res. 1998; 22:534–538. [PubMed: 9581665]

Cotto JH, Davis E, Dowling GJ, Elcano JC, Staton AB, Weiss SR. Gender effects on drug use, abuse, and dependence: A special analysis of results from the National Survey on Drug Use and Health. Gender Med. 2010; 7:402–413.

Dennhardt AA, Murphy JG. Associations between depression, distress tolerance, delay discounting, and alcohol-related problems in European American and African American college students. Psychol Addict Behav. 2011; 25:595–605. [PubMed: 21988480]

de Wit H, Flory JD, Acheson A, McCloskey M, Manuck SB. IQ and nonplanning impulsivity are independently associated with delay discounting in middle-aged adults. Pers Indiv Differ. 2007; 42:111–121.

Du W, Green L, Myerson J. Cross-cultural comparisons of discounting delayed and probabilistic rewards. Psychol Rec. 2002; 52:479–492.

Estle SJ, Green L, Myerson J, Holt DD. Differential effects of amount on temporal and probability discounting of gains and losses. Mem & Cogn. 2006; 34:914–928.

Fesahazion RG, Thorpe RJ, Bell CN, LaVeist TA. Disparities in alcohol use: Does race matter as much as place? Prev Med. 2012; 55:482–484. [PubMed: 22940615]

Ford BC, Bullard KM, Taylor RJ, Toler AK, Neighbors HW, Jackson JS. Lifetime and 12-month prevalence of Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition disorders among older African Americans: Findings from the National Survey of American Life. Am J Geriatr Psychiatry. 2007; 15:652–659. [PubMed: 17504908]

Gissler M, Hemminki E. The danger of overmatching in studies of the perinatal mortality and birthweight of infants born after assisted conception. Eur J Obstet Gynecol Reprod Biol. 1996; 69:73–75. [PubMed: 8902436]

Glynn RJ, Schneeweiss S, Sturmer T. Indications for propensity scores and review of their use in pharmacoepidemiology. Basic Clin Pharmacol Toxicol. 2006; 98:253–259. [PubMed: 16611199]

Green L, Myerson J. A discounting framework for choice with delayed and probabilistic rewards. Psychol Bull. 2004; 130:769–792. [PubMed: 15367080]

Green L, Myerson J. How many impulsivities? A discounting perspective. J Exp Anal Behav. 2013a; 99:3–13. [PubMed: 23344985]

Green L, Myerson J, Oliveira L, Chang SE. Delay discounting of monetary rewards over a wide range of amounts. J Exp Anal Behav. 2013b; 100:269–281. [PubMed: 24037826]

Green L, Myerson J, Lichtman D, Rosen S, Fry A. Temporal discounting in choice between delayed rewards: The role of age and income. Psychol Aging. 1996; 11:79–84. [PubMed: 8726373]

Haushofer J, Fehr E. On the psychology of poverty. Science. 2014; 344:862–867. [PubMed: 24855262]

Hesselbrock MN, Hesselbrock VM, Segal B, Schuckit MA, Bucholz K. Ethnicity and psychiatric comorbidity among alcohol-dependent persons who receive inpatient treatment: African Americans, Alaska natives, Caucasians, and Hispanics. Alcohol Clin Exp Res. 2003; 27:1368–1373. [PubMed: 12966342]

Holm S. A simple sequentially rejective multiple test procedure. Scand Stat Theory Appl. 1979; 6:65–70.

Johnson MW, Bickel WK. An algorithm for identifying nonsystematic delay-discounting data. Exp Clin Psychopharmacol. 2008; 16:264–274. [PubMed: 18540786]

Kirby KN, Finch JC. The hierarchical structure of self-reported impulsivity. Pers Indiv Differ. 2010; 48:704–713.

LaVeist TA, Wallace JM. Health risk and inequitable distribution of liquor stores in African American neighborhood. Soc Sci Med. 2000; 51:613–617. [PubMed: 10868674]

Lejuez CW, Magidson JF, Mitchell SH, Sinha R, Stevens MC, de Wit H. Behavioral and biological indicators of impulsivity in the development of alcohol use, problems, and disorders. Alcohol Clin Exp Res. 2010; 34:1334–1345. [PubMed: 20491733]

MacKillop J, Kahler CW. Delayed reward discounting predicts treatment response for heavy drinkers receiving smoking cessation treatment. Drug Alcohol Depend. 2009; 104:197–203. [PubMed: 19570621]

MacKillop J, Amlung MT, Few LR, Ray LA, Sweet LH, Munafò MR. Delayed reward discounting and addictive behavior: a meta-analysis. Psychopharmacol. 2011; 216:305–321.

Marsh JL, Hutton JL, Binks K. Removal of radiation dose response effects: an example of over-matching. Br Med J. 2002; 325:327–330. [PubMed: 12169512]

Martin JK, Tuch SA, Roman PM. Problem drinking patterns among African Americans: the impacts of reports of discrimination, perceptions of prejudice, and" risky" coping strategies. J Health Soc Behav. 2003; 44:408–425. [PubMed: 14582316]

Midanik LT, Tam TW, Weisner C. Concurrent and simultaneous drug and alcohol use: results of the 2000 National Alcohol Survey. Drug Alcohol Depend. 2007; 90:72–80. [PubMed: 17446013]

Mullahy, J., Sindelar, JL. Drinking, problem drinking, and productivity. In: Galanter, M., editor. Recent Developments in Alcoholism, Volume 14: The Consequences of Alcoholism. Plenum Press; New York: 1998. p. 347-359.

Murphy JG, Vuchinich RE, Simpson CA. Delayed reward and cost discounting. Psychol Rec. 2011; 51:571–578.

Myerson J, Green L. Discounting of delayed rewards: Models of individual choice. J Exp Anal Behav. 1995; 64:263–276. [PubMed: 16812772]

Myerson J, Green L, Morris J. Modeling the effect of reward amount on probability discounting. J Exp Anal Behav. 2011; 95:175–187. [PubMed: 21541126]

Myerson J, Green L, Warusawitharana M. Area under the curve as a measure of discounting. J Exp Anal Behav. 2001; 76:235–243. [PubMed: 11599641]

Myerson J, Green L, Hanson JS, Holt DD, Estle SJ. Discounting delayed and probabilistic rewards: Processes and traits. J Econ Psychol. 2003; 24:619–635.

Petry NM, Stinson FS, Grant BF. Comorbidity of DSM-IV pathological gambling and other psychiatric disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions. J Clin Psychiat. 2005; 66:564–574.

Rachlin H. Notes on discounting. J Exp Anal Behav. 2006; 85:425–435. [PubMed: 16776060]

Rachlin H, Raineri A, Cross D. Subjective probability and delay. J Exp Anal Behav. 1991; 55:233–244. [PubMed: 2037827]

Reimers S, Maylor EA, Stewart N, Chater N. Associations between a one-shot delay discounting measure and age, income, education and real-world impulsive behavior. Pers Indiv Differ. 2009; 47:973–978.

Rosenbaum, PR. Observational studies. 2. Springer; New York: 2002.

Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. Biometrika. 1983; 70:41–55.

Rossow I. Alcohol consumption and discounting. Addict Res Theory. 2008; 16:572–584.

Takahashi T, Ohmura Y, Oono H, Radford M. Alcohol use and discounting of delayed and probabilistic gain and loss. Neuro Endocrinol Lett. 2009; 30:479.

Thaler RH. Some empirical evidence on dynamic inconsistency. Econ Lett. 1981; 8:201–207.

Washio Y, Higgins ST, Heil SH, McKerchar TL, Badger GJ, Skelly JM, Dantona RL. Delay discounting is associated with treatment response among cocaine-dependent outpatients. Exp Clin Psychopharmacol. 2011; 19:243–248. [PubMed: 21517195]

Weafer J, De Arcangelis J, de Wit H. Sex differences in behavioral impulsivity in at-risk and non-risk drinkers. Front Psychiatry. 2015; 6:72. [PubMed: 26029121]

Woolverton WL, Freeman KB, Myerson J, Green L. Suppression of cocaine self-administration in monkeys: effects of delayed punishment. Psychopharmacol. 2012; 220:509–517.

Yi, R., Mitchell, SH., Bickel, WK. Delay discounting and substance abuse-dependence. In: Madden, GJ., Bickel, WK., editors. Impulsivity: The behavioral and neurological science of discounting. American Psychological Association; Washington, D.C: 2010.

Yoon JH, Stephen T, Heil SH, Sugarbaker RJ, Thomas CS, Badger GJ. Delay discounting predicts postpartum relapse to cigarette smoking among pregnant women. Exp Clin Psychopharmacol. 2007; 15:176–186. [PubMed: 17469941]

Zapolski TC, Pedersen SL, McCarthy DM, Smith GT. Less drinking, yet more problems: Understanding African American drinking and related problems. Psychol Bull. 2014; 140:188–223. [PubMed: 23477449]

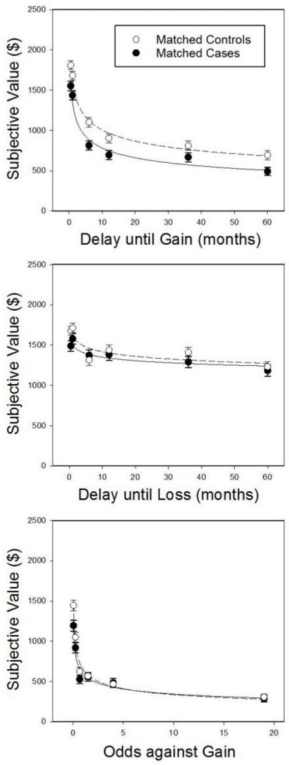

Figure 1.

Discounting of delayed gains (top panel), delayed losses (middle panel), and probabilistic gains (bottom panel) by alcohol-dependent African Americans and controls matched on age, gender, and education. Error bars represent the standard error of the mean.

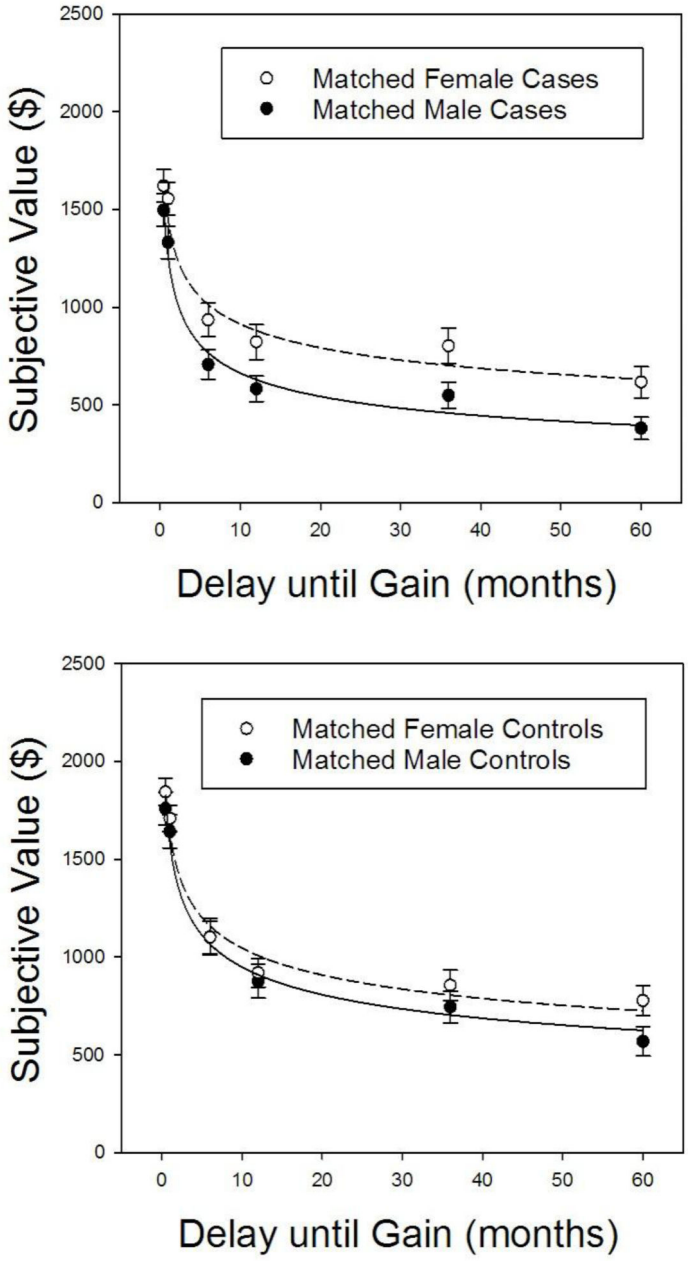

Figure 2.

Discounting of delayed gains by propensity-score matched male and female alcohol-dependent African Americans (bottom panel) and male and female controls (top panel). Error bars represent the standard error of the mean.

Table 1

Differences between alcohol-dependent cases and controls before and after propensity-score matching based on age, gender, education, and income.

Variable	Samples	Bias (%)	Reduction in Bias (%)	Case vs. Control	Variance ratio (case/control)
Age	Unmatched	−38.5	92.7	$t = 4.39^{***}$	1.19
	Matched	−2.8		$t = 0.23$	1.04
Male (%)	Unmatched	56.9	97.5	$X^2 = 38.91^{***}$	1.10
	Matched	1.4		$X^2 = 0.01$	1.00
Education	Unmatched	−84.5	93.0	$z = 8.64^{***}$	0.56
	Matched	−5.9		$z = 0.38$	0.92
Income	Unmatched	−105.8	88.9	$z = 10.59^{***}$	1.14
	Matched	−11.8		$z = 1.40$	1.25
Health Status	Unmatched	−27.0	17.1	$z = 3.15^{***}$	1.06
	Matched	−22.4		$z = 1.89$	1.08
Depression Treatment (%)	Unmatched	30.3	−42.8	$X^2 = 11.74^{***}$	1.25
	Matched	43.2		$X^2 = 12.95^{***}$	1.34

Notes:

$^{*}p<.05$,

$^{**}p<.01$,

$^{***}p<.001$.

Where Bias is positive, the mean, median, or percentage is greater for cases than for controls.

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Table 2

Differences between alcohol-dependent cases and controls before and after propensity-score matching based on age, gender, and education.

Variable	Samples	Bias (%)	Reduction in Bias (%)	Case vs. Control	Variance ratio (case/control)
Age	Unmatched	−38.5	70.5	$t = 4.39^{***}$	1.19
	Matched	−11.3		$t = 1.10$	1.27
Male (%)	Unmatched	56.9	53.8	$X^2 = 38.91^{***}$	1.10
	Matched	26.3		$X^2 = 6.09^{**}$	1.03
Education	Unmatched	−84.5	86.3	$z = 8.64^{***}$	0.56
	Matched	−11.5		$z = 1.31$	0.96
Income	Unmatched	−105.8	15.6	$z = 10.59^{***}$	1.14
	Matched	−89.4		$z = 8.42^{***}$	1.16
Health Status	Unmatched	−27.0	−14.2	$z = 3.15^{***}$	1.06
	Matched	−30.9		$z = 2.94^{**}$	1.08
Depression Treatment (%)	Unmatched	30.3	−41.8	$X^2 = 11.74^{***}$	1.25
	Matched	42.9		$X^2 = 16.88^{***}$	1.30

Notes:

$^{*}p<.05$,

$^{**}p<.01$,

$^{***}p<.001$.

Where Bias is positive, the mean, median, or percentage is greater for cases than for controls. For the continuous variable Age, *t*-tests were used to compare cases and controls; for the ordinal variables Education, Income, and Health Status, the Mann-Whitney Rank Sums test was used; for the dichotomous variables (Males, and Depression Treatment), the Chi Square test was used.

Table 3

Mean Area-under-the Curve (AuC) measures of the discounting of delayed gains, delayed losses, and probabilistic gains for alcohol-dependent cases and controls in both propensity-matched and unmatched samples.

Matching Variables	Group	Delayed Gains AuC (SD)	Delayed Losses AuC (SD)	Probabilistic Gains AuC (SD)
Unmatched	Controls	.378 (.271)	.575 (.291)	.163 (.200)
	Cases	.275 (.243)	.521 (.305)	.173 (.229)
		$t(524) = 4.51^{***}$	$t(524) = 2.07^{*}$	$t(524) = -0.51$
Age, Gender, Income, and Education	Controls	.355 (.284)	.533 (.302)	.166 (.229)
	Cases	.289 (.241)	.528 (.310)	.183 (.237)
		$t(286) = 2.10^{*}$	$t(286) = 0.16$	$t(286) = -0.60$
Age, Gender, and Education	Controls	.347 (.267)	.548 (.291)	.171 (.210)
	Cases	.272 (.242)	.519 (.313)	.168 (.229)
		$t(378) = 2.86^{**}$	$t(378) = 0.94$	$t(378) = 0.13$

Note:

* p<.05,

** p<.01,

*** p<.001