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A behavioral genetic investigation of weekend drinking among an adult sample

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Abstract

This study examined common and unique genetic and environmental influences on weekend drinking and weekday drinking reported by U.S. male and female adult participants (Mean Age = 43.9). Data from 96 monozygotic and 82 dizygotic twin pairs were used to estimate bivariate biometric models of daily levels of weekend and weekday drinking volume. Weekend and weekday drinking volume scores were calculated from end-of-day reports of drinking across eight days. As expected, more drinking occurred during weekends. Biometric models provided evidence of significant additive genetic and nonshared environmental influences on both weekend and weekday drinking. Shared environmental influences were nonsignificant. Genetic influences accounted for a greater proportion of drinking variance during weekdays than weekends (.36 compared to .17). However, these apparent differences in heritability—proportion of total variance accounted for by genetic variance—were due to increased non-shared environmental influences on weekend days, rather than greater genetic influences. Funded by NIH/NIA and John D. and Catherine T. MacArthur Foundation.

Keywords

Behavioral Genetic; Alcohol Use; Weekends

Introduction

As the expression “Thank God it’s Friday” suggests, weekends are different. They provide the opportunity to spend time with friends and family, relax a little bit, and—at least for some—have a few drinks or more. This weekly opportunity to indulge increases alcohol consumption across drinkers, regardless of the amount they regularly consume (Argeriou, 1975). The weekly increase in drinking volume may be linked to the different purpose of weekend drinking, which may be disproportionately focused on celebrating and enhancing positive experiences. Consistent with this view of weekend drinking, daily levels of anxiety—which predict drinking Monday through Thursday—do not predict drinking on Fridays and Saturdays (Orcutt & Harvey, 1995). Moreover, drinking to enhance, the sort of drinking that should be more common on weekends, may be less affected by genetic influences than is drinking to cope (Agrawal et al., 2007). Given clear differences in levels of drinking and suggested reasons for etiological differences—as well as self-evident differences in weekend vs. weekday life—we propose that genetic and environmental factors may exert different influences on weekend drinking than on weekday drinking.

To investigate the possibility of such differences, this study applied behavioral genetic analyses to investigate Friday and Saturday vs. Monday through Wednesday daily drinking volume. Our inquiry was guided by two lines of thought. First, without the daily struggle to balance the demands of weekday life the genetically influenced characteristics and traits that encourage drinking during weekdays, such as anxiety, may not be as similarly relevant to drinking during the weekend. Second, the celebratory nature of weekend life may increase drinking behaviors regardless of genetic predispositions. Before detailing the specifics of the data used and the models run, we review literature on: 1) patterns of drinking across days of the week, 2) types of drinking that may be more or less common across different days of the week, and 3) findings on the heritability and environmental nature of drinking behaviors and motives.

Drinking clearly varies across days of the week. In the 1970s, Argeriou (1975) documented across-week patterns of drinking, concluding that Mondays and Tuesdays were ‘natural’ troughs and Friday and Saturdays ‘natural’ crests in drinking volume. This weekly pattern of increased weekend drinking was not limited to a subtype of drinkers; rather, it was observed across heavy, moderate, and light drinkers. In addition to changes in volume, drinking behaviors also have been linked to different proximate etiological factors across days of the week. Aided by a detailed study design that provided information on affect and drinking during several time blocks within each day, Orcutt and Harvey (1991) found that low affect (i.e., negative affect) predicted subsequent same-day drinking during weekdays, but not during weekends.

That weekdays and weekends create troughs and crests in drinking behavior is intrinsically linked to the culture in which people experience weekdays and weekends. In the case of the studies cited above, which drew their data from U.S. samples, the culture is influenced by a legacy that includes the Protestant work ethic and temperance campaigns, on the one hand; and an ethos encouraging hedonistic consumption linked to the agricultural calendar, on the other (Measham, 2006). These oscillating sets of cultural influences set the stage for temporal switching between weekday applications of self-restraint and weekend allowances for celebrations.

Other differences between weekends and weekdays—beyond the former being about self-restraint and the second about celebration—may include different levels of experiential predictability. The grinding predictability of weekdays provides opportunities to develop routinized patterns of alcohol use to alleviate tension and pressure associated with minor daily stressors (Neff & Husaini, 1985, p. 208). Unlike weekdays’ predictability, weekends vary. Some weekends may include social events with friends and some may not. Thus, rather than a simple dichotomy of heavily scheduled weekdays and carefree weekends, an important difference between these two temporal contexts may be that weekdays have greater predictability while weekends can vary substantially from one to the next. If so, then although weekday predictability would allow individuals to tailor drinking patterns to the fit between their temperaments and the environmental challenges they routinely encounter (see Neff & Husaini, 1985), this would less likely be the case for weekends.

The link between self-regulation and days of the week is important for understanding daily variation in drinking behaviors. Regulating negative mood is recognized as a major reason for alcohol use (Wills & Shiffman, 1985). The role of alcohol use in self-regulation is consistent with earlier in-the-day low affect predicting evening drinking on weekdays but not on weekends (Orcutt & Harvey, 1991). Drinking to regulate negative mood, termed drinking to cope, also has different antecedents and implications than drinking for other reasons, such as drinking to enhance positive mood or social drinking. Unlike drinking to cope, drinking to enhance positive mood and social drinking are not predicted by the

interaction of expecting alcohol to reduce tension, negative emotionality, and avoidance coping styles (Cooper et al., 1992). In addition, drinking to enhance does not come with the same increased risks of drinking to impairment, developing tolerance, and experiencing withdrawal (Cooper et al., 1992) associated with drinking to cope. For these reasons, alcohol researchers have argued that drinking to enhance and drinking to cope may be psychologically distinct or “phenomenologically different” behaviors (Cooper et al., 1995). To the extent that drinking to enhance and drinking to cope are different behaviors and assuming that drinking to enhance predominates—or at least is more frequent—during the weekend, especially on Friday and Saturday nights, then it would follow that weekend drinking may also be phenomenologically distinct from weekday drinking.

Behavioral Genetics and Drinking to Cope

Individual differences in drinking behaviors are influenced by genetic as well as environmental factors (Heath & Martin, 1994; McGue, 1999). The environmental influences that affect drinking variance are primarily of the nonshared variety, especially during adulthood. In contrast, during adolescence shared environmental factors tend to contribute to drinking outcomes. McGue (1999) concluded that shared environmental influences on drinking outcomes dissipate once individuals leave their rearing home.

The above conclusions regarding genetic and environmental influences focus on drinking generally. It may be, however, that drinking in specific contexts may have different patterns of genetic and environmental influences. Drinking during weekends, for example, may draw upon motivations that differ from those motivating weekday drinking. If so, these differences may manifest in different patterns of genetic and environmental influences on weekend drinking relative to weekday drinking. In the last decade, behavioral genetic studies have explored influences on different types of drinking motivations. Findings are intriguing, although somewhat mixed. For example, Prescott and colleagues (2004) revealed substantial heritabilities for both drinking to manage mood and socially-oriented drinking (specifically the *Gregarious* subscale, which included peer-related drinking, had a heritability of .43) among females. Among males, however, although drinking to manage mood was moderately heritable (.36), genetic influences contributed only 11% to variation in the Gregarious Drinking subscale (Prescott et al., 2004). Similar work by Agrawal and colleagues (2007) found genetic influences on coping-related drinking motives among young adult women. Unlike Prescott et al.’s findings, however, Agrawal et al. did not uncover significant genetic effects for enhancement-oriented drinking motives among females. It is worth noting that in contrast to the general pattern of no shared environmental influence on general drinking among adults, drinking motivations have shown some evidence of shared environmental influences. For example, Prescott et al. (2004) reported significant shared environmental influences for *Gregarious Drinking* among males, but not among females. Agrawal and colleagues (2007) found evidence of shared environmental influences on enhancement-oriented drinking motives among young adult females.

Based on the above work, our study sets out to examine several analysis goals. Analysis Goal One is to investigate the relative impact of genetic and environmental influences across weekend drinking and weekday drinking. Analysis Goals Two and Three are more focused. Goal Two is to determine whether there are genetic influences that affect weekday drinking that do not influence weekend drinking. Goal Three is to examine if there are greater nonshared environmental influences on weekend drinking than on weekday drinking. It is worth noting that although Analysis Goals Two and Three focus on different sets of influences, the processes they examine, the potential of genetic influences unique to weekday drinking and greater nonshared environmental influences on weekend drinking, do not necessarily conflict with each other.

To address these Analysis Goals we fit bivariate behavioral genetic models to reports of weekend drinking and weekday drinking. These models provide information both on the degree of genetic and environmental influences on weekend drinking and weekday drinking variance and on whether genetic and environmental influences on weekend and weekday drinking are due to overlapping (i.e., common) or unique influences. On a threshold level, the results provided by behavioral genetic designs provide a check against the assumptions of family environmental influences, such as the idea that parents' alcohol use behaviors, beliefs, and attitudes affect offspring for decades, which otherwise pervade conventional approaches to understanding how alcohol use is transmitted across generations and influences policy. Results from bivariate models more specifically address the processes that link related behaviors, providing information on why behaviors co-occur within individuals and how one might target interventions to affect one or both behaviors. Being able to examine weekend drinking and contrast this behavior, and its influences, to weekday drinking allows this study to determine if the behavioral genetic findings on drinking without regard to its temporal context can be applied to drinking during the weekends, during which an inordinate amount of risky drinking behavior occurs. Prior to presenting the results of these analyses, we put forward the means and standard deviations for the analysis sample, as well as the within-twin pair correlations for weekend and weekday drinking.

Method

Sample and Procedure

Data for the analyses were drawn from the first wave of the National Study of Daily Experiences (NSDE), one of the in-depth studies of the National Survey of Midlife in the United States Survey (MIDUS). The NSDE is a nationally representative study of daily experiences among middle-aged Americans. Data were collected through phone interviews that took place each night for eight consecutive nights. Each interview took approximately 15 minutes and covered that day's experiences. The vast majority of interviews took place in the early evening. In the case of twins, co-twins were interviewed at least two weeks apart. In addition, the initiation of interviews was staggered across days of the week to control for possible confounding between day of study and day of week. Respondents received \$20 for their participation.

The total NSDE sample of 1,483 was composed of 1,031 randomly selected respondents from the MIDUS random digit dialed (RDD) subsample and 452 MIDUS twins from the larger MIDUS twin sample (Johnson & Kruger, 2005; Kessler, Gilman, Thornton, & Kendler, 2004). Only data drawn from twins were examined in the primary analyses of this study. In order to address generalizability we calculated means and SDs of daily level of drinking and daily drinking for the randomly selected respondents who participated in the NSDE and the full twin sample. These means—.57 (SD = 1.41) and .51 (SD = .94), respectively—were very similar. In fact, dividing the difference (.05) by the standard deviation of the random sample (1.41) demonstrates that the samples differ by only 3.5% of a standard deviation.

Twin pairs were selected for interviews if they had high self-reported certainty of zygosity, ascertained from a series of questions (Kessler et al., 2004). Twin pairs included monozygotic (MZ) twins, who share 100% of their genes, and dizygotic (DZ) twin pairs, who share on average 50% of their genes, allowing estimation of additive genetic, shared environmental, and non-shared environmental influences. Both members of 210 intact twin pairs, including 111 identical (MZ) twin pairs and 99 same-sex fraternal (DZ) twins pairs, participated in the diary study.

Of these 210 twin pairs, 178 had complete data on both weekend and weekday drinking. The mean age of this analysis sample was 43.9 (SD = 11.8). Forty-eight percent of the respondents were male, 52% were female. Ninety-two percent of respondents were White, 6% were African American, and 2% reported another ethnicity. Seventy-seven percent of the respondents were currently employed.

Weekend and Weekday Drinking Volume

Both weekend and weekday drinking outcomes were constructed from responses to a single item asking participants the following: “Counting a drink as a bottle of beer, glass of wine, shot of liquor, how many drinks did you have since we spoke yesterday?” Responses ranged from 0 to 12. Given that the report of drinking captured drinking from the time of the last interview to the moment of that day’s interview, drinking reports were assigned to the prior day. Weekend drinking was constructed with the average drinking reports for Friday and Saturday. To create weekday drinking volume scores the reported drinking responses for Monday through Wednesday were averaged. The specific days used to capture weekend and weekday drinking, Friday and Saturday and Monday through Wednesday, respectively, were selected because they most clearly captured the celebratory nature of weekends and routinized nature of weekdays. As they border weekends and weekdays, the meaning of Sundays and Thursdays for drinking may be more ambiguous in relation to “weekend” and “weekday” drinking, respectively. These ‘border’ days were not used to construct the weekday or weekend scores used in the primary analyses. In addition to weekend and weekday drinking outcomes, Monday through Sunday (“All days”) drinking volume was calculated.

It is important to note that abstaining participants were not excluded from primary analyses. As a result, our analyses treat non-drinkers the same as drinkers who just did not report drinking during the data collection days. One impact of this inclusion of abstainers is to make our comparison of weekend and weekday drinking more conservative—as a result of including non-drinkers, weekends and weekdays could appear more similar than they would otherwise. Moreover, including abstainers renders analyses unable to distinguish influences on abstinence vs. influences on quantity and frequency, which have been shown to be independent from each other (Heath et al., 1991). Although we do not drop abstainers from primary analyses, we investigate the impact of their inclusion by calculating and presenting the MZ and DZ pairs’ correlations for the subset of respondents who are drinkers, providing the opportunity to compare patterns of correlations for this subsample to those of the full analysis sample.

Using the above criteria, 178 pairs had complete weekday and weekend data necessary for bivariate analyses. As is common for such outcomes, drinking variables were skewed. For example, weekday drinking had a standard deviation (.843) of over twice its mean of .394. To adjust for this skew, variables were square-root transformed, which substantially reduced their skew ($M = .332$ and $SD .333$). Overall, phenotypic correlations between weekday and weekday drinking were .69 for monozygotic and .66 for dizygotic twins.

Given that the present study uses bivariate biometric models it is important to briefly set out the underlying logic of twin models generally as well as bivariate models specifically. Biometric models are most commonly used to apportion variance in drinking volume into additive genetic effects (A), shared environmental effects (C), and unshared environmental effects (E). In the case of univariate models only one version of each of these three components (A, C, and E) are estimated. Thus, these models are often referred to as ACE models. The bivariate models presented here estimate similarly unique A, C, and E contributions to each individual variables (one set of unique factors for each measured variable) as well as A, C, and E influences that contribute to both variables (i.e., influences

common to, or overlapping, both outcomes). Thus, a full version of bivariate behavioral genetic analyses of weekday and weekend drinking (i.e., the inclusive model before non-significant parameters are dropped) would estimate different sets of unique A, C, and E influences on each of the two drinking outcomes and overlapping A, C, and E influences on the two measured drinking outcomes.

All models use data drawn from monozygotic (MZ) twin pairs, who share 100% of their genes and dizygotic (DZ) twin pairs, who on average share 50% of their genes that vary (alleles). The fact that different levels of genetic similarity exist across types of twin pairs raised within the same households allows the estimation of additive genetic effects (“A” in the ACE model), as well as shared (i.e., common to the same household) and nonshared environmental effects. Because the twins in our sample were reared in the same households, they shared exposure to various aspects of that family environment, such as family socioeconomic status, neighborhood quality, and some parenting behaviors, such as parental models of drinking. To the extent that these influences make the drinking behaviors of twins reared in the same household similar to each other, these influences contribute to shared environmental or ‘common’ environmental influences (“C” in the ACE model). Of course, within the same households, twins like other siblings do not share all of their experiences. Only environmental influences that twins both share and make them similar contribute to shared environmental influences. It is also important to note that the environments are not directly assessed; rather, the influence of sharing the households is inferred from the similarity among pairs not explainable by genetic influences.

The third set of influences estimated by standard ACE models are nonshared environmental influences (“E” in the ACE model). These influences result from environmental experiences, whether or outside households, that make the twins different. Some nonshared environmental influences occur within the same family (see Anderson, Hetherington, Reiss, & Howe, 1994), while others occur in contexts outside the home (Harris, 1995). In the case of non-shared environmental influences for drinking among middle-aged adults such influences would include experiences that might occur during the data collection period that differed between siblings.

As explained above, bivariate models extend the univariate ACE models to examine overlapping and unique versions of the A, C, and E components. By using information on how the degree of covariance between twins is differently patterned across twin pairs that differ in zygosity levels, these models allow the estimation of additive genetic, shared environmental, and non-shared environmental contributions to the covariance between different phenotypes (i.e., common or “overlapping” A, C, and E) and unique variance of each phenotype. The key association that contributes to the estimation of bivariate ACE models is the cross-trait (i.e., cross-phenotype) cross-twin association, and the extent to which it varies across MZ vs. DZ twin pairs. If, for example, the cross-trait association among MZ pairs is twice that observed among DZ pairs, this pattern indicates that covariation between traits is due to genetic influences. If, however, the cross-trait cross-twin association is the same magnitude across MZ and DZ pairs, covariation is due to shared environmental influences. A key component of the bivariate model is that parameters connecting each of the common factors to the different measured variables (weekday drinking and weekend drinking) are constrained to be equal. Setting these parameters to be equivalent is necessary to identify and interpret the model.

Results

Preliminary Results

Table 1 provides means for uncorrected versions of Friday and Saturday drinking and Monday through Wednesday drinking. As expected, volume of drinking was greater on Friday and Saturday (.79) than on Monday through Wednesday (.40). With a standard deviation of 1.49, the variability for drinking was also much greater than during the week, $SD = .87$. To provide a reference point for these outcomes, mean drinking across Monday through Sunday is also presented here. The mean (and SD) for drinking across all days of the week (i.e., 'weekly drinking') was .52(.88). Notably, this mean is the same as the daily drinking value for all twins and similar to the corresponding value (.57) for daily drinking for the representative core sample of the NSDE. The similarity of the standard deviation for Monday to Sunday drinking (.88), constructed from all eight days of data with the standard deviation of Monday to Wednesday drinking (.87), demonstrates that greater variance in weekend drinking is not an artifact of only using two days of data to construct the weekend drinking outcome. Although not analyzed by gender due to sample size limitations, drinking levels across weekdays and weekends are similarly patterned for males and females. Mean of Friday to Saturday drinking among males and females was .93(1.71) and .65(1.29), respectively; Monday to Wednesday drinking for males and females was .54(1.03) and .27(.60), respectively.

Table 1 also provides cross-twin correlations for Friday and Saturday (weekend) drinking and Monday through Wednesday (weekday) drinking, as well as Monday through Sunday (all days) drinking across zygosity levels. These correlations are based on the square-root corrected variables used for the bivariate models that follow. MZ correlations exceed DZ correlations across each of the three drinking outcomes. The degree of difference in MZ and DZ correlations varies by across weekdays and weekends, however. The MZ correlation for Monday through Wednesday drinking ($r = .38^*$; * denotes significance at .05 level) was substantially more than double the DZ correlation ($r = .07_{ns}$). In contrast, the MZ correlation for Friday to Saturday drinking ($r = .21^*$), although larger, was not double the DZ correlation (.16_{ns}) for this outcome. The lower MZ correlation for Friday and Saturday drinking than for Monday to Wednesday drinking suggests that genetic influences on drinking may be less potent during the weekend. As expected, correlation patterns for Monday to Sunday (all days) drinking indicate a pattern of genetic influences. The MZ correlation for drinking across the seven days of the week ($r = .37^*$) was similar to weekday drinking. Across the three drinking outcomes, the only evidence of shared environmental influence was that the DZ correlation for weekend drinking exceeded one-half the corresponding MZ correlation. Although correlation patterns provide scant evidence of shared environmental influences, the fact that MZ correlations did not exceed .5 across any of the three drinking outcomes indicates a substantial role for nonshared environmental influences.

In addition to the correlations shown in Table 1, preliminary analyses calculated the cross-twin cross-trait correlations for Friday–Saturday and Monday–Wednesday drinking. These cross-trait cross-twin correlations (e.g., the correlation between twin 1's weekend drinking and twin 2's weekday drinking), which were based on the 96 MZ and 82 DZ twin pairs that had both Monday through Wednesday and Friday and Saturday drinking outcomes, averaged .27* among MZ twins and .17 (ns) among DZ twins. Cross-trait cross-twin MZ correlations approached twice the magnitude of the corresponding DZ twin correlations, suggesting that covariance between weekend and weekday drinking is primarily influenced by genetics.

The lower half of Table 1 provides means and correlations for the drinkers (i.e., after dropping abstainers). As expected, as a result of dropping non-drinkers these means are higher. For example, the mean for drinking on weekend days, which was only .79 for the analysis sample, exceeded one ($M = 1.10$, $SD = 1.73$). Although means are somewhat higher, the pattern of correlations generally adhere to the patterns observed among the full analysis sample—albeit being somewhat lower in magnitude—across the three outcomes. Key aspects of these correlations that match patterns observed in the full sample include that MZ correlations are higher than DZ correlations, indicating genetic influences, and that the greatest MZ-DZ differences occur for weekday drinking. Average cross-sib cross-trait correlations were .33* for MZ pairs and .15(ns) for DZ pairs.

Although the relatively small size of the analysis sample precluded reliable analyses by sex, correlations were calculated across sex. Male correlations for weekend drinking were .38* for MZ ($n = 46$) and .31 (ns) for DZ pairs ($n = 39$), respectively. Corresponding female correlations were .51* and -.08 (ns) for MZ ($n = 50$) and DZ ($n = 43$) pairs, respectively. Corresponding correlations calculated for weekend drinking were .26 (ns) and .08 (ns) among male MZ and DZ pairs, respectively; and .12 (ns) and -.10 (ns) among female pairs, respectively.

Finally, to investigate whether the correlation patterns were dependent on operationalizing weekdays with Monday through Wednesday data and weekdays with Friday and Saturday data, cross-twin correlations were calculated for Monday through Thursday and Friday through Sunday versions of weekday and weekend drinking. These correlations (not shown in tabular form), calculated on all available twin pairs, match the patterns drawn by the primary constructions of these variables. Specifically, on both types of days MZ pairs, .28* and .48*, for weekends and weekdays, respectively, show higher correlations than DZ twins, .20 (ns) and .15 (ns), respectively. Just as with the variables used in the primary analyses, MZ - DZ differences were most pronounced for weekday drinking.

Primary Analyses: Bivariate Biometric Models

Models were fit to covariance matrixes computed from square-root corrected variables using the Mx statistical package (Neale et al., 2006). Using only respondents with complete data for both Monday to Wednesday drinking and Friday and Saturday drinking ($N^{mz} = 96$, $N^{dz} = 82$), bivariate models (shown in Table 2) were fit to 4×4 covariance matrices calculated from square-root corrected versions of Monday to Wednesday drinking and Friday and Saturday drinking. Similar to univariate results, unstandardized parameters are presented. Model 1 fit included nine parameters, overlapping A, C, and E parameters, and sets of unique A, C, and E parameters for both Monday to Wednesday drinking and Friday and Saturday drinking. This full model fit the data reasonably well ($\chi^2(11df) = 23.73$; AIC = 1.73; RMSEA = .080). Many paths' parameters, however, were zero, in particular those modeling shared environmental influences. The next model, Model 2, dropped overlapping C and both unique C parameters. The fit of this model ($\chi^2(14df) = 23.73$) was identical to the full model.

The next model, Model 3, dropped parameters for unique A for both Monday to Wednesday drinking and Friday and Saturday drinking. The resulting fit was ($\chi^2(16df) = 23.90$; AIC = -8.10; RMSEA = .065), similar to Model 2. The .17 Chi-square difference between this model (2df) and Model 2 was not significant. Based on the nonsignificance (confidence intervals included zero) of the unique non-shared environmental (E) parameter for Monday through Wednesday drinking in Model 3, this parameter was dropped and the model rerun. The resulting model, Model 4—included parameters of overlapping A and E parameters and a unique E parameter for Friday and Saturday drinking—fit the data reasonably well ($\chi^2(17df) = 26.24$; AIC = -7.76; RMSEA = .063). The Chi-square difference between this

model and Model 3 [$X^2_{\text{dif}}(1\text{df}) = 2.34$] was nonsignificant. The difference between Model 4 and Model 2 [$X^2_{\text{dif}}(3\text{df}) = 2.5$] was also not significant. Based upon these nested Chi-square tests, as well as its lowest RMSEA (.063), Model 4 was accepted as the final model.

In addition to these models, three other alternative nested models were fit to the data. Because Model 4 did not estimate an E parameter for Monday to Wednesday, each of these additional models is nested within Model 3. Like Model 3, each provide Unique Non-shared Environmental parameters for both Monday to Wednesday and Friday to Saturday drinking. These three models dropped overlapping A, overlapping E, and both overlapping A and overlapping E, respectively. Compared to Model 3, each provided a poor fit to the data. Specifically, dropping overlapping A provided a Chi-square of 38.78(17df), dropping overlapping E provided a Chi-square of 106.41(17df), and Dropping both overlapping A and E led to a Chi-square of 252.23(18df).

Unstandardized coefficients for Model 4 are shown in Figure 1. Overlapping genetic and nonshared environmental factors, influencing both weekday and weekend drinking, are shown above. The unique nonshared environmental factor influencing weekend drinking is shown below. Analyses indicate that the magnitude of the unique nonshared environmental influence on Friday and Saturday drinking exceeds the size of overlapping nonshared environmental influences. Using the unstandardized parameters from Model 2, h^2 and e^2 were calculated as .17 and .83 for weekday (M–W) drinking and .36 and .64 for weekend (F–S) drinking.

Estimated heritability for weekend drinking was approximately half that of weekday drinking. These apparent differences in heritability for weekday vs. weekend drinking do not emerge from differences in unique genetic influences on drinking during weekdays. In contrast, genetic influences on weekday drinking are shared by weekend drinking. Second, rather than providing evidence that genetic influences on Monday to Wednesday drinking are different or stronger than those associated with Friday and Saturday drinking, the bivariate results reveal unique nonshared environmental influences on Friday and Saturday drinking. These unique nonshared environmental influences account for differences in the relative contribution of genetic and nonshared influences on drinking across weekdays and weekends.

Discussion

This study investigated genetic and environmental influences on Monday to Wednesday drinking and Friday and Saturday drinking in an adult sample of twins. Applying genetically informative analyses to daily-reports of drinking across weekdays and weekend days, this study was able to address whether the relative impact of genetic and environmental influences differed across weekend drinking and weekday drinking (*Analysis Goal One*), whether there are genetic influences that affect weekday drinking that do not influence weekend drinking (*Analysis Goal Two*), and whether there are greater nonshared environmental influences on weekend drinking than on weekday drinking (*Analysis Goal Three*).

As expected, preliminary analyses revealed that more drinking occurred during weekend days than on weekdays. Estimates of heritability for drinking were .17 during the weekend and .36 during the weekday. On the surface, these estimates might appear to suggest different levels of genetic influences on weekend vs. weekday drinking. If so, these results would be consistent with expectations derived from both non-genetic (e.g., Cooper et al., 1992; Orcutt & Harvey, 1991) and behavioral genetic studies (Agrawal et al., 2007; Prescott et al., 2004). However, because variance in drinking across types of days differs

substantially, these apparent differences in heritability, as a portion of total variance explained by genetic influence, can be misleading. These differences in proportions of variance explained by genetics are driven by differences in total variance of drinking across the examined temporal contexts, not by differences in genetic influences.

By finding unique nonshared environmental influences on weekend drinking, the bivariate models address Analyses *Goal Three*. Specifically, the best-fitting bivariate model included unique nonshared environmental influences on Friday and Saturday drinking. In contrast, dropping unique nonshared environmental influences on Monday to Wednesday drinking did not significantly reduce model fit.

Goal Two was to determine whether there are genetic influences that affect weekday drinking that do not influence weekend drinking. There was no evidence that genetic influences on drinking operated differently during the week. Rather than being modified by weekends, genetic influences on daily drinking persisted, remaining substantially constant as people enter their weekends. Although these genetic influences are stable across temporal contexts, in the face of a substantial increase in unshared environmental influences their relative contribution decreases.

This null finding is the core of this study's contribution. Given high-quality reports of daily drinking volume the failure to find evidence of different genetic influences on weekend vs. weekday drinking undercuts the idea that weekend drinking is a different type of drinking than weekday drinking. Potential policy implications of this null finding may include that rather than assuming that episodic drinking is a different phenomenon than regular drinking, and thus that episodic drinkers are different than regular drinkers, interventions targeted to reduce drinking volume generally may effectively reduce drinking across contexts. The specific uptick in drinking during weekends, however, may be situational. Understanding the situational differences between weekends that drive this increase in level and variance requires studies that carefully measure differences in daily experiences across weekends. The characteristics of studies needed for this research are discussed in the Future Directions section below.

The developmental context of these findings should be emphasized. Subjects were adults, 43 years of age on average. At this part of the lifespan, weekdays are likely a highly scheduled mix of work, childcare, meal preparation, and, for some, routinized drinking patterns. Finding significant unique nonshared environmental influences on weekend drinking is consistent with the idea that weekends add an aspect of unpredictability, at least for drinking. The age of the sample is also relevant to our not finding shared environmental influences on drinking variance—in either weekends or weekdays. As noted by McGue (1999), rearing environments tend not to dictate drinking behaviors once individuals leave them. In the case of our respondents, decades had passed since the sampled individuals had resided in their parents' households.

Our findings do not necessarily conflict with Orcutt and Harvey's (1991) suggestion that drinking to reduce tension can reflect a routinized use of alcohol for its stress-buffering effects. However, our findings may help explain why early-day anxiety may not predict variance in same-day drinking during the weekend, as it does during the week. It may be that negative emotional state could still lead to drinking behavior during weekends, but links between negative mood and drinking might be counterweighted by more active links between positive mood and drinking during the weekend. Moreover, the magnitude of associations between anxiety and drinking might also be attenuated by substantial increases in both amount and variance in weekend drinking. The apparent differences between our findings and Orcutt and Harvey's work may also be due to differences in the age and life

course context of the two studies. Orcutt and Harvey's sample was drawn from a population of traditional-age college students. Adult drinking may differ greatly from drinking in college for several reasons. Unlike college students, adults in this sample have had the opportunity to develop long-term patterns of daily drinking. Weekend drinking likely incorporates these patterns and the heritable influences that contribute to them. In contrast, college students have not had the same long-term opportunities to develop daily patterns. Come the weekend, the college atmosphere may sweep all but the most resolute teetotalers into alcohol use. Finally, the majority of adults have jobs.

Our finding that drinking during weekends has the same genetic influences as drinking during the week differs somewhat from our expectations and might be seen as contradictory to Agrawal et al.'s (2008) finding of no genetic contributions to drinking to enhance. Rather than viewing these findings as contradictory, however, we believe they help understand the nature (and *nurture*) of weekend drinking. Rather than weekend drinking being limited to drinking that is entirely social- and enhancement-oriented, it may be that the totality of weekend drinking is a composite of drinking related to situational factors that are more common during the weekend and drinking that is related to the same factors than influence weekday drinking. Direct measures of enhancement drinking motivations may assess the former, more situational drinking behaviors.

That the unique weekend factors are of the nonshared environmental, rather than the genetic, variety is consistent with the idea that weekend influences do not influence drinking differentially by genetic predispositions. In other words, we did not find evidence that people differ in genetic susceptibility to weekends' effects. Rather, consistent with Argeriou's (1975) observations, weekends likely increase drinking among all levels of drinkers.

Although a substantial majority of the variation in drinking behaviors, and overlapping genetic and non-shared environmental influences, may carry through from weekdays to weekends, there is an increase in the volume and variability of drinking during the weekends. From a policy perspective these increases are public health risks unrelated to genetics or differences in family-rearing experiences (parental modeling of alcohol use) that would show up as shared environmental experiences. The link between these weekend differences and non-shared environmental influences unique to weekends suggests that changing the way in which we—as a society—view weekends and alcohol is key to reducing the risk behaviors associated with alcohol use that occur during these times.

That these increases in weekend drinking are not due to shared environmental influences indicates where not to intervene. Shared environmental influences correspond most closely to household experiences, such as parenting and parenting practices, in twin pairs-rearing environments. Thus, our findings suggest that parents' own drinking behaviors—such as those that might be blamed for family transmission of “drinking expectations”—are not to be blamed for decades-later, weekend-related drinking behaviors. However, non-shared influences are difficult to parse beyond that. It may be that individuals have encountered specific environmental experiences during their development (those that would not be common to their household) that have led them to drink more heavily than their co-twin during weekends. Or it may be the case that one twin's weekend was just different than their co-twin's during the data collection period. As is often the case with behavioral genetics, these results only point to general domains for further analyses. When findings suggest genetic influences, the next steps can include analyses of specific candidate genes. In this case, finding unique non-shared influences on weekend drinking points to the importance of considering specific environmental influences, which could vary between twins during the data collection periods.

Weekend drinking's unique environmental factors suggest that these behaviors are very modifiable via changes to the proximate environment of individuals. Thus, at least on an abstract level, policies that reduce the temporal attractiveness of drinking during the weekends, or the acceptability of heavy drinking during the weekends, may be best suited for having a substantial impact on reducing the harm linked to drinking. However, on a less abstract level, without identifying the specific environmental factors that drive this variance the policy implications are limited. As mentioned above, future research will have to go further to identify specific aspects of non-shared experiences. How studies should be structured to do this is elaborated upon in the Future Directions section below.

Study Strengths

The daily diary data used led directly to two particular study strengths: Daily reports of drinking, and the ability to apply a within-person framework to investigate weekend vs. weekday drinking. First, respondents were asked to report on their drinking over the last 24 hours. This approach avoids the problems associated with asking respondents to report on their average weekend and weekend drinking over a longer period of time. The fact that mean levels of drinking matched the pattern of other day-level drinking data (see Argeriou, 1975) supports their validity. Second, daily diary data collected over the course of eight days provided this study with the opportunity to consider overlapping and unique influences on weekday and weekend drinking. Put another way, by investigating the same behavior, drinking, among the same respondents but across two contexts, this study was able to investigate the impact of contextual influences while holding constant person-level influences. In other words, weekends happen to everyone. In contrast, if the contextual factor examined was a specific context that not all respondents were as likely to encounter, such as going to bars or attending parties where heavy alcohol use is encouraged, analyses would be vulnerable to validity threats associated with genetically (i.e., rGE) and environmentally influenced self-selection into these experiences.

The application of the within-person design to study an environmental influence is particularly important in the context of behavioral genetics, which has been the target of critiques for its somewhat opaque treatment of environmental influences. In short, behavioral genetics conventionally divides all variance not associated with genetics into two components—those shared by twins and those that are non-shared. This latent distinction is difficult to link to concrete aspects of the environment. In contrast, by applying a behavioral genetic design to drinking data collected across weekends and weekdays, we were able to identify specific variance due to weekend environments.

Another benefit of the daily approach to drinking is that it allowed comparisons between weekend and weekday outcomes and drinking across all seven days of the week. Correlation patterns for drinking from Monday through Sunday look much more like Monday to Wednesday drinking than Friday to Saturday drinking, suggesting that other research findings on total drinking, at least among adults, may be more driven by and thus more applicable to during-the-week drinking than weekend drinking. Perhaps when asked about their “normal” or average drinking, respondents are more likely to report on their weekday drinking than their drinking during weekend celebrations—which they may consider to be exceptions to their general drinking behaviors.

Limitations

Despite the advantage of daily reports of drinking, the practice of assigning all drinking reported since the prior day's interview to that prior day could be improved with multiple data collections per day or multiple questions about drinking in each end-of-day interview. As nearly all interviews occurred in the early evening, however, assigning drinking to the

prior day appeared reasonable. Of course, the possibility that some participants may have consumed alcohol earlier in the day creates some uncertainty. This uncertainty may be more critical if, rather than modeling drinking on blocks of days, we were attempting to make more specific distinctions between contiguous days within blocks of similar days (e.g., Monday vs. Tuesday drinking or Friday vs. Saturday drinking). Given that we combined drinking within blocks of similar days and that the mean levels of weekend and weekday drinking fit with expectations, we are confident that our measures capture differences between weekday and weekend drinking. Another limitation involves the untested assumptions of twin models. These assumptions include no assortative mating, that environmental experiences are similarly shared by twins across levels of zygosity, and that genetic and environmental influences are additive.

Not being able to examine potential differences by sex is another limitation. Given the suggestions of different levels of genetic influences on enhancement drinking found by Prescott and colleagues (2004), it would be interesting to investigate whether the unique nonshared environmental influences found for the full sample differed by sex. The limited sample size, with 40 to 56 pairs per sex by zygosity group, and associated instability of correlations undercut the ability to perform these analyses with certainty. In fact, when calculated separately by sex the DZ correlations for weekend drinking exceeding the MZ correlation among males and being negative among females, demonstrate this instability. It should be noted, however, that the instability in these DZ correlations is unlikely to have led to the identification of unique non-shared influences during weekends. This finding, rather, is driven by the relatively low MZ correlations for weekend drinking, which were .21 in the full sample, and .25 and .15 in the male and female subsamples.

A final limitation is not being able to examine the contexts of the unique non-shared environmental influences found for weekend drinking. This shortcoming and a suggestion on how to the type of study that could address it are addressed below.

Future Directions

This study used within-person data for behavioral genetic modeling of daily drinking volume across weekends and weekdays. Using within-person data in this fashion provides a novel opportunity to consider person-by-context interactions. At the outset, we expected to find stronger, or novel, genetic influences on weekday drinking. In contrast, we found that genetic influences on weekday drinking were the same as those impacting weekend drinking. Rather than finding unique genetic influences on weekday drinking, we uncovered unique nonshared environmental influences on weekend drinking. This finding highlights the ability of genetically-informative designs to document environmental effects. To our knowledge this is the first behavior genetic study to consider such person-by-context processes with a within-person design. We suggest that this approach—using within-person, rather than between-person, data for behavioral genetic decompositions—can be applied to other outcomes for which genetic and/or environmental influences may vary across different contexts or situations. Making use of contextual differences that vary across time in groups of people allows designs to avoid rGE confounds, such as genetically-influenced self-selection of pro-drinking contexts, which can undercut the validity of between-person investigations of person by context processes.

Attempts to clarify the nonshared environmental factors that contribute to heavier drinking should focus on measuring specific experiences linked to heavier weekend drinking. Such inquiries would not have to make use of genetically informative designs. They would however, have to use within-persons designs that provide data on variation in experiences across multiple weekends. This type of data has been collected by the University Life Study (Patrick, Maggs, & Osgood, 2010), a project that collects data from college students in a

series of 14-day bursts spread out over several years, specifically seven semesters and 96 days of total data. This study provides a template for how to collect the type of data needed to gain a better understanding of within-person variability in environmental experiences, such as how weekends differ from one another and how such differences might encourage drinking behaviors. Given that the contexts of drinking among college students differ from those of midlife adults, however, it is unlikely that specific environmental experiences that encourage heavier drinking among college students would generalize to the population we examined here.

As a final note, this study draws upon the drinking-to-cope theory (Cooper et al., 1995) to explain why differences could be present in genetic vs. environmental influences on drinking across weekends and weekdays. This use of coping theory is very different than that of using weekend vs. weekday comparisons to test drinking-to-cope theory. Similarly structured within-person behavioral genetic studies could address drinking to cope more directly. For example, by comparing genetic and environmental influences across high- vs. low-stress days, such studies could more directly investigate whether drinking to cope is phenomenologically different than other types of drinking.

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References

- Argeriou M. Daily alcohol consumption patterns in Boston: Some findings and a partial test of the Tuesday hypothesis. *Alcoholism and Clinical and Experimental Research*. 1975; 12:137–142.
- Agrawal A, Dick DM, Bucholz KK, Madden PAF, Cooper ML, Sher KJ, Heath AC. Drinking expectancies and motives: A Genetic Study of Young Adult Missouri Women. *Addiction*. 2008; 103:192–204. [PubMed: 18199297]
- Cooper ML, Frone MR, Russell M, Mudar P. Drinking to regulate positive and negative emotions: A motivational model of alcohol use. *Journal of Personality and Social Psychology*. 1995; 69:990–1005. [PubMed: 7473043]
- Cooper ML, Russell M, Skinner JB, Windle M. Development and validation of a three-dimensional measure of drinking motives. *Psychological Assessment*. 1992; 4:123–132.
- Heath AC, Martin NG. Genetic influences of alcohol consumption patterns and problem drinking: Results from the Australian NHandMRC twin panel follow-up survey. *Ann. N.Y. Acad. Sci.* 1994; 708:72–85. [PubMed: 8154691]
- Heath AC, Meyer J, Jardine R, Martin N. The Inheritance of Alcohol Consumption Patterns in a General PopulationTwinSample:II. Determinants of Consumption Frequency and Quantity Consumed. *Journal of Studies on Alcohol*. 1991; 52:425–433. [PubMed: 1943097]
- McGue, M. Behavioral genetic models of alcoholism and drinking. In: Leonard, KE.; Blane, HT., editors. *Psychological theories of drinking and alcoholism*. 2nd ed. Guilford Press; New York: 1999. p. 372–421.
- Neale, MC.; Boker, SM.; Xie, G.; Maes, HH. Mx: Statistical Modeling. 7th Edition. Department of Psychiatry; Richmond, VA: 2006. VCU Box 90012623298
- Neff JA, Husaini BA. Stress buffering properties of alcohol consumption: The role of urbanicity and religious identification. *Journal of Health and Social Behavior*. 1985; 26:207–222. [PubMed: 4067237]
- Orcutt JD, Harvey LK. The temporal patterning of tension reduction: Stress and alcohol use on weekdays and weekends. *Journal of Studies on Alcohol*. 1991; 52:415–424. [PubMed: 1943096]
- Patrick ME, Maggs JL, Osgood DW. LateNight Penn State Alcohol-Free Programming: Students Drink Less on Days They Participate. *Prevention Science*. 2010; 11:155–162. [PubMed: 20020210]

- Prescott CA, Cross RJ, Kuhn JW, Horn JL, Kendler KS. Is risk for alcoholism mediated by differences in drinking motivations? *Alcoholism: Clinical and Experimental Research*. 2004; 28:29–39.
- Texas Department of Transportation. [Retrieved June, 20, 2012] DUI (Alcohol) Related Crashes by Hour and Day of the Week. 2010. http://ftp.dot.state.tx.us/pub/txdot-info/trf/crash_statistics/2010/41_2010.pdf
- Wills, TA.; Shiffman, S. Coping and substance use: A conceptual framework. In: Shiffman, S.; Wills, TA., editors. *Coping and substance use*. Academic Press; New York: 1985. p. 3-24.
- United States Department of Transportation. National Highway Traffic Safety Administration (NHTSA). *Traffic Safety Facts 2009: Alcohol-Impaired Driving*. NHTSA; Washington (DC): 2010. Available at URL: <http://www-nrd.nhtsa.dot.gov/Pubs/811385.PDF> [retrieved June 2012]

Figure 1.
Common and unique influences on weekday and weekend drinking

Table 1

Drinking volume by weekday - means and inter-twin correlations.

Analysis Sample			
	All Days	Fridays–Saturdays	Mondays–Wednesdays
	Means (SD) ¹		
	.52(.88)	.79(1.49)	.40(.87)
	Correlations ²		
MZ (n=96)	.37*	.21*	.38*
DZ (n=82)	.19 _{ns}	.16 _{ns}	.07 _{ns}
Non-Abstainers Only			
	All Days	Fridays–Saturdays	Mondays–Wednesdays
	Means (SD)		
	.64(1.08)	1.10 (1.73)	.57(1.16)
	Correlations		
MZ (N=62)	.40*	.21*	.41*
DZ (N=52)	.19 _{ns}	.12 _{ns}	.05 _{ns}

1 = raw scores; 2 = correlations based on square-root corrected scores. Mean of Fri.–Sat. drinking among males and females was .93(1.71) and .65(1.29); Mon.–Wednes. drinking was .54(1.03) and .27(.60) for males and females.

Table 2

Results of bivariate models daily drinking volume across weekends and weekdays

Bivariate Model: Mondays–Wednesdays and Fridays and Saturdays drinking (N = 96 MZ; 82 DZ)													
Model	X ² (df)	AIC	p	RMSEA	Overlapping Factors			Unique Factors					
					a ¹	c ¹	e ¹	a ^{mw}	e ^{mw}	a ^{fs}	c ^{fs}	e ^{fs}	
M1	23.73(11)	1.73	.014	.080	.32 (-.40 - .40) ²	.00 (-.29 - .29)	.41 (.34 - .48)	.00 (-.18 - .18)	.00 (-.13 - .13)	.15 (-.23 - .23)	.11 (-.27 - .27)	.00 (-.21 - .21)	.51 (.45 - .57)
M2	23.73(14)	-4.71	.049	.073	.32 (-.22 - .40)	---	.41 (.34 - .38)	.00 (-.18 - .18)	---	.15 (-.23 - .23)	.11 (.27 - .27)	---	.51 (.45 - .57)
M3	23.90(16)	-8.10	.092	.065	.32 (.22 - .40)	---	.41 (.38 - .49)	---	---	.15 (-.23 - .23)	---	---	.55 (.51 - .59)
M4	26.24(17)	-7.17	.070	.063	.32 (.22 - .40)	---	.43 (.38 - .49)	---	---	---	---	---	.55 (.51 - .59)

Note 1 = Unstandardized coefficients. Note 2 = 95% confidence intervals.