Drinking Norm–Behavior Association Over Time Using Retrospective and Daily Measures*

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ABSTRACT. Objective: Social norm–based interventions in college drinking are common but show mixed efficacy. Although such interventions assume a passive social-influence process, past research relied heavily on retrospective measures, leaving open the possibility that heuristic biases during recall may alternatively account for or inflate estimates of social influence from prospective norm–drinking associations. The present study examined this possibility, using retrospective and daily aggregated measures of self and perceived peer drinking behavior. **Method:** For each of 3 years, students ($N = 574$; 288 men) reported on their drinking levels and perceptions of descriptive drinking norms, using conventional retrospective reports over a month period and daily diary reports for 30 days. Using structural equation modeling, we tested cross-lag longitudinal models for evidence of social-influence/alternative processes and compared cross-lag effects across retrospective

and daily aggregate models to determine the extent to which heuristic recall biases contribute to the norm–behavior association. **Results:** Perceptions of social norms had a small but reliable effect on changing drinking behavior across years, as indicated by model comparisons. Past drinking behavior also consistently shaped changing perceptions of drinking norms. These effects were not attributable to, nor inflated by, heuristic biases during retrospective reporting of personal and peer behavior. **Conclusions:** These results suggest that social influence and not heuristic biases contribute to the long-term norm–drinking association but that alternative processes, whereby past drinking behavior shapes norm perceptions, contribute more to the norm–drinking association. Implications for interventions designed to reduce college drinking are discussed. (*J. Stud. Alcohol Drugs*, 71, 769–777, 2010)

IN AN EFFORT TO REDUCE the prevalence of heavy drinking among adolescents and the negative consequences that accompany such behaviors, many college administrators have turned to social norm–based interventions (Borsari and Carey, 2003). These social-norm campaigns posit that most students have inflated misperceptions of their campus peers' drinking; by educating students about the discrepancy between perceived and actual norms, social-norm campaigns seek to reduce alcohol consumption on college campuses (Lewis and Neighbors, 2006; Neighbors et al., 2004; Prentice and Miller, 1993; Schroeder and Prentice, 1998). In support of this approach, a number of studies have found that perceptions of drinking norms correlate positively with individual drinking behavior, with perceived norms typically exceeding personal levels of drinking (see Borsari and Carey, 2003, for a review).

The effectiveness of social norm–based interventions in reducing alcohol consumption by educating students of the

actual and, presumably, more moderate drinking norms, is mixed, however, with some studies demonstrating modest support (e.g., Perkins and Craig, 2006) and others finding norm campaigns to be ineffective (e.g., Clapp et al., 2003). One reason for these mixed effects may be a lack of understanding about the processes through which social norms and drinking behavior become related over time. Research and theory suggest several distinct processes by which the norm perception–drinking behavior association may develop: social influence (Prentice and Miller, 1993), cognitive dissonance-reduction (Gerrard et al., 1996), heuristic recall biases (Mullen and Hu, 1988; Tversky and Kahneman, 1990), and selective affiliation (Read et al., 2005; Reifman et al., 2006). The study described in this article examined the extent to which social-influence processes, as opposed to other processes, uniquely contribute to the norm–behavior association over time. A second goal of this research was to determine the extent to which estimates of the effect of these processes may be skewed by heuristic memory biases during recall using longitudinal designs with retrospective and daily aggregate measures (Tennen et al., 2000).

Social-influence processes

Much of the norms literature, as it pertains to alcohol consumption, asserts a passive social-influence process by which students adjust their behavior over time to match what they perceive to be the behavioral norm among their peers

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(e.g., Prentice and Miller, 1993). According to various models of social influence, normative information about what others are doing (be it through observation of behavior or expression of opinions and attitudes) or descriptive information regarding what most members of a relevant group are doing all shape and inform how the individual will behave (Cialdini et al., 1990; Latané, 1981; Sherif, 1936). With respect to drinking and other health behaviors, however, most of the research offered as support for a social-influence process via norm perception is cross-sectional (see Borsari and Carey, 2003) or did not measure both behavior and norm perceptions contemporaneously (e.g., Larimer et al., 2004; Schroeder and Prentice, 1998), making it difficult to discern causal order from the association between perceived drinking norms and personal drinking behavior (see Borsari and Carey, 2003, for a review).

In one of the few longitudinal studies investigating the norm perception–drinking behavior association in early adolescents, Marks et al. (1992) found evidence of a social-influence process, in that past perceptions of drinking prevalence predicted changes in drinking over the course of 1 year. Likewise, Gerrard et al. (1996) found that increases in perceptions of the prevalence of drinking, smoking, and drunk driving over the course of the first year of their study subsequently predicted risk behaviors over the course of the second year. Although these longitudinal studies are informative, they share analytic limitations. First, these studies used conventional multiple-regression analytic techniques, often with only a single-item indicator, making it difficult to account for error in the measurement of the intended constructs when assessing time-lagged and presumably causal associations. Second, the regression approach used in these studies cannot investigate the reciprocal prospective norms–drinking association, over the same time lag, in the same model (Finkel, 1995).

The few studies that did investigate both prospective paths of association over the same time lag (i.e., cross-lag studies; Finkel, 1995) have found less clear support for a prospective social-influence process. Neighbors et al. (2006a) simultaneously measured norm perceptions and drinking at two time points separated by 2 months. They found that perceived drinking norms at the start of the study were related to changes in drinking at follow-up but that drinking frequency at the start of the study was not related to changes in perceived drinking norms at follow-up. Using a similar design, Read et al. (2005) found that active forms of social influence (e.g., social modeling of close friends, and drink offers) predicted change in drinking behavior over an 18-month period but that more passive forms of social influence (e.g., perceived norms) did not predict change in drinking behavior. Taken together, these cross-lag findings offer support for a social-influence process in general but offer more mixed support for a passive social-influence process specifically, whereby perceptions of drinking norms lead to adjustments

in drinking behavior over time to approach “normal” drinking levels.

Heuristic recall biases

Heuristic recall biases—such as the representative heuristic, availability heuristic, and anchoring (Tversky and Kahneman, 1990)—might also explain the drinking norm–behavior association. On the one hand, when people recall their moods and behavior, the representative heuristic may lead them to unwittingly infer their own past behavior from their knowledge of the normative behaviors of the groups to which they belong (Oishi, 2002; Robinson et al., 1998). Thus, prospective associations between norm perceptions and change in drinking behavior may be the result of heuristic biases during recall of norms and personal behavior, rather than a passive social-influence process. On the other hand, people may have more structured and available knowledge of their own behavior than of the collective behaviors of their peers and, therefore, may unwittingly use knowledge of their own behavior as an anchor during recall of group behavior; this may in turn skew their estimates of the behavior of others toward greater alignment with their own behavior (Mullen and Hu, 1988).

Furthermore, heuristic biases during recall increase with time, as people begin to shift from drawing on episodic, context-specific memory (e.g., “I had four alcoholic drinks at the club last night”) to general, context-independent semantic knowledge about themselves and their typical behavior (e.g., “My friends and I usually have only one or two alcoholic drinks per occasion”; Robinson and Clore, 2002). Thus, short recall draws on episodic memory whereas longer term recall draws on available semantic memory, which is more subject to heuristic bias (Robinson and Clore, 2002; Tennen et al., 2000). As previous studies investigating prospective associations between drinking and norm perceptions have relied heavily on retrospective self-reports, the extent to which heuristic biases may be contributing to the drinking–norm perception association over time remains unclear. If heuristic biases during recall are contributing to the cross-lag effects of (a) norm perceptions on change in drinking and (b) drinking on change in norm perceptions, then the magnitude of these effects should be smaller when the recall span is for shorter intervals (i.e., daily reports).

Present study

To date, few studies have used both longitudinal designs and structural equation modeling (SEM) to investigate the drinking–norm association. Furthermore, to our knowledge, no prior research has addressed the extent to which heuristic biases contribute to the drinking–norm association over time. According to a social-influence process hypothesis, past perceptions of drinking norms induce change in per-

sonal drinking behavior, whereas other processes (dissonance reduction, selective affiliation) suggest that past drinking behaviors induce change in norm perceptions. If heuristic recall biases are contributing to these prospective effects, the cross-lag effects should be greater when the window of recall for self-report is longer (e.g., monthly vs. daily). The present study investigated both drinking behavior and perceptions of drinking norms among college students over a 3-year period, using SEM. In addition, we compared results of models using conventional retrospective measures, which require that participants recall personal and peer drinking behavior over a 1-month period, with the results of models using daily measures of personal and peer drinking.

Method

Participants

We initially recruited 574 students (288 men, 286 women) from a New England university Introductory Psychology participant pool for a multiyear study of health behavior. From this original sample, we retained 537 (94%) for the second year of the study (Year 2), and 509 (89%) for the third year of the study (Year 3). Inclusion of all participants, regardless of the number of years of data they provided, is consistent with recent guidelines for maximizing the accuracy of parameter estimates derived from maximum likelihood-based models (e.g., Raudenbush and Bryk, 2002). At Year 1, 57% of participants were freshmen, 34% were sophomores, and 9% were juniors or seniors. Additionally, 6 participants responding at Year 2 and 21 responding at Year 3 had graduated from college by the time of data collection for each wave. Exclusion of these participants' postgraduation responses did not change the pattern of results reported here. The mean age of participants at Year 1 was 18.8 years ($SD = 1.1$). The majority of participants were White (86%), with the remaining participants being either Asian (6%), African American (4%), or Hispanic (3%); 1% did not indicate their ethnicity. Participants received \$20 each year for completing the initial questionnaire, and received \$1-\$5 per day of participation in the daily diary surveys, depending on the day of the week.

Procedure

As part of a broader study on health behaviors, participants responded each year to a battery of measures, including retrospective self-report measures of alcohol use and perceptions of descriptive drinking norms. For each year, data were collected approximately 1 month into the start of either the fall (61% of respondents) or spring semester (39% of respondents), and each subsequent year's data was collected during the same school-year semester for which participants responded at the beginning of the study. All

measures were administered online using a secure Website and participants had roughly 1 week to respond to these retrospective measures. In the first year of the study, participants provided their email, phone, and permanent address (which was used to contact them in subsequent years of the study), and they updated their contact information yearly.

Two weeks after completing retrospective measures, participants began the diary phase of the study, responding online daily, for up to 30 days, to a variety of health-related questions. Participants logged on between the hours of 2:30-7:00 P.M. daily. For most students, this time window coincided with the naturally occurring interim between the end of the school day and the beginning of evening activities. This window also helped ensure that students had time to respond regularly, and it limited the likelihood of participants responding while under the influence of alcohol. The online diary included daily assessments of drinking behavior and perceptions of normative drinking during the occasions during which participants drank alcohol. During this phase of the study, participants received daily as well as weekly emails, reminding them of the number of weeks remaining in the diary phase. Participants who missed more than 2 days in a row received a phone call reminder from a research assistant.

For analyses of the daily data, we included participants who completed the online diary for at least 15 days of the 30-day-diary phase during at least 1 year of the study. This inclusion criterion resulted in a final useable sample of 537 participants, with 530 participants responding adequately during Year 1 of the study (99%), 452 during Year 2 (85%), and 413 during Year 3 (78%).

Conventional retrospective measures

Drinking behavior. In each year, participants responded to four measures of drinking behavior developed by Wechsler and colleagues (1995) and were provided with a standard definition for servings of alcohol (e.g., one 5-oz. glass of wine, one 12-oz. wine cooler). First, participants reported the frequency with which they drank alcohol over the past 30 days using the following 7-point response scale: 0 = 0, 1-2 = 1, 3-5 = 2, 6-9 = 3, 10-19 = 4, 20-39 = 5, and 40 or more = 6. Second, they reported the quantity of alcoholic drinks they typically consumed per occasion in the last 30 days, using the following 9-point response scale: *no drinks* = 0, *1 drink* = 1, to *9 or more drinks* = 9. Third, participants indicated how recently they last had a drink of alcohol, using a 5-point response scale (*never had a drink* = 0, *not in the past year* = 1, *more than 30 days ago but less than a year ago* = 2, *more than a week ago but less than 30 days ago* = 3, *within the last week* = 4). Last, participants indicated how often they engaged in heavy drinking (i.e., how often they drank enough to get drunk in the past 30 days), using the following 7-point scale: *never/no drinking in the past 30 days* = 0, *1-2 occasions* = 1, *3-5 occasions* = 2, *6-9 occasions* = 3, *10-19*

occasions = 4, *20-39 occasions* = 5, *40 or more occasions* = 6. Responses to all four variables were converted to *z* scores before conducting SEM analyses in order to standardize the response scales across measures and to facilitate comparable measurement of the latent variable scores. Alpha coefficients for the retrospective drinking behavior composite were .88 at Year 1, .87 at Year 2, and .88 at Year 3. The standardized factor loadings for each observed drinking behavior variable ranged from .71 to .90 in Year 1, from .68 to .87 in Year 2, and from .60 to .86 in Year 3.

Drinking norms. Each year, participants also completed three measures that we developed of perceptions of descriptive drinking norms. Participants reported how much alcohol they thought the typical college student of their gender consumed, how much alcohol they thought their close friends consumed, and how much they thought members of their social group consumed. Participants responded to all three measures using the following 5-point response scale: *none* = 1, *one to three drinks per month* = 2, *one to three drinks per week* = 3, *one drink per day* = 4, *more than one drink per day* = 5. Alpha coefficients for retrospective drinking norms composites were .84, .87, and .85 for Years 1, 2, and 3, respectively. The standardized factor loadings for each observed drinking norm variable ranged from .62 to .94 in Year 1, from .62 to .97 in Year 2, and from .66 to .95 in Year 3.

Daily aggregate measures

Drinking behavior. During the daily diary phase of each year of the study, participants reported whether they had consumed alcohol the previous night and, if so, the number of alcoholic drinks consumed. Each day, participants were provided with the same standard definition for a serving of alcohol as used in the retrospective study (Wechsler et al., 1995). Participants selected 1 of 17 response options from a drop-down box, with options ranging from "0" through "15" as well as ">15." We computed three drinking behavior variables from the aggregate of participants' daily responses for each year, corresponding to our retrospective measures of drinking quantity, drinking frequency, and heavy drinking. First, we computed a daily average for drinking quantity by taking the mean of the number of drinks consumed on the drinking days; for individuals with no drinking days we set the value of this variable to zero. Second, we computed a measure of monthly drinking frequency by recoding the number of drinks to "0" if no drinks were consumed or "1" if any drinks were consumed for the entire day and then taking the mean of the available 30 days for each person for each year. Third, we created a measure of monthly heavy drinking by first recoding daily responses of five or more drinks for men and four or more drinks for women, as "1" (i.e., heavy drinking days; Wechsler et al., 1995). We then averaged daily heavy drinking scores across all responses. Alpha coefficients for daily aggregate drinking behaviors

composite were .89, .87, and .85 for Years 1, 2, and 3, respectively. The standardized factor loadings for each observed daily aggregate drinking behavior variable ranged from .73 to .86 in Year 1, from .72 to .98 in Year 2, and from .76 to .77 in Year 3.

Drinking norms. During the daily diary phase of each year of the study, participants also reported whether they were with others when they consumed alcohol the previous night. The vast majority of student drinking was social (i.e., occurring with others present), as indicated by the high correlation between proportion of drinking days with days during which students drank with others ($r_s = .71, .77$, and $.83$ for Years 1, 2, and 3, respectively). If participants indicated that they were with others when they drank the night before, they were asked to indicate the average number of alcoholic drinks that others present consumed that night, using a drop-down menu with options ranging from 1 to 15 and >15. We then created a daily drinking norm variable by averaging across all response days for each participant for each year (Epstein, 1983). This measure was used as a single indicator of descriptive drinking norms.

Results

Analytical procedures

We used AMOS 7.0 software (Arbuckle, 2006) with maximum likelihood estimation and the means and intercepts option. This approach reduces the loss of overall power due to missing data from any single indicator at any single time point. The overall pattern of results for both the retrospective and daily aggregate SEM models were the same when missing cases were deleted listwise and parameter estimates were computed based directly on the available raw data; thus, we present results in which intercept scores are computed based on all available raw data and are entered for each missing response. We tested, specifically, the fit of two sets of longitudinal cross-lag models: one using conventional retrospective data and another using daily aggregated data. Furthermore, the comparison of the cross-lag effect of past drinking behavior on change in norm perceptions across retrospective and daily aggregate models may help to distinguish between processes of heuristic recall bias from social-influence processes.

All observed drinking behavior and drinking norms measures were standardized before conducting SEM analyses, and the last indicator of drinking behavior and norm perception (drinking to get drunk, and perceived drinking of one's social group, respectively) were set to 1.0 for each year for identification and scaling purposes (Kline, 2005). Autoregressive error covariances for each observed variable were modeled across years to improve overall model fit by controlling for the association between error terms for each observed variable across years (Finkel, 1995).

When determining the fit of a model to the data, model chi-square scores are typically not useful with sample sizes greater than 200, because most chi-square scores will be significant (Hu and Bentler, 1999; Kline, 2005). To determine the fit of each model itself, we used a series of other common model fit indices with normative standards for scores that indicate a well-fitting model. Among these, root mean square error of approximation (RMSEA) scores less than or equal to .05 are considered a good fit, with .05-.08 indicating a reasonably good fit (Kline, 2005). We also used normed fit index (NFI) and comparative fit index (CFI); scores of .90 or greater are considered indicative of a well-fitting model (Hu and Bentler, 1999; Kline, 2005). Together, these model fit indices can provide converging evidence of the fit of a model. Table 1 depicts means and standard deviations of each latent variable as well as the correlations between latent variables within each SEM model.

Retrospective model

We tested a recursive structural model with two cross-lag periods between Years 1 and 2 and Years 2 and 3. In this

model, we investigated cross-lag paths of drinking to norm perception and norm perception to drinking independent of the autoregressive paths of each construct across years. In this model, the cross-lag paths can be thought of as indicating the degree to which past norm perceptions evoke change in drinking behavior and vice versa. The structural model and the standardized path coefficients between latent constructs are depicted in Figure 1.

The overall model represented a good fit of the data, $\chi^2(157) = 525.7$, RMSEA = .064, NFI = .93, and CFI = .95. Drinking behavior and norm perceptions generally showed reasonably high and moderate stability across years, respectively. Of primary concern, the model also demonstrated several significant cross-lag effects. First, the path from Year 1 drinking behavior to Year 2 norm perception was significant, as was the Year 2 drinking to Year 3 norm perception path. Second, the path from Year 1 norm perception to Year 2 drinking behavior was also significant, albeit with a smaller magnitude of effect. The Year 2 norm to Year 3 drinking cross-lag path did not reach conventional levels of significance ($p = .12$), however.

TABLE 1. Latent variable correlations with alphas and standard deviations

Latent variables	Retrospective model					
	Year 1		Year 2		Year 3	
	Drinking behavior	Drinking norm	Drinking behavior	Drinking norm	Drinking behavior	Drinking norm
Y1 drinking behavior	$M = 0$ $SD = .86$					
Y1 drinking norm	.41	$M = 0$ $SD = .87$				
Y2 drinking behavior	.65	.34	$M = 0$ $SD = .85$			
Y2 drinking norm	.35	.46	.43	$M = 0$ $SD = .78$		
Y3 drinking behavior	.67	.34	.71	.38	$M = -.02$ $SD = .83$	
Y3 drinking norm	.41	.47	.38	.50	.47	$M = .01$ $SD = .90$
Latent variables	Daily aggregate model					
	Year 1		Year 2		Year 3	
	Drinking behavior	Drinking norm	Drinking behavior	Drinking norm	Drinking behavior	Drinking norm
Y1 drinking behavior	$M = 0$ $SD = .86$					
Y1 drinking norm	.59	$M = 0$ $SD = 1.0$				
Y2 drinking behavior	.73	.47	$M = 0$ $SD = .85$			
Y2 drinking norm	.50	.51	.64	$M = 0$ $SD = 1.0$		
Y3 drinking behavior	.69	.45	.79	.54	$M = 0$ $SD = .83$	
Y3 drinking norm	.52	.48	.57	.65	.67	$M = 0$ $SD = 1.0$

Notes: Means (M) and standard deviations (SD) are listed in the diagonal. All correlations were significant at the $p < .001$ level. All latent variables are derived from standardized observed scores. Y = year.

FIGURE 1. Retrospective and daily aggregate cross-lag models across 3 years.

Daily aggregate model

Next, we estimated a similar model using the aggregate daily diary data. This model was structurally identical to the retrospective model but differed slightly in the measurement portion of the model. Specifically, a single indicator of norm perception (i.e., average daily report of alcohol consumed by proximal others across the 30-day period) was used. After correcting for a negative error variance for one of the daily aggregate drinking indicators and some additional correlated error terms between daily average drinking quantity and the norm perception measure, the model achieved conventional standards for a good fit, $\chi^2(40) = 356.1$, RMSEA = .12, NFI = .93, and CFI = .93, $\Delta\chi^2(1) = 85.2$, $p < .001$. This unique error term correlation likely is derived from similarity in the measurement items and response scaling of the daily aggregate drinking quantity and norm perception variables. The results reported below reflect this corrected model, although ignoring this unique error term correlation did not change the overall structural pattern of results. The structural model and the standardized path coefficients between latent constructs are depicted in Figure 1.

Once again, drinking behavior and norm perceptions showed reasonably high stability and moderate stability

across years, respectively. The model also replicated the significant cross-lag effects found in the retrospective model. First, the path from Year 1 drinking behavior to Year 2 norm perception was significant as was the Year 2 drinking to Year 3 norm perception path. Second, the path from Year 1 norm perception to Year 2 drinking behavior was not significant ($p = .16$). The Year 2 norm to Year 3 drinking cross-lag path was significant ($p = .02$), however.

Alternative model comparisons

We also tested the overall cross-lag effect of norm perceptions on drinking and drinking on norm perceptions at the model level. First, for both retrospective, $\chi^2(159) = 533.6$, and daily, $\chi^2(42) = 412.0$, data, we tested a model that presumed no social-influence effect—by constraining the norm to drinking cross-lag paths to zero. In both cases, these models represented significantly worse fits than the freely estimated cross-lag paths reported above: retrospective data, $\Delta\chi^2(2, N = 574) = 7.9$, $p = .019$; and daily data $\Delta\chi^2(2, n = 537) = 6.7$, $p = .035$. This indicates that the norm perception to drinking cross-lag effect makes a significant contribution to the retrospective and daily models, consistent with a passive social-influence process.

To directly compare the magnitude of cross-lag effects, we tested a model that constrained the norm to drinking and drinking to norm cross-lag effects to be equal to one another on both retrospective, $\chi^2(161) = 541.1$, and daily, $\chi^2(44) = 381.1$, data. In both cases, these models represented significantly worse fits than the freely estimated cross-lag paths reported above: retrospective data, $\Delta\chi^2(4, N = 574) = 15.7, p = .003$, and daily data, $\Delta\chi^2(4, n = 537) = 25.0, p < .003$. This indicates that the average drinking to norm cross-lag effect is significantly larger than the average norm to drinking cross-lag effect.

Testing for heuristic recall biases

If heuristic recall biases were contributing to the effect of norm perception on change in past drinking behavior or vice versa, then these cross-lag effects should be smaller when drinking and norm perceptions are assessed daily. The average magnitude of norm perception to drinking cross-lag effect across Years 1 and 2 and Years 2 and 3 in the retrospective model ($b = .09$) and the daily aggregate model ($b = .08$) were no different in magnitude (N.S.). The average magnitude of the drinking to norm perception cross-lag effect across Years 1 and 2 and Years 2 and 3 in the retrospective model ($b = .26$) and the daily aggregate model ($b = .26$) were also no different in magnitude (N.S.). Thus, these cross-lag effects do not appear to be attributable to, nor inflated by, heuristic recall biases (e.g., representative heuristic and anchoring).

Discussion

Summary

Using retrospective and daily aggregated data collected over 3 years, we found a reliable pattern of association between perceptions of drinking norms and drinking behavior. Consistent with a passive social-influence process, norm perceptions, on average, had a small albeit reliable effect on drinking behavior over yearly time lags (Lipsey and Wilson, 2001). In addition, drinking behavior, on average, had a medium-sized and reliable effect on norm perceptions over a 1-year period (Lipsey and Wilson, 2001). Furthermore, the effect of past drinking behavior on change in norm perceptions appears to be significantly larger than the effect of past norm perceptions on change in drinking behavior. Overall, the cross-lag effects did not appear to be inflated as a result of heuristic recall biases during retrospective reporting, as evidenced by the high degree of similarity in cross-lag effect sizes between the retrospective and daily aggregate models.

Implications

Social-influence processes versus heuristic recall biases. Past cross-sectional and longitudinal research showing sup-

port for a passive social-influence process have relied on self-report measures that required participants to recall their own drinking behavior and perceptions of others' drinking behavior over a relatively long window of time (e.g., 1 month). Longer recall windows can systematically increase the opportunity for heuristic biases to skew self-reports of behavior and affect (Robinson and Clore, 2002). Therefore, past findings that show that norm perceptions shape drinking behavior leave open the possibility that heuristic recall biases may instead be driving this effect. Our results comparing prospective effects using retrospective and daily aggregated measures help rule out this possibility. The results of the present study suggest that social-influence processes via norm perceptions provide a reliable and robust effect, independent from heuristic biases. Furthermore, with both retrospective and daily aggregate measures, we found the magnitude of the effect to be very similar to past findings (Gerrard et al., 1996; Marks et al., 1992).

Last, although our findings demonstrate that passive social-influence processes via norm perceptions have small long-term effects, there is still the possibility of more active social-influence processes having larger and more long-term effects on drinking behavior. Indeed, Read et al. (2005) found that active social influences (e.g., modeling of drinking attitudes and behaviors or receiving drinking offers from proximal others) contributed to changes in drinking behavior over 6-month and 1-year intervals. Similarly, more dynamic social-influence processes occurring within networks of interacting individuals have been shown to result in medium to large effects on the formation of actual group attitudinal and behavioral norms over time (Cullum and Harton, 2007). Thus, informal social-influence processes may contribute in important ways to group differences in risk for alcohol misuse and other health behaviors (Christakis and Fowler, 2008) beyond the influence of mental representations of group norms.

Alternative processes linking perceived norms and drinking behavior. The literature also suggests two other mechanisms in the norm-drinking associations whereby past drinking behavior shapes norm perceptions. First, dissonance-reduction processes (Festinger, 1957; Gerrard et al., 1996; Marks et al., 1992) might explain the effect of past drinking on norm perceptions. Gerrard et al. (1996) suggest that when people engage in health behaviors perceived as risky or undesirable, they are more inclined to project that behavior onto others in an effort to normalize it and, thereby, reduce the dissonance between knowledge of their own behavior and their perceptions of normative behavior. Second, selective-affiliation is another possible explanation for the influence of drinking behavior on norm perceptions (Read et al., 2005; Reifman et al., 2006). People tend to gravitate toward others with similar attitudes and behavior (Byrne et al., 1986) and away from those with dissimilar attitudes and behavior (Rosenbaum, 1986). Thus, past drinking behavior

may, over time, lead people to increasingly expose themselves to others with drinking levels similar to their own, resulting in their perceptions of normative drinking among networks of friends growing increasingly in line with their own drinking.

Both of these processes may account for past drinking behavior shaping norm perceptions over time. Neither past work nor the present study, however, clearly differentiates the effect of dissonance-reduction from selective-affiliation. The present work demonstrates, nevertheless, that heuristic recall biases do not appear to be inflating the evidence for these processes when inferring from prospective relationships between past personal drinking behavior and perceptions of drinking norms.

Interventions and retrospective assessments. The social-norm campaign is a popular intervention strategy used by university officials who hope to reduce heavy drinking in student populations (Borsari and Carey, 2003). The efficacy of such intervention strategies is mixed, however (e.g., Clapp et al., 2003; Perkins and Craig, 2006). Furthermore, relatively little long-term research investigating the presumed mechanism by which norm-based interventions reduce alcohol consumption—passive social-influence processes via norm perceptions—is currently available. The present study shows that social norm-based interventions may not be the most cost-effective strategies for reducing alcohol consumption, because the passive social-influence processes on which they are based have smaller long-term effects. To our knowledge, only one other study (Barnett et al., 1996) directly compared social-norm and dissonance-reduction interventions. In this study, the researchers found both approaches to be effective for reducing alcohol consumption but found no evidence of an additive effect of combining the interventions. Similarly, personalized normative feedback interventions, which have been found to be effective at reducing heavy drinking (Neighbors et al., 2004), often confound social influence (e.g., presenting descriptive information about actual drinking norms) with dissonance induction (e.g., pointing out discrepancies between actual drinking norms, perceived drinking norms, and personal drinking behavior; Lewis and Neighbors, 2006; Neal and Carey, 2004). Thus, the present findings warrant future intervention research that more rigorously separates dissonance processes from social-influence processes. In addition, the consistent pattern of findings between models using retrospective and daily measures suggests that retrospective measures of alcohol consumption, at least for intervals up to 1 month long, are robust against memory biases and therefore provide an accurate assessment tool of drinking behavior and related psychological processes.

Limitations

The present study has several limitations of note. First, retrospective norm perceptions were not measured as sen-

sitively as were measures of personal drinking behavior; this might have restricted the variance of this measure and attenuated its effect on drinking behavior. Whatever imprecision there may be in these norm-perception measures, however, would restrict the magnitude of all path parameters, including cross-lag effects (Cohen et al., 2003), and not merely the effect of past norm perceptions on change in drinking behavior. Despite this higher degree of imprecision in norm-perception measurement, the effect of past norm perceptions on change in drinking behavior we observed, using both retrospective and daily aggregate measures, was similar in magnitude to that of past longitudinal studies that used scales with greater sensitivity (Gerrard et al., 1996; Marks et al., 1992; Neighbors et al., 2004).

Second, our study investigated social influence and alternative processes over 3 years using relatively long-term time lags (yearly). The impact of social-influence processes may be occurring in greater proportion over shorter and more proximal time periods (Neighbors et al., 2006a). It may be the case, similarly, that passive social-influence processes contribute more to proximate behavior within particular settings or contexts (e.g., while at the bar; cf. Aarts and Dijksterhuis, 2003; Neighbors et al., 2006b) or across shorter periods (e.g., daily, weekly; cf. Tennen et al., 2000). As such, future research may find larger passive social-influence effects over shorter intervals of time.

Conclusions

Our present findings advance the understanding of the mechanisms by which drinking behavior and perceptions of drinking norms become associated over time; this research should inform future prevention research regarding alcohol misuse and inform policy and administrative officials who are deciding among various intervention options. Given the negative consequences of heavy drinking and problem alcohol use, greater understanding of the processes that affect drinking behavior can aid in the development of more effective interventions. Findings of the present study suggest that conventional retrospective measures can be reliable in discerning causal processes involving alcohol consumption. Further research into intervention strategies that use dissonance and/or selective-affiliation processes for long-term reductions in alcohol consumption is warranted.

References

- Aarts, H., & Dijksterhuis, A. (2003). The silence of the library: Environment, situational norm, and social behavior. *Journal of Personality and Social Psychology*, 84, 18-28.
- Arbuckle, J. L. (2006). AMOS (Version 7.0) [Computer Program]. Chicago, IL: SPSS.
- Barnett, L. A., Far, J. M., Mauss, A. L., & Miller, J. A. (1996). Changing perceptions of peer norms as a drinking reduction program for college students. *Journal of Alcohol and Drug Education*, 41 (2), 39-62.

- Borsari, B., & Carey, K. B. (2003). Descriptive and injunctive norms in college drinking: A meta-analytic integration. *Journal of Studies on Alcohol*, 64, 331-341.
- Byrne, D., Clore, G. L., & Smeaton, G. (1986). The attraction hypothesis: Do similar attitudes affect anything? *Journal of Personality and Social Psychology*, 51, 1167-1170.
- Christakis, N. A., & Fowler, J. H. (2008). The collective dynamics of smoking in a large social network. *New England Journal of Medicine*, 358, 2249-2258.
- Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, 58, 1015-1026.
- Clapp, J. D., Lange, J. E., Russell, C., Shillington, A., & Voas, R. B. (2003). A failed social norms marketing campaign. *Journal of Studies on Alcohol*, 64, 409-414.
- Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlational analysis for the behavioral sciences*. Mahwah, NJ: Lawrence Erlbaum.
- Cullum, J., & Harton, H. C. (2007). Cultural evolution: Interpersonal influence, issue importance, and the development of shared attitudes in college residence halls. *Personality and Social Psychology Bulletin*, 33, 1327-1339.
- Epstein, S. (1983). Aggregation and beyond: Some basic issues on the prediction of behavior. *Journal of Personality*, 51, 360-392.
- Festinger, L. A. (1957). *A theory of cognitive dissonance*. Evanston, IL: Row, Peterson.
- Finkel, S. E. (1995). *Causal analysis with panel data*. Thousand Oaks, CA: Sage.
- Gerrard, M., Gibbons, F. X., Benthin, A. C., & Hessling, R. M. (1996). A longitudinal study of the reciprocal nature of risk behaviors and cognitions in adolescents: What you do shapes what you think, and vice versa. *Health Psychology*, 15, 344-354.
- Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, 6, 1-55.
- Kline, R. B. (2005). *Principles and practice of structural equation modeling*. New York: Guilford Press.
- Larimer, M. E., Turner, A. P., Mallett, K. A., & Geisner, I. M. (2004). Predicting drinking behavior and alcohol-related problems among fraternity and sorority members: Examining the role of descriptive and injunctive norms. *Psychology of Addictive Behaviors*, 18, 203-212.
- Latané, B. (1981). The psychology of social impact. *American Psychologist*, 36, 343-356.
- Lewis, M. A., & Neighbors, C. (2006). Social norms approaches using descriptive drinking norms education: A review of the research on personalized normative feedback. *Journal of American College Health*, 54, 213-218.
- Lipsey, M. W., & Wilson, D. B. (2001). *Practical meta-analysis*. Thousand Oaks, CA: Sage.
- Marks, G., Graham, J. W., & Hansen, W. B. (1992). Social projection and social conformity in adolescent alcohol use: A longitudinal analysis. *Personality and Social Psychology Bulletin*, 18, 96-101.
- Mullen, B., & Hu, L. (1988). Social projection as a function of cognitive mechanisms: Two meta-analytic integrations. *British Journal of Social Psychology*, 27, 333-356.
- Neal, D. K., & Carey, K. B. (2004). Developing discrepancy within self-regulatory theory: Use of personalized normative feedback and personal strivings. *Addictive Behaviors*, 29, 281-297.
- Neighbors, C., Dillard, A. J., Lewis, M. A., Bergstrom, R. L., & Neil, T. A. (2006a). Normative misperceptions and temporal precedence of perceived norms and drinking. *Journal of Studies on Alcohol*, 67, 290-299.
- Neighbors, C., Larimer, M. E., & Lewis, M. A. (2004). Targeting misperceptions of descriptive drinking norms: Efficacy of a computer-delivered personalized normative feedback alcohol intervention. *Health Psychology*, 25, 571-579.
- Neighbors, C., Oster-Aaland, L., Bergstrom, R. L., & Lewis, M. A. (2006b). Event- and context-specific normative misperceptions and high-risk drinking: 21st birthday celebrations and football tailgating. *Journal of Studies on Alcohol*, 67, 282-289.
- Oishi, S. (2002). The experiencing and remembering of well-being: A cross-cultural analysis. *Personality and Social Psychology Bulletin*, 28, 1398-1406.
- Perkins, H. W., & Craig, D. W. (2006). A successful social norms campaign to reduce alcohol misuse among college student-athletes. *Journal of Studies on Alcohol*, 67, 880-889.
- Prentice, D. A., & Miller, D. T. (1993). Pluralistic ignorance and alcohol use on campus: Some consequences of misperceiving the social norm. *Journal of Personality and Social Psychology*, 64, 243-256.
- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.
- Read, J. P., Wood, M. D., & Capone, C. (2005). A prospective investigation of relations between social influences and alcohol involvement during the transition into college. *Journal of Studies on Alcohol*, 66, 23-34.
- Reifman, A., Watson, W. K., & McCourt, A. (2006). Social networks and college drinking: Probing processes of social influence and selection. *Personality and Social Psychology Bulletin*, 32, 820-832.
- Robinson, M. D., Johnson, J. T., & Shields, S. A. (1998). The gender heuristic and the database: Factors affecting the perception of gender-related differences in the experience and display of emotions. *Basic and Applied Social Psychology*, 20, 206-219.
- Robinson, M. D., & Clore, G. L. (2002). Belief and feeling: Evidence for an accessibility model of emotional self-report. *Psychological Bulletin*, 128, 934-960.
- Rosenbaum, M. E. (1986). The Repulsion Hypothesis: On the nondevelopment of relationships. *Journal of Personality and Social Psychology*, 51, 1156-1166.
- Schroeder, C. M., & Prentice, D. A. (1998). Exposing pluralistic ignorance to reduce alcohol use among college students. *Journal of Applied Social Psychology*, 28, 2150-2180.
- Sherif, M. (1936). *The psychology of social norms*. New York: Harper.
- Tennen, H., Affleck, G., Armeli, S., & Carney, M. A. (2000). A daily process approach to coping: Linking theory, research and practice. *American Psychologist*, 55, 626-636.
- Tversky, A., & Kahneman, D. (1990). Judgment under uncertainty: Heuristics and biases. In P. K. Moser (Ed.), *Rationality in action: Contemporary approaches* (pp. 171-188). New York: Cambridge University Press.
- Wechsler, H., Dowdall, G., Davenport, A., & Rimm, E. B. (1995). A gender-specific measure of binge drinking among college students. *American Journal of Public Health*, 85, 982-985.