When alcohol fills the gap: Basic psychological need satisfaction and frustration predict drinking patterns
Supplementary Materials

James H. Conigrave[1], Emma L. Bradshaw[2], Charles-Étienne Lavoie[3], Kylie Lee[1,4,5,6,7], & Richard M. Ryan[2,8]

[1] La Trobe University, Centre for Alcohol Policy Research, Melbourne, Victoria, Australia
[2] Institute for Positive Psychology and Education, Australian Catholic University
[3] Université du Québec à Montréal, Quebec, Canada
[4] University of Sydney, Faculty of Medicine and Health, Sydney Pharmacy School, Sydney, New South Wales, Australia
[5] The Edith Collins Centre (Translational Research in Alcohol, Drugs and Toxicology), Sydney Local Health District, Sydney, New South Wales, Australia
[6] National Drug Research Institute, Faculty of Health Sciences, Curtin University, Perth, Western Australia, Australia
[7] Burnet Institute, Melbourne, Victoria, Australia
[8] Department of Education, Ewha Womans University, Seoul, Republic of Korea

Contents

Alcohol Satisfaction of Basic Psychological Needs Scale **2**

Psychometrics 2

Construct validity of the Need Satisfaction from Alcohol Scale 2

Perceived Locus of Causality for Drinking (PLOC) items 7

Amotivation 7

External regulation 8

Introjected regulation 8

Identified regulation 8

Correspondence concerning this article should be addressed to James H. Conigrave, La Trobe University, Centre for Alcohol Policy Research, Building NR1, Melbourne, Victoria 3086, Australia. E-mail: j.conigrave@latrobe.edu.au

Intrinsic motivation 8
Study 1 sensitivity analyses 8
Hierarchical regression with winsorization 8
Replication of model predicting AUDIT with Study 2 Data 10

Study 2 **12**

Hierarchical regression with winsorization 12
Within-between decomposition 14

References **19**

Alcohol Satisfaction of Basic Psychological Needs Scale

Psychometrics

In this section we justify the use of a single mean score for the BPN-ALC scale.

While items 1–3, 4–6, and 7–9 are respectively autonomy, competence, and relatedness items, there was only a single clear factor.

The items used were:

1. When I drink, I feel free to be who I am
2. I can express myself more when drinking
3. When I drink, I feel more able to be myself
4. Drinking makes me feel confident
5. When I drink, I feel like I'm good at things in general
6. I feel more self-assured when drinking
7. Drinking makes me feel close to others
8. Drinking makes me feel like part of the group
9. I feel connected and included when drinking

As can be seen in Figure S1, a scree plot of the BPN-ALC scale suggests only one substantive factor.

Additionally, there was no practical difference between using factor scores and simple mean scores ($r = 0.9992$). So for simplicity, we used mean scores in the manuscript.

Construct validity of the Need Satisfaction from Alcohol Scale

To evaluate construct validity of the Need Satisfaction from Alcohol Scale, we examined intercorrelations with the available Study 1 scales.

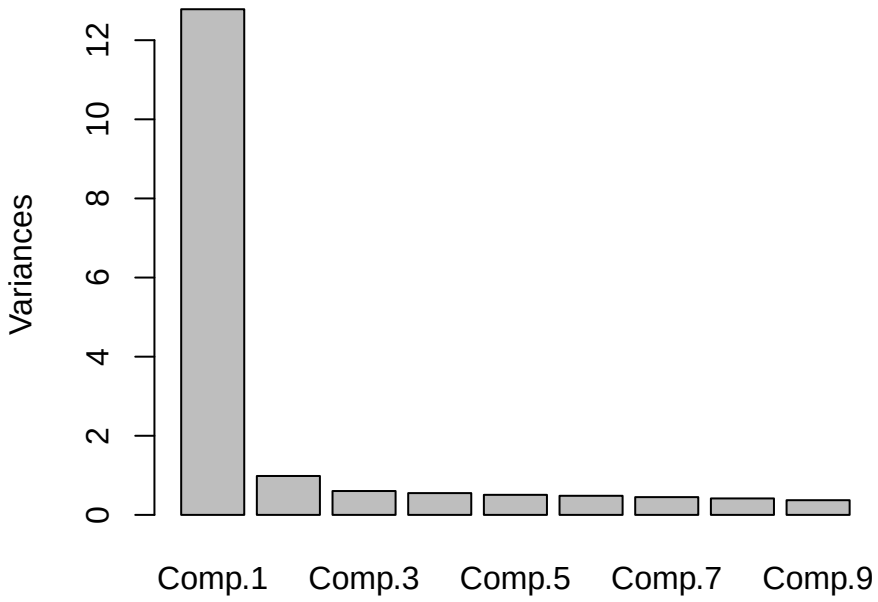


Figure S1. Scree plot for the BPN-ALC scale

Table S1 shows the intercorrelations between Need Satisfaction from Alcohol and other relevant constructs where we had specific expectations for how the variables would be related. Table S2 tabulates what our specific expectations were, and whether each observed association was consistent with those expectations. Figure S2 shows a multidimensional scaling plot of the intercorrelations between all the scales included in the analysis, which provides a visual representation of how the constructs are related to each other.

The observed pattern was generally consistent with expectations. Need satisfaction from alcohol was associated most strongly with drinking motives that align with need satisfaction (social, enhancement, and coping motives—if people use alcohol to cope, alcohol is likely experienced as need-satisfying in-the-moment, otherwise other coping methods would likely be selected). Conformity motives were still strongly linked, but less so than the other more need-aligned motives. We were somewhat surprised that amotivation for drinking was strongly associated with need satisfaction from alcohol. However, the Perceived Locus of Causality for Drinking (PLOC) dimension we are using here is itself not yet validated, so its inclusion here is exploratory. The pattern across the rest of the drinking regulation constructs was more consistent with expectations with more intrinsic regulation showing strong associations than more external regulation. There was not a strong link to vitality or life satisfaction, which was consistent with our expectations.

Taken together, these results suggest that the NS from alcohol scale is likely capturing a construct that is consistent with finding alcohol need-satisfying.

Table S1
Intercorrelations for Study 1 With All Available Scales.

	1	2	3	4	5	6	7	8	9	10	11	12
1. NS from alcohol	-											
2. AUDIT	.58*	-										
3. DMQ enhancement	.73*	.59*	-									
4. DMQ coping	.79*	.64*	.78*	-								
5. DMQ social	.69*	.43*	.77*	.66*	-							
6. DMQ conformity	.64*	.61*	.60*	.68*	.58*	-						
7. Drinking Amotivation	.59*	.78*	.58*	.66*	.45*	.73*	-					
8. Drinking External regulation	.59*	.64*	.51*	.60*	.46*	.84*	.82*	-				
9. Drinking Introjected regulation	.73*	.70*	.66*	.76*	.57*	.83*	.85*	.86*	-			
10. Drinking Identified regulation	.76*	.61*	.77*	.74*	.68*	.66*	.67*	.66*	.76*	-		
11. Drinking Intrinsic motivation	.66*	.51*	.81*	.62*	.68*	.47*	.50*	.45*	.58*	.80*	-	
12. Vitality	-.12*	-.12*	-.06	-.23*	.01	-.05	-.15*	-.11*	-.16*	-.03	.06	-
13. Life satisfaction	.08*	.12*	.12*	-.01	.13*	.22*	.15*	.20*	.14*	.17*	.19*	.63*

Note. N = 742, NS from alcohol = Need Satisfaction from Alcohol; AUDIT = Alcohol Use Disorders Identification Test; * $p < 0.05$

Table S2

Construct-validity Hypothesis Checks for Need Satisfaction from Alcohol in Study 1.

Comparator	Expected association	r	r [95% CI]	p	Supportive
AUDIT	Strong positive	0.58	0.58 [0.53, 0.62]	< .001	Yes
DMQ enhancement	Strong positive	0.73	0.73 [0.70, 0.76]	< .001	Yes
DMQ social	Strong positive	0.69	0.69 [0.65, 0.73]	< .001	Yes
DMQ coping	Strong positive	0.79	0.79 [0.76, 0.82]	< .001	Yes
DMQ conformity	Moderate positive, < other DMQ subscales	0.64	0.64 [0.59, 0.68]	< .001	Yes
Drinking Amotivation	Weak, weakest of PLOC	0.59	0.59 [0.54, 0.63]	< .001	No
Drinking External regulation	Moderate positive, < other PLOC	0.59	0.59 [0.54, 0.63]	< .001	Partial
Drinking Introjected regulation	Strong positive	0.73	0.73 [0.69, 0.76]	< .001	Yes
Drinking Identified regulation	Strong positive	0.76	0.76 [0.72, 0.79]	< .001	Yes
Drinking Intrinsic motivation	Strongest of PLOC	0.66	0.66 [0.61, 0.69]	< .001	Partial
Vitality	Weak	-0.12	-0.12 [-0.19, -0.05]	< .001	Yes
Life satisfaction	Weak	0.08	0.08 [0.01, 0.15]	.030	Yes

Note. Expected patterns are stated in the 'Expected association' column. 'Supportive' indicates whether the observed correlation matched the stated expectation.

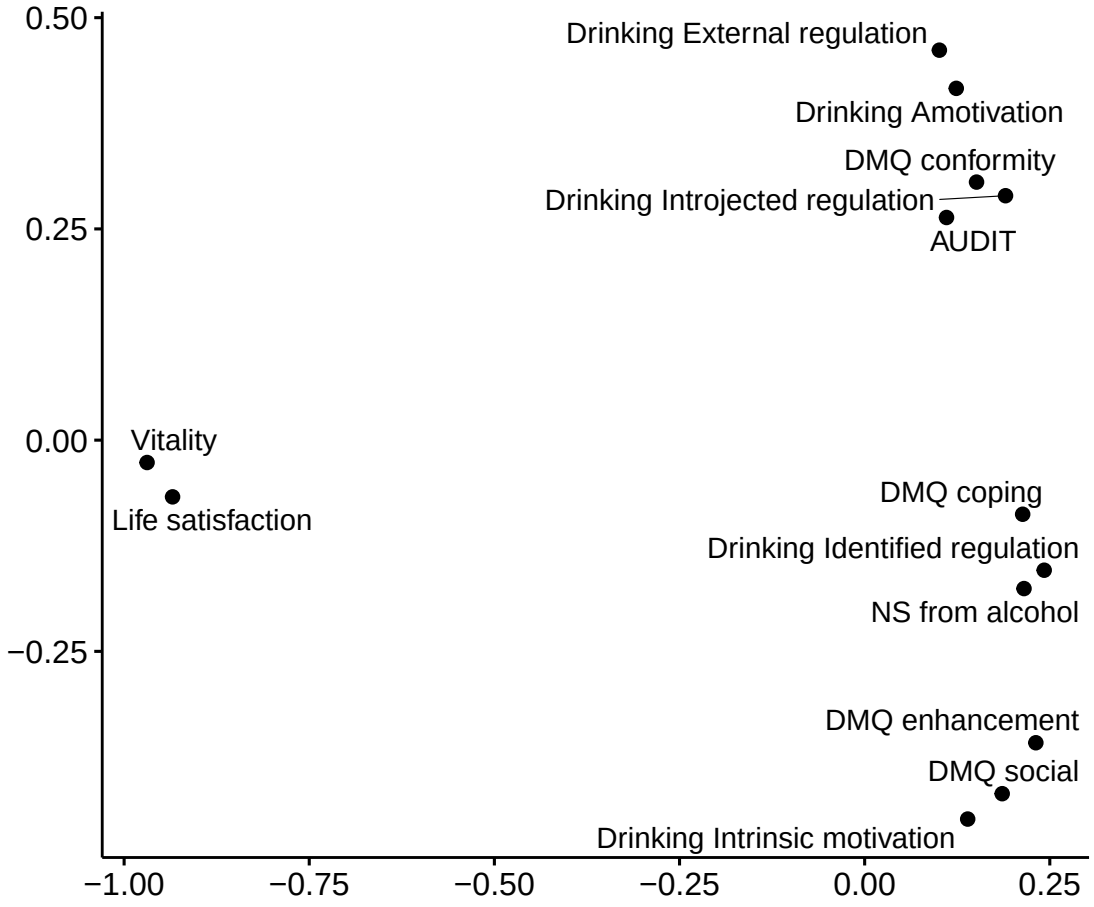


Figure S2. Multidimensional scaling visualization for Study 1 scales.

Perceived Locus of Causality for Drinking (PLOC) items

For reference, the items used to measure the different dimensions of drinking regulation are listed below. These were based on the item set described in Ryan and Connell (1989):

"The next set of questions includes some reasons why people might be inclined to drink alcoholic beverages. Please read each of the following items carefully. Using the five-point scale provided below, please decide how frequently your own drinking is motivated by each of the reasons listed."

Amotivation.

1. Because when it comes to drinking, I really can't help myself.
2. Because I feel unable to control the desire to drink.
3. Actually, I don't feel like I could stop drinking, even if I wanted to.
4. Because I don't know how I could avoid drinking.

External regulation.

1. Because others put pressure on me to drink.
2. Because that's what people in my group are supposed to do.
3. So that others won't get mad at me.
4. Because there's a social cost to me if I don't.

Introjected regulation.

1. Because I feel bad about myself if I don't drink.
2. Because I would feel embarrassed if I didn't join in drinking.
3. Because I think it makes me more likeable.
4. Because it helps me feel better about myself.

Identified regulation.

1. Because I find it brings me many positive experiences.
2. Because I find value in drinking with others.
3. Because I find my experiences while drinking meaningful.
4. Because drinking provides me with a good way to recover and reset.

Intrinsic motivation.

1. Because it's fun.
2. Because I enjoy it.
3. Because I find the experience of drinking interesting.
4. Because drinking brings me a lot of pleasure.

Study 1 sensitivity analyses

Hierarchical regression with winsorization. We repeated the hierarchical regression from study 1 with winsorized AUDIT scores. We winsorized the upper 1% of AUDIT scores to the 99th percentile. The original AUDIT range was 1 to 38. The winsorized AUDIT range was 1 to 34. Results were substantively unchanged from the original analysis, see Table S3.

Table S3

Hierarchical Regression Model Using Satisfaction from Alcohol and General Need Frustration to Predict AUDIT scores (Winsorized; Age and Sex Adjusted) in Study 1

Term	b [95% CI]	SE	t	p	R2	$\triangle R^2$
Model 1					24.24%	
Intercept	7.82 [7.31, 8.33]	0.26	30.26	$< .001$		
Model 2					39.23%	14.99%
Intercept	8.03 [7.57, 8.49]	0.23	34.61	$< .001$		
NS from alcohol (z)	3.65 [3.12, 4.18]	0.27	13.54	$< .001$		
Model 3					45.24%	6.00%
Intercept	8.17 [7.74, 8.61]	0.22	37.01	$< .001$		
NS from alcohol (z)	2.73 [2.19, 3.27]	0.28	9.91	$< .001$		
Need frustration (z)	2.43 [1.90, 2.95]	0.27	9.05	$< .001$		
Model 4					48.16%	2.93%
Intercept	7.42 [6.94, 7.90]	0.24	30.46	$< .001$		
NS from alcohol (z)	2.78 [2.25, 3.31]	0.27	10.36	$< .001$		
Need frustration (z)	2.13 [1.61, 2.65]	0.26	8.04	$< .001$		
NS from alcohol (z) $*$ Need frustration (z)	1.42 [0.99, 1.84]	0.22	6.53	$< .001$		

Note. Scaled variables are indicated with '(z)'. Models were adjusted for age and sex; covariate coefficients are omitted for readability. The upper 1% of AUDIT scores were winsorized to the 99th percentile.

Replication of model predicting AUDIT with Study 2 Data

In Study 2, we collected daily frustration data along with baseline AUDIT and need satisfaction from alcohol. This allowed us to partially replicate the cross-sectional findings from Study 1, using mean daily frustration across the diary period in lieu of general need frustration (which we did not measure at baseline).

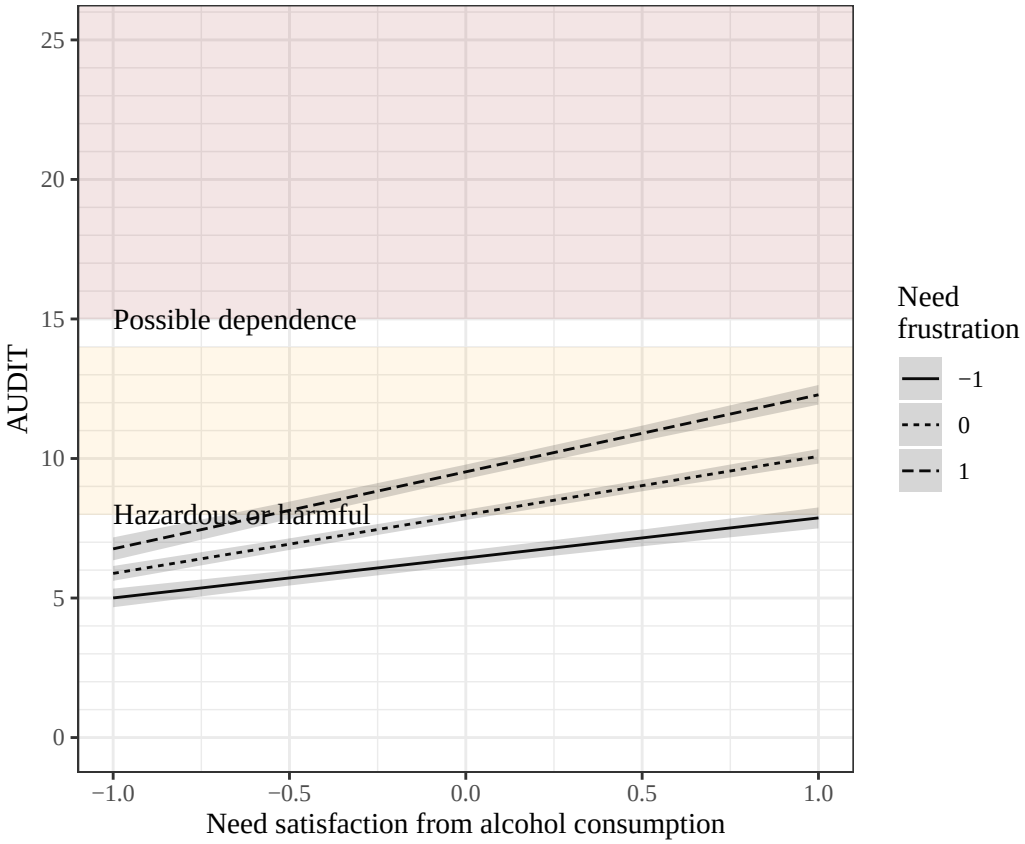


Figure S3. Predicted AUDIT scores from the model replicating Study 1 findings using Study 2 baseline data (age and sex adjusted).

As shown in Figure S3, the simple slopes pattern mirrors the primary Study 1 model: higher alcohol-based need satisfaction is associated with elevated AUDIT scores across levels of general need frustration. Table S4 reports the corresponding coefficient estimates.

Table S4

Hierarchical Regression Predicting Baseline AUDIT scores using Mean Daily Need Frustration and Baseline Alcohol Need Satisfaction (Study 2 data, Age and Sex Adjusted).

Term	b [95% CI]	SE	t	p	R2	$\triangle R^2$
Model 1					3.37%	
Intercept	8.08 [7.88, 8.28]	0.10	78.40	$< .001$		
Model 2					15.65%	12.28%
Intercept	8.08 [7.89, 8.27]	0.10	83.84	$< .001$		
NS from alcohol (z)	2.20 [2.00, 2.39]	0.10	22.11	$< .001$		
Model 3					21.98%	6.33%
Intercept	8.08 [7.90, 8.26]	0.09	87.17	$< .001$		
NS from alcohol (z)	2.00 [1.81, 2.19]	0.10	20.79	$< .001$		
Need frustration (z)	1.56 [1.38, 1.75]	0.09	16.52	$< .001$		
Model 4					23.16%	1.18%
Intercept	7.98 [7.80, 8.16]	0.09	85.66	$< .001$		
NS from alcohol (z)	2.10 [1.91, 2.29]	0.10	21.75	$< .001$		
Need frustration (z)	1.54 [1.36, 1.73]	0.09	16.40	$< .001$		
NS from alcohol (z) $*$ Need frustration (z)	0.66 [0.48, 0.84]	0.09	7.23	$< .001$		

Note. Scaled variables are indicated with '(z)'. Models were adjusted for age and sex; covariate coefficients are omitted for readability. AUDIT = Alcohol Use Disorders Identification Test.

Study 2

Hierarchical regression with winsorization

We repeated the hierarchical regression from study 2 with winsorized daily drinks. We winsorized the upper 1% of daily drinks to the 99th percentile. The original daily drinks range was 0 to 21. The winsorized daily drinks range was 0 to 12. Results were substantively unchanged from the original analysis. However, the borderline significant interaction in Model 4 became borderline non-significant, see Table S5. We did not winsorize the any drinking logit model as the outcome was binary.

Table S5

Hierarchical Regression Predicting Daily Drinks (Age and Sex Adjusted).

Term	IRR [95% CI]	lnIRR	SE	z	p	Likelihood Ratio Test
Model 1						
Intercept	1.21 [1.11, 1.31]	0.19	0.04	4.58	< .001	
Model 2						$\chi^2(1) = 23.59$, $p = < .001$
Intercept	1.21 [1.12, 1.31]	0.19	0.04	4.68	< .001	
NS from alcohol (z)	1.21 [1.12, 1.31]	0.19	0.04	4.87	< .001	
Model 3						$\chi^2(1) = 0.14$, $p = .708$
Intercept	1.21 [1.12, 1.31]	0.19	0.04	4.69	< .001	
NS from alcohol (z)	1.21 [1.12, 1.31]	0.19	0.04	4.83	< .001	
Daily frustration (z)	1.01 [0.96, 1.06]	0.01	0.03	0.37	.708	
Model 4						$\chi^2(1) = 3.03$, $p = .081$
Intercept	1.20 [1.11, 1.30]	0.19	0.04	4.52	< .001	
NS from alcohol (z)	1.22 [1.13, 1.32]	0.20	0.04	4.97	< .001	
Daily frustration (z)	1.00 [0.94, 1.05]	0.00	0.03	-0.11	.911	
NS from alcohol (z) $*$ Daily frustration (z)	1.05 [0.99, 1.11]	0.05	0.03	1.74	.082	

Note. (z) = scaled variable. Models included random intercepts for participants and were adjusted for age and sex; covariate coefficients are omitted for readability. IRR = incident rate ratio; lnIRR = Natural logarithm of the incident rate ratio; LRT = likelihood ratio test statistic. The IRR is the multiplicative change in the expected number of drinks consumed for each one unit increase in the predictor variable. The p-value of model 4 was statistically non-significant. N (complete cases) = 3355; 3 observations excluded due to missing data.

Within-between decomposition

We examined whether results changed after decomposing daily frustration into between-person (mean scores across each diary) and within-person (person-mean centered) components. In both models, predicting daily drinks (Table S6) and any drinking (Table S7), need satisfaction from alcohol showed a main effect and significantly interacted with between-person (mean) frustration, but it did not interact with within-person (daily) frustration. For the within-between count model, we winsorized the upper 1% of daily drinks to the 99th percentile before model fitting.

Table S6

Within-between Mixed-effects Models (Negative Binomial) Predicting Daily Drinks (Age and Sex Adjusted).

Term	IRR [95% CI]	lnIRR	SE	z	p	Likelihood Ratio Test
Model 1						
Intercept	1.21 [1.11, 1.31]	0.19	0.04	4.58	$< .001$	
Model 2						$\chi^2(1) = 23.59$, $p = < .001$
Intercept	1.21 [1.12, 1.31]	0.19	0.04	4.68	$< .001$	
NS from alcohol (z)	1.21 [1.12, 1.31]	0.19	0.04	4.87	$< .001$	
Model 3						$\chi^2(1) = 4.57$, $p = .032$
Intercept	1.21 [1.12, 1.31]	0.19	0.04	4.73	$< .001$	
NS from alcohol (z)	1.20 [1.11, 1.30]	0.18	0.04	4.58	$< .001$	
Daily frustration (between z)	1.08 [1.01, 1.17]	0.08	0.04	2.15	.032	
Model 4						$\chi^2(1) = 1.43$, $p = .231$
Intercept	1.21 [1.12, 1.31]	0.19	0.04	4.72	$< .001$	
NS from alcohol (z)	1.20 [1.11, 1.30]	0.18	0.04	4.58	$< .001$	
Daily frustration (between z)	1.08 [1.01, 1.17]	0.08	0.04	2.14	.032	
Daily frustration (within z)	0.98 [0.95, 1.01]	-0.02	0.02	-1.20	.232	
Model 5						$\chi^2(1) = 3.86$, $p = .050$
Intercept	1.20 [1.11, 1.30]	0.18	0.04	4.43	$< .001$	
NS from alcohol (z)	1.21 [1.12, 1.31]	0.19	0.04	4.76	$< .001$	
Daily frustration (between z)	1.08 [1.00, 1.16]	0.08	0.04	2.00	.046	
Daily frustration (within z)	0.98 [0.95, 1.01]	-0.02	0.02	-1.19	.233	
NS from alcohol (z) $*$ Daily frustration (between z)	1.07 [1.00, 1.16]	0.07	0.04	1.97	.049	
Model 6						$\chi^2(1) = 1.40$, $p = .237$
Intercept	1.20 [1.11, 1.30]	0.18	0.04	4.42	$< .001$	
NS from alcohol (z)	1.21 [1.12, 1.31]	0.19	0.04	4.78	$< .001$	
Daily frustration (between z)	1.08 [1.00, 1.16]	0.08	0.04	1.99	.046	
Daily frustration (within z)	0.97 [0.94, 1.01]	-0.03	0.02	-1.56	.118	
NS from alcohol (z) $*$ Daily frustration (between z)	1.08 [1.00, 1.16]	0.07	0.04	1.98	.048	
NS from alcohol (z) $*$ Daily frustration (within z)	1.02 [0.99, 1.06]	0.02	0.02	1.18	.239	

Table S6 continued

Term	IRR [95% CI]	lnIRR	SE	z	p	Likelihood Ratio Test

Note. (z) = scaled variable. Outcome is number of standard drinks yesterday (nbinom1). Models include random intercepts for participants and are adjusted for age and sex; covariate coefficients are omitted for readability. Within-person daily frustration is person-mean centered; between-person reflects mean frustration values. IRR = incident rate ratio; lnIRR = natural logarithm of IRR; LRT = likelihood ratio test statistic. The upper 1% of daily drinks was winsorized to the 99th percentile. N (complete cases) = 3355; 3 observations excluded due to missing data.

Table S7

Within-between Logistic Mixed-effects Models Predicting Any Drinking Yesterday (Age and Sex Adjusted).

Term	OR [95% CI]	lnOR	SE	z	p	Likelihood Ratio Test
Model 1						
Intercept	1.74 [1.51, 2.02]	0.56	0.07	7.49	$< .001$	
Model 2						$\chi^2(1) = 8.08$, $p = .004$
Intercept	1.74 [1.51, 2.01]	0.56	0.07	7.53	$< .001$	
NS from alcohol (z)	1.23 [1.07, 1.43]	0.21	0.07	2.84	.005	
Model 3						$\chi^2(1) = 4.18$, $p = .041$
Intercept	1.75 [1.51, 2.02]	0.56	0.07	7.56	$< .001$	
NS from alcohol (z)	1.21 [1.05, 1.41]	0.19	0.07	2.61	.009	
Daily frustration (between z)	1.16 [1.01, 1.35]	0.15	0.07	2.04	.042	
Model 4						$\chi^2(1) = 1.42$, $p = .233$
Intercept	1.75 [1.51, 2.02]	0.56	0.07	7.56	$< .001$	
NS from alcohol (z)	1.21 [1.05, 1.41]	0.19	0.07	2.61	.009	
Daily frustration (between z)	1.16 [1.01, 1.35]	0.15	0.07	2.04	.042	
Daily frustration (within z)	0.95 [0.87, 1.03]	-0.05	0.04	-1.19	.234	
Model 5						$\chi^2(1) = 4.68$, $p = .030$
Intercept	1.71 [1.48, 1.98]	0.54	0.07	7.23	$< .001$	
NS from alcohol (z)	1.24 [1.07, 1.44]	0.22	0.08	2.87	.004	
Daily frustration (between z)	1.17 [1.01, 1.35]	0.15	0.07	2.04	.041	
Daily frustration (within z)	0.95 [0.87, 1.03]	-0.05	0.04	-1.19	.233	
NS from alcohol (z) $*$ Daily frustration (between z)	1.17 [1.01, 1.35]	0.16	0.07	2.16	.031	
Model 6						$\chi^2(1) = 0.02$, $p = .899$
Intercept	1.71 [1.48, 1.98]	0.54	0.07	7.23	$< .001$	
NS from alcohol (z)	1.24 [1.07, 1.44]	0.22	0.08	2.87	.004	
Daily frustration (between z)	1.17 [1.01, 1.35]	0.15	0.07	2.04	.041	
Daily frustration (within z)	0.95 [0.87, 1.03]	-0.05	0.04	-1.19	.233	
NS from alcohol (z) $*$ Daily frustration (between z)	1.17 [1.01, 1.35]	0.16	0.07	2.16	.031	
NS from alcohol (z) $*$ Daily frustration (within z)	1.01 [0.93, 1.09]	0.01	0.04	0.13	.899	

Table S7 continued

Term	OR [95% CI]	lnOR	SE	z	p	Likelihood Ratio Test

Note. (z) = scaled variable. Outcome is any drinks yesterday (0/1). Models include random intercepts for participants and are adjusted for age and sex; covariate coefficients are omitted for readability. Within-person daily frustration is person-mean centered; between-person reflects mean frustration values. N (complete cases) = 3355; 3 observations excluded due to missing data.

References

Ryan, R. M., & Connell, J. P. (1989). Perceived locus of causality and internalization: Examining reasons for acting in two domains. *Journal of Personality and Social Psychology*, *57*(5), 749–761. https://doi.org/10.1037/0022-3514.57.5.749