Supplemental Information for

Daily Stress Predicts Later Drinking Initiation via Craving in Heavier Social Drinkers: A Prospective In-Field Daily Diary Study

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Supplemental Material

A conceptual diagram (Supplemental Figure 1) has been included in this section to provide an overview of the associations tested in the mediation and moderated mediation models. The results for the same analyses using stress events as the predictor is described below. We have also included the results of the full mediation and moderated mediation (Supplemental Table 1 for subjective stress and Table 2 for stress events) analyses that led to the final analyses described in the main paper.

Supplemental Results

Mediation Model with Stress Events

Between-person Level Associations. As in the subjective stress model, increased QFI was related to higher craving and drinking overall (Table S2). Social drinkers who experienced higher number of stress events experienced more craving, b=0.602, *95% CI*: 0.101-1.113 (Figures S3a and S3b); however, craving was not a significant predictor of drinking in this model, b=0.261, *95% CI*: -0.053 - 0.600, unless accounting for the moderation of QFI (see below). Neither the direct, b=-0.262, *95% CI*: -0.956-0.371, nor indirect effect of stress events on craving was significant, b=0.140, *95% CI*: -0.032-0.468. At the between-person level, the model accounted for 32.3% of the variance in craving, R^2=0.323, *95% CI*: 0.157-0.494, and 62.6% in drinking, R^2= 0.626, *95% CI*: 0.336-0.963, without the moderating effect of QFI shown below.

Within-person Level Associations. In contrast to the subjective stress models, stress events did not influence craving, b=0.020, *95% CI*: -0.130-0.191 (Table S2), accounting for only 1.2% of the variance in craving at the within level, R^2=0.012, *95% CI*: 0.005-0.023. The direct effect of stress events on drinking later that evening was not significant, b=0.191, *95% CI*: -0.140-0.469. Days with higher craving still resulted in drinking later that night, b=0.545, *95% CI*: 0.384-0.720. The model accounted for 19.9% of the variance in drinking at the within-person level, R^2=0.196, *95% CI*: 0.136-0.257.

Moderated Mediation Model with Stress Events

QFI at baseline did not moderate any of the associations at the between-person level (Table S3). In contrast to the mediation-only model, between-person craving was a significant predictor of overall drinking throughout the study, b=0.292, *95% CI*: 0.005-0.601 (Figure S3c). At the within-person level, we found that the

craving-drinking path significantly differed based on QFI (Figures S3d and S3f, Table S3). Specifically, those with higher QFI (+1 SD or 97.7th percentile) were 20.0% more likely to drink that evening if their craving was also higher, predicted prob = 0.200, *b*=0.905, *95% CI*: 0.544-1.312; whereas craving that day was not associated with drinking later in individuals who were lighter drinkers (-1 SD or 2.3rd percentile), *b*=-0.053, *95% CI*: -0.620-0.503. Experiencing a stress event was not associated with craving or drinking (Figure S3e).

Exploratory Analyses

We explored if Black individuals displayed stronger links between stress, craving, and drinking as compared to Whites or other races at the between-subject level, because recent work has shown that Black individuals have stronger ties between stress and drinking relative to White or other minorities (Pedersen et al., 2021). We found that the links between stress, craving, and drinking were not different between Black and other racial groups or White and other racial groups (*p*'s > 0.164, see Supplemental Table 4).

Supplemental Table 1.
Results investigating the effect of subjective stress level on daily drinking, directly and indirectly via craving, using mediated and fully moderated multilevel structural equation models.

Parameter	Mediation MSEM Model					Moderated Mediation MSEM Model				
	Est.	Posterior S.D.	p	95% C.I. Lower	Upper	Est.	Posterior S.D.	p	95% C.I. Lower	Upper
Between										
a_{mx}: Stress Level → Craving	**0.380**	**0.098**	**<.001**	**0.191**	**0.573**					
a_{mxw}: QFI x Stress Level → Craving						0.091	0.099	0.175	-0.102	0.286
-1 SD QFI: Stress Level → Craving						**0.376**	**0.098**	**<.001**	**0.186**	**0.571**
+1 SD QFI: Stress Level → Craving						**0.614**	**0.172**	**0.001**	**0.274**	**0.954**
b_{ym}: Craving → Drinks	**0.328**	**0.164**	**0.011**	**0.054**	**0.676**					
b_{ymw}: QFI x Craving → Drinks						-0.180	0.169	0.134	-0.528	0.136
-1 SD QFI: Craving → Drinks						**0.654**	**0.305**	**0.012**	**0.081**	**1.289**
+1 SD QFI: Craving → Drinks						0.293	0.186	0.056	-0.077	0.662
c_{yx}: Stress Level → Drinks	-0.073	0.144	0.312	-0.355	0.219					
c_{yxw}: QFI x Stress Level → Drinks						-0.204	0.294	0.240	-0.790	0.363
-1 SD QFI: Stress Level → Drinks						0.027	0.219	0.450	-0.396	0.470
+1 SD QFI: Stress Level → Drinks						-0.177	0.199	0.182	-0.570	0.218
c'_{yx}: Stress Level → Drinks	-0.200	0.156	0.096	-0.522	0.100					
c'_{yxw}: QFI x Stress Level → Drinks						-0.155	0.298	0.298	-0.740	0.434
-1 SD QFI: Stress Level → Drinks						-0.161	0.215	0.223	-0.582	0.267
+1 SD QFI: Stress Level → Drinks						-0.315	0.217	0.072	-0.743	0.110
QFI → Craving	**0.337**	**0.076**	**<.001**	**0.187**	**0.486**	**0.351**	**0.076**	**<.001**	**0.201**	**0.499**
QFI → Drinks	**0.354**	**0.111**	**0.001**	**0.135**	**0.570**	**0.272**	**0.122**	**0.012**	**0.036**	**0.515**
Stress Level indirect ₍between₎	**0.119**	**0.072**	**0.011**	**0.018**	**0.297**					
-1 SD QFI: indirect ₍between₎						0.168	0.135	0.032	-0.007	0.505
+1 SD QFI: indirect ₍between₎						0.128	0.100	0.056	-0.033	0.363

	Est	S.D.	p	C.I. LL	C.I. UL	Est	S.D.	p	C.I. LL	C.I. UL
Difference indirect $_{between}$						-0.041	0.163	0.386	-0.402	0.249

Within

	Est	S.D.	p	C.I. LL	C.I. UL	Est	S.D.	p	C.I. LL	C.I. UL
a_{mx}: Stress Level → Craving	**0.130**	**0.051**	**0.006**	**0.028**	**0.230**					
a_{mxw}: QFI x Stress Level → Craving						0.008	0.053	0.435	-0.095	0.112
-1 SD QFI: Stress Level → Craving						0.129	0.052	0.008	0.027	0.233
+1 SD QFI: Stress Level → Craving						**0.138**	**0.071**	**0.025**	**0.000**	**0.278**
b_{ym}: Craving → Drinks	**0.540**	**0.088**	**<.001**	**0.371**	**0.714**					
b_{ymw}: QFI x Craving → Drinks						**0.257**	**0.114**	**0.008**	**0.048**	**0.493**
-1 SD QFI: Craving → Drinks						0.166	0.182	0.190	-0.206	0.508
+1 SD QFI: Craving → Drinks						**0.679**	**0.107**	**<.001**	**0.485**	**0.904**
c_{yx}: Stress Level → Drinks	0.068	0.077	0.186	-0.079	0.223					
c_{yxw}: QFI x Stress Level → Drinks						0.118	0.177	0.246	-0.220	0.478
-1 SD QFI: Stress Level → Drinks						0.000	0.136	0.499	-0.273	0.268
+1 SD QFI: Stress Level → Drinks						0.119	0.107	0.125	-0.088	0.334
c'_{yx}: Stress Level → Drinks	-0.003	0.072	0.487	-0.137	0.143					
c'_{yxw}: QFI x Stress Level → Drinks						0.022	0.084	0.395	-0.137	0.193
-1 SD QFI: Stress Level → Drinks						0.004	0.080	0.481	-0.159	0.157
+1 SD QFI: Stress Level → Drinks						0.024	0.094	0.392	-0.160	0.213
Stress Level indirect $_{within}$	**0.069**	**0.030**	**0.006**	**0.014**	**0.135**					
-1 SD QFI: indirect $_{within}$						0.014	0.029	0.227	-0.030	0.089
+1 SD QFI: indirect $_{within}$						**0.092**	**0.051**	**0.025**	**0.000**	**0.202**
Difference indirect $_{within}$						0.074	0.060	0.098	-0.041	0.197

Note: Est. = estimate, S.D. = standard deviation, C.I.= credibility interval, *p* = Bayesian one-tailed p-value, or the proportion of the posterior distribution that overlaps zero (for positive estimates=proportion below zero, for negative estimates=proportion above zero), c' = the direct effect of stress on drinking after accounting for craving, c = the total effect of stress on drinking. Results in bold typeface indicate a significant result. Analyses controlled for gender, age, and weekend day. The Bayesian credibility interval encompasses the lower 2.5% and 97.5% in the posterior distribution.

Supplemental Table 2. Results investigating the effect of stress events on daily drinking, directly and indirectly via craving, using mediated and fully moderated multilevel structural equation models.

Parameter	Mediation MSEM Model					Moderated Mediation MSEM Model				
	Est.	Posterior S.D.	p	95% C.I. Lower	95% C.I. Upper	Est.	Posterior S.D.	p	95% C.I. Lower	95% C.I. Upper
Between										
a_{mx}: Stress Events → Craving	**0.602**	**0.256**	**0.010**	**0.101**	**1.113**					
a_{mxw}: QFI x Stress Events → Craving						0.284	0.237	0.114	-0.182	0.749
-1 SD QFI: Stress Events → Craving						**0.693**	**0.263**	**0.005**	**0.176**	**1.213**
+1 SD QFI: Stress Events → Craving						**1.258**	**0.586**	**0.015**	**0.116**	**2.425**
b_{ym}: Craving → Drinks	0.261	0.166	0.050	-0.053	0.600					
b_{ymw}: QFI x Craving → Drinks						-0.233	0.167	0.075	-0.573	0.088
-1 SD QFI: Craving → Drinks						**0.436**	**0.181**	**0.005**	**0.099**	**0.813**
+1 SD QFI: Craving → Drinks						-0.191	0.322	0.269	-0.829	0.448
c_{yx}: Stress Events → Drinks	-0.103	0.332	0.374	-0.772	0.524					
c_{yxw}: QFI x Stress Events → Drinks						0.058	0.667	0.464	-1.243	1.395
-1 SD QFI: Stress Events → Drinks						-0.168	0.502	0.363	-1.183	0.809
+1 SD QFI: Stress Events → Drinks						-0.109	0.473	0.407	-1.056	0.817
c'_{yx}: Stress Events → Drinks	-0.262	0.338	0.211	-0.956	0.371					
c'_{yxw}: QFI x Stress Events → Drinks						0.065	0.335	0.419	-0.584	0.736
-1 SD QFI: Stress Events → Drinks						-0.444	0.477	0.167	-1.409	0.466
+1 SD QFI: Stress Events → Drinks						-0.307	0.497	0.265	-1.312	0.647
a_{mw}: QFI → Craving	**0.342**	**0.078**	**<.001**	**0.190**	**0.495**	**0.343**	**0.081**	**<.001**	**0.182**	**0.502**
b_{yw}: QFI → Drinks	**0.392**	**0.115**	**<.001**	**0.167**	**0.621**	**0.311**	**0.124**	**0.006**	**0.071**	**0.556**
indirect $_{between}$	0.140	0.128	0.059	-0.032	0.468					
-1 SD QFI: indirect $_{between}$						0.236	0.268	0.106	-0.140	0.910
+1 SD QFI: indirect $_{between}$						0.173	0.203	0.122	-0.125	0.672
QFI Difference indirect $_{between}$						-0.060	0.324	0.415	-0.773	0.537
Within										
a_{mx}: Stress Events → Craving	0.020	0.076	0.391	-0.130	0.170					
a_{mxw}: QFI x Stress Events → Craving						-0.037	0.067	0.288	-0.168	0.095
-1 SD QFI: Stress Events → Craving						0.040	0.067	0.272	-0.092	0.172
+1 SD QFI: Stress Events → Craving						0.004	0.086	0.483	-0.165	0.172
b_{ym}: Craving → Drinks	**0.545**	**0.086**	**<.001**	**0.384**	**0.720**					

	Est.	S.D.	p	C.I.		Est.	S.D.	p	C.I.	
b_{ymw}: QFI x Craving → Drinks						**0.254**	**0.110**	**0.009**	**0.046**	**0.480**
-1 SD QFI: Craving → Drinks						0.168	0.176	0.166	-0.186	0.509
+1 SD QFI: Craving → Drinks						**0.678**	**0.105**	**<.001**	**0.484**	**0.894**
c_{yx}: Stress Events → Drinks	0.200	0.157	0.116	-0.127	0.490					
c_{yxw}: QFI x Stress Events → Drinks						0.023	0.373	0.474	-0.687	0.783
-1 SD QFI: Stress Events → Drinks						0.151	0.297	0.309	-0.431	0.721
+1 SD QFI: Stress Events → Drinks						0.180	0.197	0.182	-0.201	0.578
c'_{yx}: Stress Events → Drinks	0.191	0.152	0.120	-0.140	0.469					
c'_{yxw}: QFI x Stress Events → Drinks						0.037	0.367	0.459	-0.672	0.778
-1 SD QFI: Stress Events → Drinks						0.139	0.296	0.324	-0.442	0.709
+1 SD QFI: Stress Events → Drinks						0.178	0.188	0.173	-0.184	0.558
indirect $_{within}$	0.011	0.042	0.391	-0.072	0.095					
-1 SD QFI: indirect $_{within}$						0.007	0.028	0.313	-0.035	0.084
+1 SD QFI: indirect $_{within}$						0.002	0.059	0.483	-0.115	0.121
QFI Difference indirect $_{within}$						-0.010	0.066	0.437	-0.143	0.119

Note: Est. = estimate, S.D. = standard deviation, C.I.= credibility interval, p = Bayesian one-tailed p-value, or the proportion of the posterior distribution that overlaps zero (for positive estimates=proportion below zero, for negative estimates=proportion above zero), c' = the direct effect of stress on drinking after accounting for craving, c = the total effect of stress on drinking. Results in bold typeface indicate a significant result. Analyses controlled for gender, age, and weekend day. Stress events were coded as 0 = No stress event that day and 1 = Stress event that day. The Bayesian credibility interval encompasses the lower 2.5% and 97.5% in the posterior distribution. The significant moderation effect of QFI on between-person craving did not remain significant in the final model after non-significant interactions were removed, and thus was not included in the final model.

Supplemental Table 3

Final moderated mediation investigating stress events on daily drinking, directly and indirectly via craving, using MSEM.

Parameter	Est.	Posterior SD	p	95% C.I.	
				Lower	Upper
Between					
a_{mx}: Stress Events → Craving	**0.633**	**0.258**	**0.007**	**0.126**	**1.142**
b_{ym}: Craving → Drinks	**0.292**	**0.151**	**0.023**	**0.005**	**0.601**
c_{yx}: Stress Events → Drinks	-0.077	0.333	0.403	-0.741	0.566
c'_{yx}: Stress Events → Drinks	-0.263	0.338	0.212	-0.944	0.391
a_{mw}: QFI → Craving	**0.340**	**0.079**	**<.001**	**0.183**	**0.495**
b_{yw}: QFI → Drinks	**0.347**	**0.112**	**0.001**	**0.128**	**0.569**
Indirect $_{between}$	**0.095**	**0.057**	**0.023**	**0.001**	**0.228**
Within					
a_{mx}: Stress Events → Craving	0.033	0.066	0.302	-0.096	0.162
b_{ymw}: QFI x Craving → Drinks at mean QFI	**0.240**	**0.113**	**0.014**	**0.027**	**0.467**
-1 SD: Craving → Drinks	0.187	0.181	0.147	-0.167	0.543
+1 SD: Craving → Drinks	**0.664**	**0.106**	**0.000**	**0.474**	**0.890**
c_{yx}: Stress Events → Drinks at mean QFI	0.178	0.148	0.107	-0.104	0.481
-1 SD QFI: c_{yx}: Stress Events → Drinks	0.007	0.029	0.327	-0.041	0.080
+1 SD QFI: c_{yx}: Stress Events → Drinks	0.027	0.056	0.302	-0.082	0.143
c'_{yx}: Stress Events → Drinks	0.164	0.145	0.123	-0.115	0.460
indirect $_{within}$ at mean QFI	0.014	0.029	0.302	-0.043	0.074
-1 SD: indirect $_{within}$	0.003	0.018	0.359	-0.026	0.050
+1 SD: indirect $_{within}$	0.022	0.045	0.302	-0.066	0.112

Note: Est. = estimate, SD = standard deviation, C.I.= credibility interval, p = Bayesian one-tailed p-value, or the proportion of the posterior distribution that overlaps zero (for positive estimates=proportion below zero, for negative estimates=proportion above zero). Results in bold typeface indicate a significant result. Analyses controlled for gender, age, and weekend day. Stress was coded as 1 = Stress event that day. The Bayesian credibility interval encompasses the lower 2.5% and 97.5% in the posterior distribution. The significant moderation effect of QFI on between-person craving did not remain significant in the final model after non-significant interactions were removed, and thus was not included in the final model.
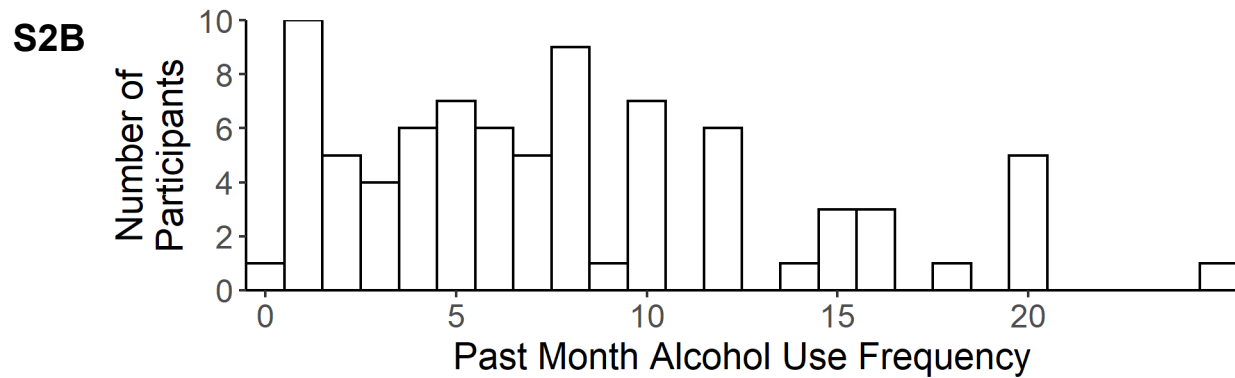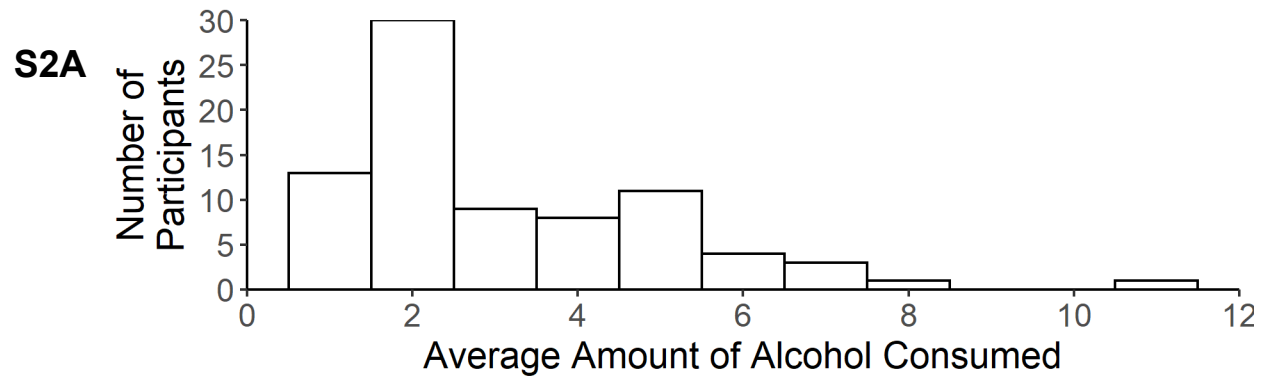
Supplemental Table 4

General linear models investigating if racial identity moderated the impact of subjective stress on craving and drinking.

	Mean Craving			Drinking Day Frequency		
	Est	*F*	*p*	*Est*	*F*	*p*
Stress	**0.268**	**13.103**	**<.001**	-0.302	0.146	0.703
Craving				**0.590**	**15.120**	**<.001**
Black vs. else	0.044	0.083	0.774	-1.418	0.734	0.394
White vs. else	-0.887	0.225	0.637	-0.804	1.392	0.242
Stress x Black vs. else	0.068	0.013	0.910	0.205	0.001	0.980
Stress x White vs. else	0.080	0.165	0.686	0.093	0.331	0.567
Craving x Black vs. else				-0.397	1.974	0.164
Craving x Black vs. else				0.149	0.169	0.682
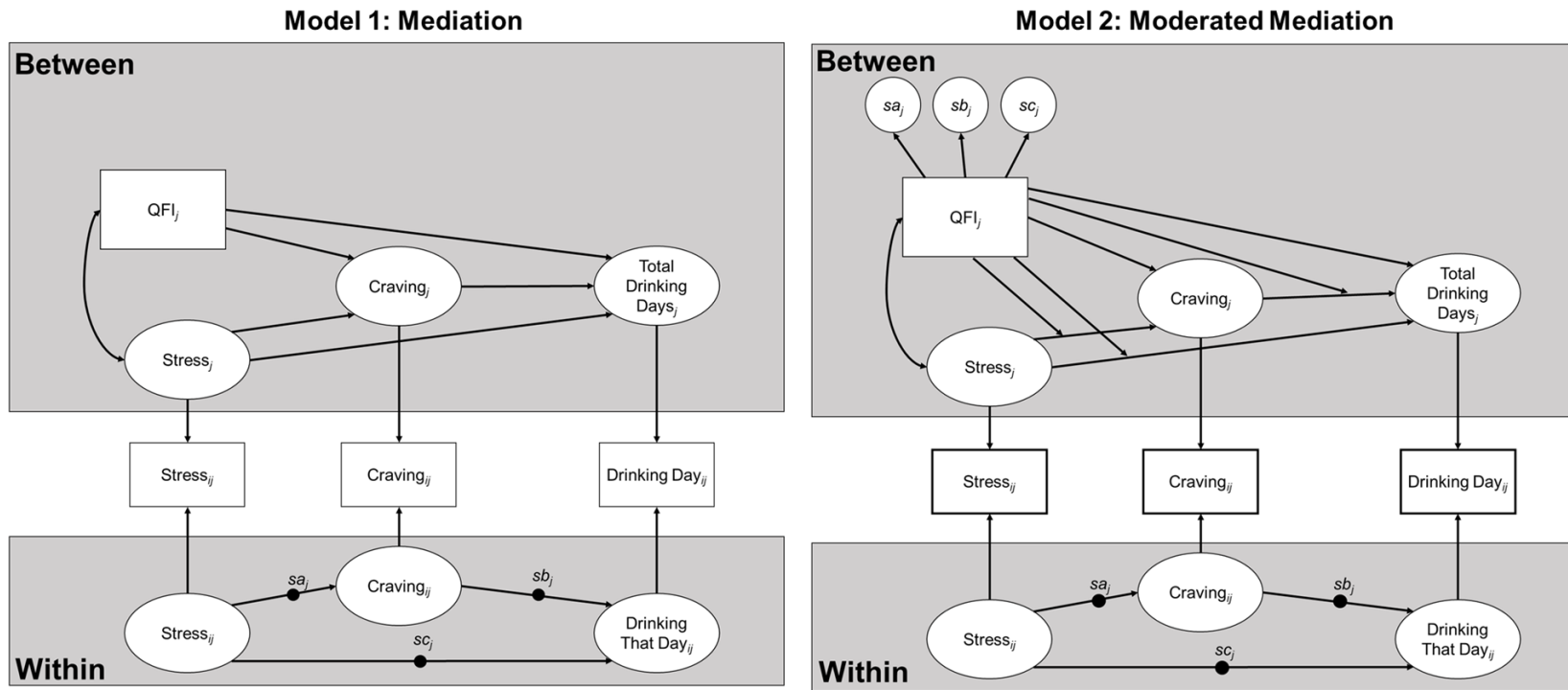
Supplemental Figure 1. Conceptual diagram for testing hypothesized effects using Multilevel Structural Equation Models in a (1) mediational model and (2) a fully moderated mediation model. We examined the averaged mediating effect of craving pre-drinking in the relationship between overall daily subjective stress levels and drinking later that night across individuals (between-person) and within-person in mediation models. We then assessed if these paths differed between binge/heavy and light social drinkers (moderated mediational model). *sa, sb,* and *sc* represent each participant's individual relationship, i.e., random slope, between stress, craving, and drinking.

Supplemental Figure 2. Histogram depicting the (S2A) average amount of alcohol consumed and (S2B) the past month frequency of alcohol use in the 30 days prior to starting the study.
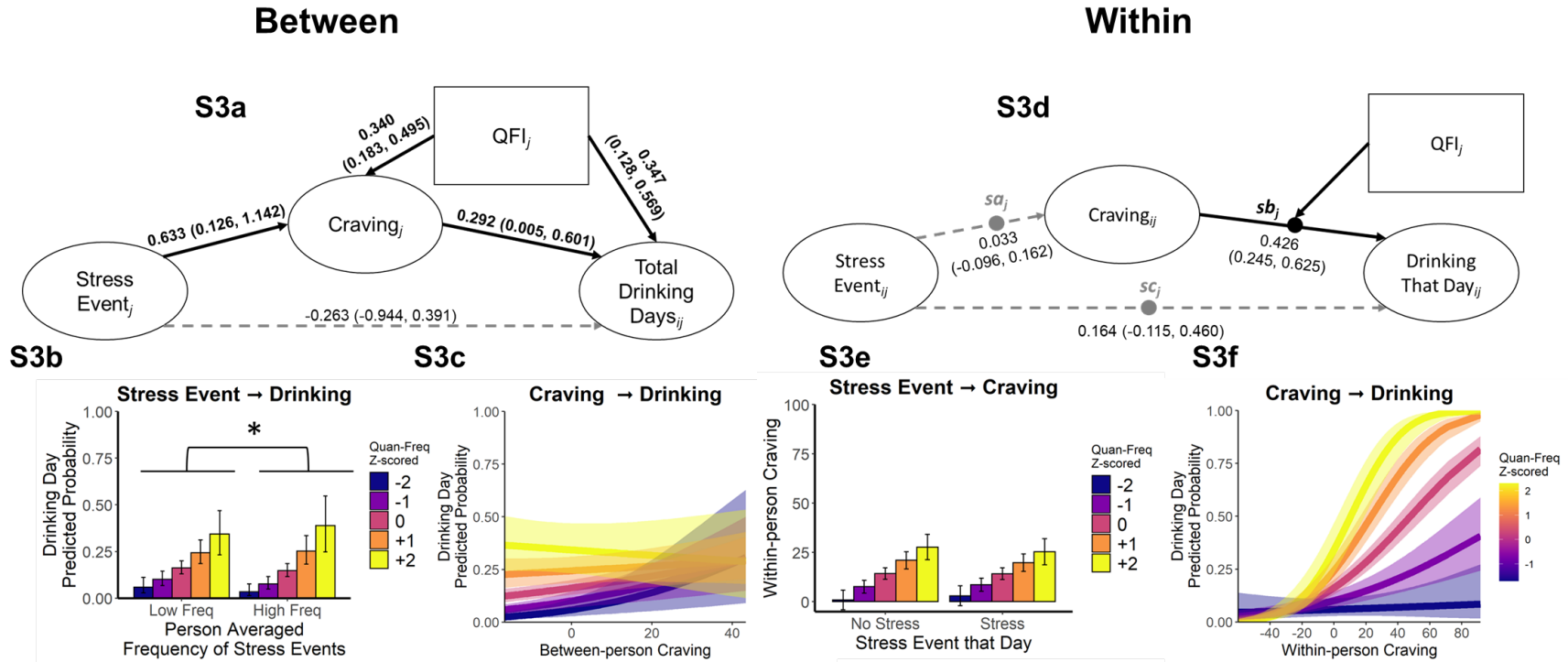
Note. The final moderated mediation model for stress events at the between- (3a) and within-person level (3d). Significant paths are shown in solid black lines, non-significant paths are depicted with gray dashed lines. Graphs depicting the relationships of stress events on craving (3b, 3e) and craving on initiating drinking (3c, 3f) by z-scored QFI. * indicates significant effects on bar graphs (95% CI that do not cross 0).