Is anxiety sensitivity a risk factor for, or complication of, alcohol misuse? A meta-analysis

Sara J. Bartel[a*], Simon B. Sherry[a], Martin M. Smith[b], Vanja V Vidovic[c], & Sherry H. Stewart[d,a].

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[a]Department of Psychology and Neuroscience, Dalhousie University, Life Sciences Centre, 1355 Oxford Street, PO BOX 15000, Halifax, Nova Scotia, B3H4R2, Canada

[b]School of Sport, York St John University, Lord Mayor's Walk, York,Y031 7EX, United Kingdom.

[c]Department of Psychology, University of Waterloo, 200 University Ave West, PAS 1401, Waterloo, Ontario, N2L3G1, Canada

[d]Department of Psychiatry, Dalhousie University, 5909 Veterans' Memorial Lane, 8th Floor, Abbie J. Lane Memorial Building, QEII Health Sciences Centre, Halifax, Nova Scotia, B3H2E2, Canada

*Corresponding author. Tel: 902-494-3793. Fax: 902-494-6585.

Email address: sara.bartel@dal.ca (S. J. Bartel)

Abstract

Anxiety sensitivity (AS) refers to a dispositional tendency to respond to one's anxiety sensations with fear. Longstanding theoretical accounts implicate AS in alcohol misuse; however, the relationship between AS and alcohol misuse remains unclear. We addressed this by testing whether AS is a risk factor for, and/or complication of, alcohol misuse by conducting a rigorous meta-analysis using random effect models. Our literature search yielded 15 studies (N = 9,459). Studies were included if they used a longitudinal design, assessed AS and alcohol misuse at baseline, and assessed alcohol misuse and/or AS at follow-up. Results failed to support AS as a risk factor for, or complication of, alcohol misuse. Researchers are encouraged to test if the link between AS and alcohol misuse emerges under specific conditions (e.g., elevated state anxiety).

Keywords: anxiety sensitivity, alcohol misuse, meta-analysis

1. Introduction

Alcohol misuse is associated with adverse social, economic, and personal outcomes. For instance, excessive consumption of alcohol confers risk for accidents and injuries and is a contributing factor in over 200 different health problems (World Health Organization, 2014). Given these negative consequences, advancing our understanding of risk factors for alcohol misuse is essential.

One putative risk factor for alcohol misuse is anxiety sensitivity (AS). AS refers to a dispositional tendency to respond to one's anxiety sensations with fear (Reiss & McNally, 1985; Reiss, Peterson, Gursky, & McNally, 1986). This fear response is thought to stem from the belief that anxiety sensations have harmful consequences (Reiss & McNally, 1985; Reiss et al., 1986). It has been demonstrated that alcohol consumption results in reductions in the emotional reactivity individuals high in AS experience related to these feared physical sensations (MacDonald, Baker, Stewart & Skinner, 2000). Thus, it has been theorized by Stewart, Samoluk and MacDonald (1999) that people higher in AS may be more likely to use alcohol to eradicate, regulate, or decrease fear and/or arousal associated with the feared anxiety sensations (i.e., the risk model).

While cross-sectional research consistently links AS to alcohol use (e.g., Stewart, Peterson, & Pihl, 1995; Stewart, Zvolensky, & Eifert, 2001), prospective research examining whether AS is a risk factor for alcohol misuse has not consistently supported this relationship. In young adolescents, baseline levels of AS are unrelated to the number of drinks consumed per occasion and to binge drinking at follow up (Jurk et al., 2015; Malmberg et al., 2013), suggesting AS is not a risk factor for alcohol misuse. However, results from Schmidt, Buckner, and Keough (2007), although lacking the proper controls for a stringent test of the risk model (e.g., not

controlling for baseline alcohol misuse), imply that AS may predict the development of a alcohol use disorder in older adolescents and young adults. Similarly, evidence suggests reducing AS via intervention results in decreased alcohol-related problems, further suggesting that AS is causally linked to alcohol use (e.g., Olthuis, Watt, MacKinnon & Stewart, 2015).

As research investigating the potential role of AS as a risk factor for alcohol misuse has produced notable inconsistencies, it is possible that an alternative model of the relationship between AS and alcohol misuse may be warranted to explain the concurrent association between these two variables. A scar/complication model positing that alcohol misuse results in temporary (complication) or permanent (scar) changes in AS has been proposed as one such alternative model (Stewart et al., 1999). Within this model, changes in AS are theorized to occur as a result of alcohol use. For instance, alcohol misuse can result in unpleasant physiological sensations such as elevated heart rate and/or sweating (either during intoxication or during a hangover). These sensations may become feared, and that fear may subsequently be generalized, such that an individual begins to fear all physiological anxiety-related sensations. Unfortunately, while data exists that would allow for an empirical evaluation of the scar/complication models, these models have not been formally tested or investigated.

1.1. Advancing research on the AS-alcohol misuse relationship using meta-analysis

Despite ample research on AS and alcohol misuse, the temporal precedence and directionality of the relationship between AS and alcohol misuse remain unclear. Since determining the nature of the relationship between AS and alcohol misuse is essential for treatment and prevention efforts, an increased understanding is urgently needed. To this end, a comprehensive synthesis of available data is crucial. Such a synthesis would allow for the implementation of statistical controls (i.e., whether AS predicts follow-up alcohol misuse beyond

baseline alcohol misuse and vice versa) that are missing from extant studies (e.g. Schmidt et al., 2007), as well as allow for an examination of moderating variables (e.g., age), which might help to explain inconsistent findings in the AS-alcohol misuse literature. Moreover, as existing longitudinal studies of AS and alcohol misuse vary widely in how they assess alcohol misuse, a systematic effort to synthesize findings based on alcohol misuse operationalization will allow for an investigation of whether AS is a vulnerability factor for specific alcohol outcomes (e.g., alcohol-related problems vs. alcohol quantity) and/or whether specific alcohol misuse variables predict longitudinal change in AS.

1.2. Objectives and hypotheses

We tested whether AS is a risk factor for, or complication of, alcohol misuse by conducting a comprehensive meta-analysis. While cross-sectional research has found conflicting evidence of AS's association with quantity of alcohol use (Stewart et al., 1995, 2001), research does suggest AS is related to increased frequency of alcohol consumption (Stewart et al., 2001), frequency of binge drinking (Stewart et al., 1995, 2001), and alcohol-related problems (Chavarria et al., 2015). Given these findings, we expected to find similar results in prospective research on AS. Specifically, we hypothesized that, while controlling for baseline levels of the alcohol misuse measure in question, AS would predict increased frequency of alcohol consumption, increased frequency of binge drinking, and increased alcohol-related problems, but would not significantly predict increases in quantity of alcohol consumption. Additionally, we investigated whether AS is a complication of alcohol misuse; however, given the absence of literature examining whether AS is a complication of alcohol misuse, we considered questions concerning this model to be exploratory. Finally, we also explored whether the relationship

between AS and alcohol misuse is moderated by age, percentage of females in the sample, and time lag between measurements.

2. Method

2.1. Study identification

Medline, Psycinfo, ERIC, and Proquest Dissertations and Theses were searched to locate longitudinal studies of AS and alcohol misuse. Literature searches were conducted using keywords and Boolean search terms ("anxiety sensitive" OR "anxiety sensitivity" OR "fear of fear" OR "anxiety sensitivity index" OR ASI) AND (alcoho* OR drinking OR "substance use" OR "substance abuse" OR "substance misuse") AND (longitudinal OR "repeated measure" OR "serial measure" OR prospective OR "multi-wave" OR "follow up" OR cohort). We did not restrict our search by year of publication, language, or publication status. Studies were included if they met the following criteria: the study used a longitudinal design; AS and/or alcohol misuse outcomes were assessed at baseline; and the same alcohol misuse and/or AS outcomes were assessed at follow-up. Intervention studies including all three components were eligible if data from an untreated control group was available. We placed no restrictions on study samples with respect to sex, gender, age, or ethnicity.

Our search returned 465 studies. After removing duplicates, 334 studies remained. Abstracts of all studies were first screened for inclusion by the first and the fourth author. Next, two raters reviewed the full-text of all remaining articles. At each stage, rating discrepancies were resolved through discussion and consensus with co-authors. Following full-text screening, the references of and publications citing each article that met eligibility criteria were screened. Studies known to the authors that were not detected through the literature search were also screened for inclusion (n = 6). Following the addition of these six articles, a total of 15 studies

met our inclusion criteria (see Supplemental Material A for included studies and Supplemental Material B for excluded studies). See Figure 1 for the PRISMA flowchart of the literature search and study selection. When studies did not report effect sizes, or sufficient information to compute effect sizes (n = 14), this information was requested from the primary author. All contacted authors provided the necessary statistical information. In January 2017, the literature search was concluded and data extraction began.

2.2. Coding of studies

Studies meeting inclusion criteria were coded on seven characteristics: sample size, type of sample, mean age of participants, percentage of female participants, publication type, measure(s) used to assess AS, and measure(s) used to assess alcohol misuse. See Table 1 for characteristics of included studies.

2.3. Measures

AS was assessed using three measures (see Supplemental Material D). Four alcohol outcomes were included: frequency, frequency of binge drinking, quantity, and alcohol-related problems. See Supplemental Material A for the details of how frequency, frequency of binge drinking, and quantity were assessed in the included studies. Alcohol-related problems was assessed using four measures (see Supplemental Material D).

2.4. Meta-analytic procedure

Comprehensive Meta-Analysis software (Version 3.3; Borenstein, Hedges, Higgins, & Rothstein, 2009) using random effects models were used for all analyses. To estimate mean effect sizes and variance in observed scores after taking sampling error into account, we followed Hunter and Schmidt (1990). As precision is greater in studies with larger sample sizes, we weighted mean effect sizes by sample size. Following this, weighted effect size estimates

were aggregated. Semi-partial correlations were computed using MPlus6 (Muthén & Muthén, 1998-2010), to test the extent to which AS predicts follow-up alcohol misuse after controlling for baseline alcohol misuse, and to test whether alcohol misuse predicts follow-up AS after controlling for baseline AS. To prevent overrepresentation of studies including multiple effects, effects using more than one measure to assess AS were averaged so the analysis only included one effect (Card, 2012). Prior to averaging, correlations were transformed into Fisher's Z (Card, 2012). Correlations within each individual study appear in Supplemental Material A.

For each analysis, the total heterogeneity (Q_T) of weighted mean effect sizes was calculated (see Table 3). A significant Q_T indicates the variance in weighted mean effect sizes is larger than would be expected due to sampling error (Card, 2012), suggesting a basis for testing moderation. We also computed the inconsistency in observed relationships across studies for each analysis (I^2; Higgins, Thompson, Deeks, & Altman, 2003). This measure of consistency provides percentages of total variation from 0-100%, with values of 25% (low heterogeneity), 50% (medium heterogeneity), and 75% (high heterogeneity; Higgins et al., 2003).

3. Results

3.1. Overall effect sizes

Weighted mean effect sizes between AS and alcohol misuse appear in Table 2. AS did not predict follow-up frequency of alcohol consumption, binge drinking frequency, quantity, or alcohol-related problems after controlling for baseline alcohol misuse variables. Similarly, frequency of alcohol consumption, frequency of binge drinking, quantity, and alcohol-related problems did not predict follow-up AS after controlling for baseline AS. Both alcohol misuse and AS were highly stable.

The test of the total heterogeneity of variance of weighted mean effect sizes (Q_T) was

significant for the overall effect of AS predicting change in frequency of alcohol consumption and AS predicting change in frequency of binge drinking. As the percentage of total variance owing to heterogeneity (I^2) ranged from medium to large, this suggested the possible presence of moderators.

3.2. Moderator analyses

Analyses of moderators (see Supplemental Material E) were used to test if effect sizes with significant heterogeneity (Q_T) were moderated by mean age, mean proportion of female participants, and time between waves of data collection. Evidence suggested moderation by age, with the relationship between AS and alcohol misuse (drinking frequency and binge drinking frequency) being stronger among younger participants. Given the restricted mean age range of our sample of studies examining AS and drinking/binge drinking frequency, however, caution is warranted when interpreting the analysis of moderators, as this pattern of moderation may not be found beyond the mean age range of 12.6-14.8 years.

3.3. Publication bias

Egger's regression intercept (see Table 2) and funnel plots (see Supplemental Material F) did not provide evidence for publication bias. Following the imputation of missing studies, the adjusted point estimates for AS predicting alcohol misuse, and alcohol misuse predicting AS, provided the same substantive implications as the unadjusted point estimates (see Table 2).

4. Discussion

Understanding the relationship between AS and alcohol misuse is critical for prevention and treatment efforts. Thus, we conducted a comprehensive meta-analysis of 15 longitudinal studies. Results suggested AS does not predict increased frequency of alcohol consumption, frequency of binge drinking, quantity of alcohol consumption, or alcohol-related problems, while controlling for baseline alcohol outcomes. Though this supports our hypothesis related to quantity, our hypotheses related to frequency of alcohol consumption, frequency of binge drinking, and alcohol-related problems were not supported. Indeed, our tests of the scar/complication model indicated frequency of alcohol consumption, frequency of binge drinking, quantity of alcohol consumption, and alcohol-related problems do not predict AS, while controlling for baseline AS. Results suggest AS may not be a risk factor for, or scar/complication of, alcohol misuse.

Additionally, though we found little evidence of moderation overall, our preliminary findings suggested the relationship between AS and alcohol misuse may change over development. AS may act as a risk factor for more frequent alcohol consumption and binge drinking in early adolescence but become a protective factor for these behaviors in later adolescence. Nonetheless, our moderation results indicated a weak relationship between AS and alcohol misuse and represent a very restricted (i.e., two year) mean age range (see Supplemental Material E). Accordingly, more research, conducted across a wider age range, is needed to increase our confidence in moderation by age.

4.1. Conceptual considerations

Our results indicated the link between AS and alcohol misuse is not etiological in nature; however, this does not mean AS is unrelated to alcohol misuse. On the contrary, instead of being

a risk factor, AS may modify alcohol consumption pathoplastically by maintaining alcohol misuse. For example, individuals who engage in alcohol misuse may experience guilt about their alcohol consumption or about their behaviors while under the influence of alcohol, which may result in increased anxiety-related sensations. To escape such sensations, high AS individuals may continue to misuse alcohol (Stewart & Kushner, 2001).

It is also possible the relationship between AS and alcohol misuse is better captured by a diathesis-stress model. According to the diathesis-stress model, AS may be a risk factor for alcohol misuse (diathesis), but only in the presence of a stressor. For instance, it has been suggested that individuals with high levels of AS may only be susceptible to misusing alcohol during periods in which they are also experiencing elevated state anxiety (i.e., a stressor; Stewart & Kushner, 2001). As these individuals find the physiological and the cognitive sensations which accompany elevated levels of anxiety to be aversive, they may turn to alcohol to dampen their arousal and cope with their anxiety.

4.2. Limitations

Our findings are limited by the studies included in our meta-analysis. AS and alcohol misuse were highly stable, meaning the variance available to be accounted for by AS (risk model) or by alcohol misuse (scar/complication) model was relatively small (see Table 2). Moreover, our included studies involved variable time lags (i.e., 2 weeks to 24 months; see Table 1) and focused on one developmental period (e.g., high school). The risk and the scar/complication models should be studied across developmental periods when AS and alcohol misuse are likely to change (e.g., transitioning from high school to university), as well as studied using longer time lags between measurement points, so there is more variability to predict once baseline levels are controlled.

Additionally, our included studies lacked consistency with respect to the way alcohol misuse outcomes were measured. This inconsistency may have complicated the relationship between AS and alcohol misuse. Moreover, our included studies used measures that may be unable to detect subtleties in the relation of AS and to alcohol-related problems. Research suggests AS may be related to physical and to interpersonal alcohol-related problems, rather than global alcohol-related problems (Olthuis, Watt, Mackinnon, & Stewart, 2015). As 14 out of the 15 included studies measured alcohol-related problems globally, we were unable to investigate the possibility of this nuanced relationship.

Similarly, while evidence suggests AS has three separate dimensions (i.e., physical, cognitive, and social concerns; Zinbarg, Barlow, & Brown, 1997), 12 out of the 15 included studies did not use an AS measure that captured these three dimensions well (e.g., the ASI-3; Taylor et al., 2007). Rather, they used the SURPS (Woicik, Stewart, Pihl, & Conrod, 2009), which appears to focus primarily on the physical concerns AS dimension. It is possible only certain AS dimensions act as a risk factor for alcohol misuse, and that such distinctions could not be detected in this meta-analysis because of the ways in which our included studies assessed AS.

Limitations in the available studies translated into limitations in our meta-analysis. As our included studies were composed exclusively of participants from North America, Western Europe, and Australia, the extent to which these results generalize to other regions is unclear. Moreover, as the average ages of the samples in our included studies ranged from 13-36 years old, and 10 of our 15 included studies had secondary/high school student samples, our results may not extend across the lifespan. Finally, the extracted data only allowed us to study the link between AS and alcohol misuse at the between-persons level. Perhaps AS does not predict alcohol misuse at this level, but does predict within-person, day-to-day variability in alcohol

misuse. Research should use daily diary methods and multi-level modeling to test this idea.

Another limitation is that, despite a-priori hypotheses and a data analytic plan devised prior to receiving data from contacted authors, our meta-analysis was not pre-registered. This is noteworthy because a firm commitment to a particular analytic plan has been demonstrated to be associated with a decreased risk of biased results (Watt & Kennedy, 2016). However, the risk for such bias would present a greater study limitation if findings had supported our a-priori hypothesized relationships between AS and alcohol misuse. Overall, our meta-analysis should be considered exploratory, rather than confirmatory, in nature (Wagenmakers, Wetzels, Borsboom, van der Maas, & Kievit, 2012). And future meta-analyses examining the link between AS and alcohol misuse should follow guidelines set out by Watt and Kennedy (2016) to be truly confirmatory and to further resolve the debate on the relationship between AS and alcohol misuse.

4.3. Conclusion

Our meta-analysis represents the most comprehensive test of the longitudinal relationship between AS and alcohol misuse to date. Our analyses indicated that AS does not appear to be a risk factor for alcohol misuse, nor does AS appear to be a complication of alcohol misuse. While some nuances exist (e.g., AS is a risk factor for more frequent alcohol use and binge drinking in early but not late adolescence), these effects were relatively weak and inconsistent across alcohol measures. Thus, the link between AS and alcohol misuse may be better captured by a model other than the risk and the scar/complication models tested here.

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Table 1

Characteristics of longitudinal studies included in the meta-analysis

	Sample								Measure	
	Overall/ condition	*N*	Sample type	Mean age	Time lag	Attrition %	Female %	Status	Alcohol misuse	Anxiety sensitivity
Castellanos-Ryan et al. (2013)	overall	1,162	secondary/high school students	13.7	6.00	22.0	42.1[IDA]	A	frequency binge drinking frequency quantity RAPI	SURPS CASI
Conrod et al. (2006)	control	131	secondary/high school students	NR	4.00	12.0	55.0	A	frequency binge drinking frequency quantity RAPI	CASI
Conrod et al. (2008)	control	169	secondary/high school students	14.0*	6.00	19.0	75.0	A	frequency binge drinking frequency quantity RAPI-short form	SURPS
Conrod et al. (2011)	control	168	secondary/high school students	14.0*	6.00	20.3	NR	A	frequency binge drinking frequency quantity RAPI-short form	SURPS
Janssen et al. (2014)	overall	397	secondary/high school students	14.9	6.00	NR	64.6	A	binge drinking frequency quantity	SURPS
Jurk et al. (2015)	overall	2,205	secondary/high school students	14.4*	24.00	24.3	51.0*	A	frequency binge drinking frequency quantity	SURPS

									AUDIT	
Krank et al. (2011)	overall	1315	secondary/high school students	NR	12.00	11.5	NR	A	CRAFFT	SURPS
Kruse (2014)	overall	219	undergraduate students	21.6	0.50	4.5	77.3	T	RAPI-3 year RAPI-7 day	SURPS
Loxton et al. (2015)	overall	255	undergraduate students	18.1	3.00	NR	34.5	A	quantity	SURPS
Mackinnon et al. (2014)	overall	302	undergraduate students	20.8	6.00	16.9	72.5	A	quantity RAPI	SURPS
Malmberg et al. (2013)	overall	1259	secondary/high school students	12.9_{IDA}	8.00	3.8	52.5_{IDA}	A	frequency frequency of binge drinking	SURPS
Moser et al. (2014)	overall	936	undergraduate students	18.1	1.00	13.0	50.0	A	BYAACQ	SURPS
Newton et al. (2016)	overall	527	secondary/high school students	13.4	24.00	16.0	67.0	A	frequency binge drinking frequency quantity RAPI	SURPS
Olthuis et al. (2015)	control	40	treatment-seeking community	36.3	2.00	10.0	NR	A	SIP-R	ASI-3
Peeters et al. (2014)	overall	374	secondary/high school students	13.6	7.00	25.0	11.8	A	frequency CRAFFT	SURPS

Note. Unless indicated otherwise, statistics are for the original sample at baseline. Overall/control = data represent participants from the entire sample (overall) or the control condition of the study (control); Time lag is in months; $_{IDA}$ = statistics for participants included in data analysis; NR = not reported; *N* = total number of participants; status = publication status of the study: A = article; T = master's thesis; * = median age; SURPS = Substance Use Risk Profile Scale (Woicik, Stewart, Pihl, & Conrod, 2009); CASI = Children's Anxiety Sensitivity Index (Silverman, Fleisig, Rabian, & Peterson, 1991); RAPI-Short form = 7 item short form of the RAPI (Conrod et al., 2011); AUDIT = Alcohol Use Disorders Identification Test (Saunders, Aasland, Babor, De La Fuente, & Grant, 1993); CRAFFT = brief alcohol and

other drug screening test (Knight, Shrier, & Bravender, 1999); RAPI-3 year = Rutgers Alcohol Problem Index over the past 3 years (White & Labouvie, 1989); RAPI-7 day = Rutgers Alcohol Problem Index over the past 7 days (White & Labouvie, 1989); BYAACQ = Brief Young Adults Alcohol Consequences Questionnaire (Kahler, Strong, & Read, 2005); SIP-R = Short Inventory of Problems-Recent (Miller, Tonigan, & Longabaugh, 1995); ASI-3 = Anxiety Sensitivity Index Third Edition (Taylor et al., 2007).

Table 2

Summary of effect sizes for the relationship between anxiety sensitivity and alcohol misuse

Variable	*k*	*N*	r^+	95% *CI*	Q_T	I^2(%)	Egger's Intercept	95% *CI*	k^{TF}	Trim and fill estimates r^+ [95% *CI*]
Frequency										.
^{r}AS, F	9	6,090	-.04	[-.09, .01]	24.60*	67.48	-1.77	[-5.04, 1.49]	0	-.04 [-.09, .01]
$AS_1 \rightarrow AS_2$	9	5,418	.49**	[.40, .57]	114.72**	93.03	4.22	[-2.69, 11.14]	2	.45 [.36, .53]
$F_1 \rightarrow F_2$	9	5,418	.63**	[.48, .74]	477.82**	98.33	1.31	[-14.73, 17.36]	0	.63 [.48, .74]
$F_1 \rightarrow AS_2$	9	5,418	.03	[.01, .06]	5.43	0.00	-0.61	[-2.24, 1.02]	0	.03 [.01, .06]
$AS_1 \rightarrow F_2$	9	5,418	.02	[-.06, .10]	63.37**	87.38	-1.08	[-6.86, 4.69]	0	.02 [-.06, .10]
Frequency of binge drinking										
^{r}AS, BF	8	5,894	-.02	[-.07, .02]	19.87*	64.77	-0.92	[-4.94, 3.09]	0	-.02 [-.07, .02]
$AS_1 \rightarrow AS_2$	8	5,276	.48**	[.39, .57]	106.48**	93.43	4.96	[-3.39, 13.31]	2	.44 [.35, .52]
$BF_1 \rightarrow BF_2$	8	5,276	.57**	[.42, .69]	326.72**	97.96	4.84	[-11.47, 21.15]	0	.57 [.42, .59]
$BF_1 \rightarrow AS_2$	8	5,276	.01	[-.04, .06]	16.39	57.29	0.01	[-3.80, 3.82]	2	-.01 [-.06, .04]
$AS_1 \rightarrow BF_2$	8	5,276	.01	[-.06, .08]	38.56**	81.85	-0.39	[-6.22, 5.44]	0	.01 [-.06, .08]
Quantity										
^{r}AS, Q	10	5,429	-.04	[-.08, .00]	17.44	48.39	-2.29	[-4.00, -0.59]	0	-.04 [-.08, .00]
$AS_1 \rightarrow AS_2$	9	4,663	.52**	[.42, .60]	127.95**	93.75	5.85	[-0.16, 11.86]	1	.49 [.40, .58]
$Q_1 \rightarrow Q_2$	10	4,918	.60**	[.50, .69]	236.19**	96.19	3.43	[-5.65, 12.51]	1	.58 [.47, .67]
$Q_1 \rightarrow AS_2$	9	4,633	.02	[-.02, .06]	12.41	35.53	-1.08	[-3.37, 1.20]	0	.02 [-.02, .06]
$AS_1 \rightarrow Q_2$	10	4,918	.00	[-.03, .03]	3.49	0.00	-0.82	[-1.76, 0.12]	0	.00 [-.03, .03]
Alcohol-related problems										
^{r}AS, ARP	12	5,689	.02	[-.03, .07]	30.21*	63.59	0.78	[-1.98, 3.46]	0	.02 [-.03, .07]
$AS_1 \rightarrow AS_2$	11	4,433	.55**	[.45, .64]	183.26**	94.54	6.55	[1.14, 11.96]	0	.55 [.45, .64]
$ARP_1 \rightarrow APR_2$	12	5,250	.60**	[.54, .66]	86.34**	87.26	1.31	[-3.21, 5.83]	1	.58 [.52, .64]
$ARP_1 \rightarrow AS_2$	11	4,433	.00	[-.04, .04]	13.29	24.74	-0.73	[-2.63, 1.16]	0	.00 [-.04, .04]
$AS_1 \rightarrow ARP_2$	12	5,250	.01	[-.02, .04]	8.68	0.00	0.29	[-1.16, 1.74]	0	.01 [-.02, .04]

Note. ***k*** = number of studies; ***N*** = total number of participants in the *k* samples; $\boldsymbol{r^+}$ = weighted mean *r*; ***CI*** = confidence interval; $\boldsymbol{Q_T}$ = measure of heterogeneity of effect sizes; $\boldsymbol{I^2}$ = percentage of heterogeneity; **Egger's intercept** = Egger's test of regression to the intercept; $\boldsymbol{k^{TF}}$ = number of imputed studies as part of trim and fill method; **AS** = anxiety

sensitivity; **F** = frequency of alcohol use; **Q** = quantity of alcohol use; **BF** = binge drinking frequency; **ARP** = alcohol-related problems; $\mathbf{r_{AS,\ F}}$ = bivariate correlation between AS and frequency; $\mathbf{AS_1 \rightarrow AS_2}$ = standardized beta for baseline AS predicting follow-up AS while controlling for time 1 frequency; $\mathbf{F_1 \rightarrow F_2}$ = standardized beta for time 1 frequency predicting time 2 frequency while controlling for time 1 AS; $\mathbf{AS_1 \rightarrow F_2}$ = standardized beta for baseline AS predicting follow-up frequency, while controlling for baseline frequency; $\mathbf{F_1 \rightarrow AS_2}$ = standardized beta for baseline frequency predicting follow-up AS, while controlling for baseline AS.
$^{*}p < .01$; $^{**}p < .001$.

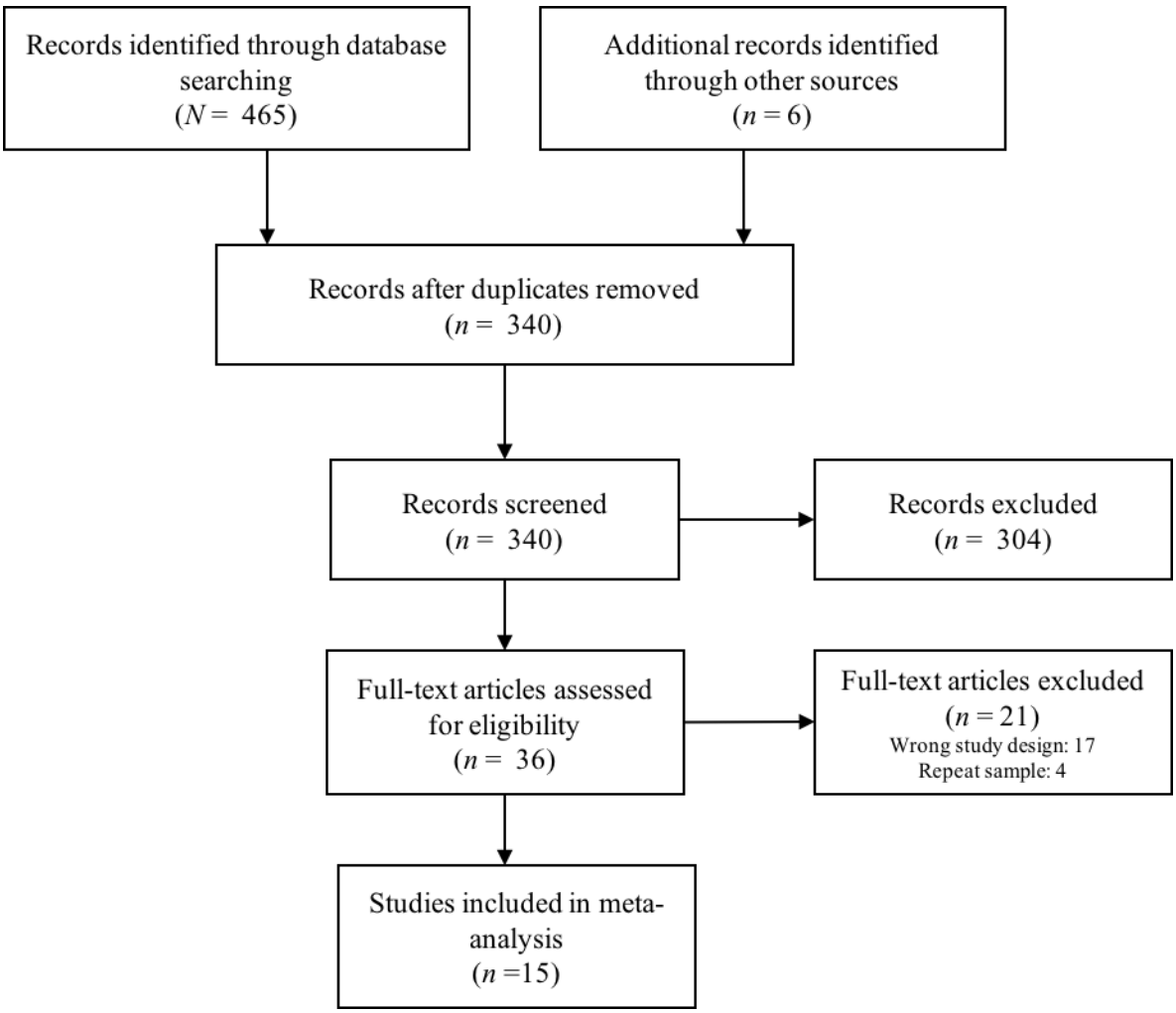

Figure 1. PRISMA flowchart of literature search and study selection.

Supplemental Material A: Included Studies

Castellanos-Ryan, N., O'Leary-Barrett, M., Sully, L., & Conrod, P. (2013). Sensitivity and specificity of a brief personality screening instrument in predicting future substance use, emotional, and behavioral problems: 18-month predictive validity of the substance use risk profile scale. *Alcoholism: Clinical and Experimental Research*, *37*, 281-290.

Conrod, P. J., Castellanos, N., & Mackie, C. (2008). Personality-targeted interventions delay the growth of adolescent drinking and binge drinking. *Journal of Child Psychology and Psychiatry, 49*, 181-190.

Conrod, P. J., Castellanos-Ryan, N., & Mackie, C. (2011). Long-term effects of a personality-targeted intervention to reduce alcohol use in adolescents. *Journal of Consulting and Clinical Psychology*, *79* 296-306.

Conrod, P. J., Stewart, S. H., Comeau, N., & Maclean, A. M. (2006). Efficacy of cognitive–behavioral interventions targeting personality risk factors for youth alcohol misuse. *Journal of Clinical Child and Adolescent Psychology*, *35*, 550-563.

Janssen, T., Larsen, H., Peeters, M., Pronk, T., Vollebergh, W. A., & Wiers, R. W. (2014). Interactions between parental alcohol-specific rules and risk personalities in the prediction of adolescent alcohol use. *Alcohol and Alcoholism*, *49*, 579-585.

Jurk, S., Kuitunen-Paul, S., Kroemer, N. B., Artiges, E., Banaschewski, T., Bokde, A. L., ... & Frouin, V. (2015). Personality and substance use: Psychometric evaluation and validation of the Substance Use Risk Profile Scale (SURPS) in English, Irish, French, and German adolescents. *Alcoholism: Clinical and Experimental Research*, *39*, 2234-2248.

Krank, M., Stewart, S. H., O'Connor, R., Woicik, P. B., Wall, A. M., & Conrod, P. J. (2011).

Structural, concurrent, and predictive validity of the Substance Use Risk Profile Scale in early adolescence. *Addictive Behaviors, 36,* 37-46.

Kruse, A. S. (2014). *Personality, drinking motives and protective behavioural strategies among undergraduates* (Unpublished master's thesis). Lakehead University, Ontario, CA.

Loxton, N. J., Bunker, R. J., Dingle, G. A., & Wong, V. (2015). Drinking not thinking: A prospective study of personality traits and drinking motives on alcohol consumption across the first year of university. *Personality and Individual Differences, 79,* 134-139.

Mackinnon, S. P., Kehayes, I. L. L., Clark, R., Sherry, S. B., & Stewart, S. H. (2014). Testing the four-factor model of personality vulnerability to alcohol misuse: A three-wave, one-year longitudinal study. *Psychology of Addictive Behaviors, 28,* 1000-1012.

Malmberg, M., Kleinjan, M., Overbeek, G., Vermulst, A. A., Lammers, J., & Engels, R. C. (2013). Are there reciprocal relationships between substance use risk personality profiles and alcohol or tobacco use in early adolescence? *Addictive Behaviors, 38,* 2851-2859.

Moser, K., Pearson, M. R., Hustad, J. T., & Borsari, B. (2014). Drinking games, tailgating, and pregaming: Precollege predictors of risky college drinking. *American Journal of Drug and Alcohol Abuse, 40,* 367-373.

Newton, N. C., Barrett, E. L., Castellanos-Ryan, N., Kelly, E., Champion, K. E., Stapinski, L., ... & Teesson, M. (2016). The validity of the substance use risk profile scale (SURPS) among Australian adolescents. *Addictive Behaviors, 53,* 23-30.

Olthuis, J. V., Watt, M. C., Mackinnon, S. P., & Stewart, S. H. (2015). CBT for high anxiety sensitivity: Alcohol outcomes. *Addictive Behaviors, 46,* 19-24.

Peeters, M., Monshouwer, K., van de Schoot, R., Janssen, T., Vollebergh, W. A., & Wiers, R. W. (2014). Personality and the prediction of high-risk trajectories of alcohol use during

adolescence. *Journal of Studies on Alcohol and Drugs*, *75*, 790-798.

Supplemental Material B: Excluded Studies That Measured AS and Alcohol Misuse

Conrod, P. J., O'Leary-Barrett, M., Newton, N., Topper, L., Castellanos-Ryan, N., Mackie, C., & Girard, A. (2013). Effectiveness of a selective, personality-targeted prevention program for adolescent alcohol use and misuse: A cluster randomized controlled trial. *JAMA Psychiatry*, *70*, 334-342.

Heinrich, A., Müller, K. U., Banaschewski, T., Barker, G. J., Bokde, A. L., Bromberg, U., ... & Gallinat, J. (2016). Prediction of alcohol drinking in adolescents: Personality-traits, behavior, brain responses, and genetic variations in the context of reward sensitivity. *Biological Psychology*, *118*, 79-87.

Mackie, C. J., Castellanos-Ryan, N., & Conrod, P. J. (2011). Personality moderates the longitudinal relationship between psychological symptoms and alcohol use in adolescents. *Alcoholism: Clinical and Experimental Research*, *35*, 703-716.

O'Leary-Barrett, M., Castellanos-Ryan, N., Pihl, R. O., & Conrod, P. J. (2016). Mechanisms of personality-targeted intervention effects on adolescent alcohol misuse, internalizing and externalizing symptoms. *Journal of Consulting and Clinical Psychology*, *84*, 438-452.

O'Leary-Barrett, M., Mackie, C. J., Castellanos-Ryan, N., Al-Khudhairy, N., & Conrod, P. J. (2010). Personality-targeted interventions delay uptake of drinking and decrease risk of alcohol-related problems when delivered by teachers. *Journal of the American Academy of Child & Adolescent Psychiatry*, *49*, 954-963.

Schmidt, N. B., Buckner, J. D., & Keough, M. E. (2007). Anxiety sensitivity as a prospective predictor of alcohol use disorders. *Behavior Modification*, *31*, 202-219.

Watt, M., Stewart, S., Birch, C., & Bernier, D. (2006). Brief CBT for high anxiety sensitivity

decreases drinking problems, relief alcohol outcome expectancies, and conformity drinking motives: Evidence from a randomized controlled trial. *Journal of Mental Health*, *15*, 683-695.

Table B1

Characteristics of studies excluded from the meta-analysis

Study Authors	Sample					Measures		Reason for exclusion
	N	Sample type	Mean age	Female	Status	Anxiety sensitivity	Alcohol use	
Conrod et al. (2013)	2,643	secondary/high school students	13.7	NR	article	SURPS	quantity frequency frequency of binge drinking RAPI	duplicate data (see Conrod et al. 2008)
Heinrich et al. (2016)	736	secondary/high school students	14.4	48.8%	article	SURPS	AUDIT	duplicate data (see Jurk et al. 2015)
Mackie et al. (2011)	809	secondary/high school students	13.0	NR	article	SURPS	quantity frequency	duplicate data (see Conrod et al. 2008)
O'Leary-Barrett et al. (2010)	1,159	secondary/high school students	NR	44.8%	article	SURPS	quantity frequency RAPI	duplicate data (see Conrod et al. 2008)
O'Leary-Barrett et al. (2016)	1,210	secondary/high school students	13.7	46.0%	article	SURPS	quantity frequency frequency of binge drinking RAPI	duplicate data (see Conrod et al. 2008)
Schmidt et al. (2007)	404	mixed[a]	19.3	61.0%	article	ASI	alcohol use disorder	control group received an

									intervention
Watt et al. (2006)	221	undergraduate students	19.0	100%	article	ASI	quantity frequency RAPI	control group received an intervention

Note. This table includes studies that explicitly measured both AS and alcohol outcomes, but were ultimately excluded for various reasons shown in table. **NR** = not reported; ***N*** = total number of participants; **female %** = percentage of sample that is female; **status** = publication status of the study (e.g., article or thesis); **SURPS** = Substance Use Risk Profile Scale (Woicik, Stewart, Pihl & Conrod, 2009); **ASI** = Anxiety Sensitivity Index (Reiss, Peterson, Gurskey, & McNally, 1986); **RAPI =** Rutgers Alcohol Problem Index (White & Labouvie, 1989); **AUDIT** = Alcohol Use Disorders Identification Test (Saunders, Aasland, Babor, De La Fuente, & Grant, 1993).

[a]undergraduate, secondary school, and community

Supplemental Material C: Effect Sizes

Table C1

Effect sizes for anxiety sensitivity and alcohol use

					Frequency			
	AS Outcome	Frequency	$^{r}AS_1, F_1$	$^{r}AS_2, F_2$	$AS_1 \rightarrow AS_2$	$F_1 \rightarrow F_2$	$F_1 \rightarrow AS_2$	$AS_1 \rightarrow F_2$
Castellanos-Ryan et al. (2013)	SURPS	frequency[a]	-.04	.10	.23	.65	.08	.00
	CASI		-.01	.04	.54	.65	.03	.04
	Overall		**-.03**	**.07**	**.40**	**.65**	**.06**	**.02**
Conrod et al. (2006)	CASI	frequency[a]	-.14	-.24	.58	.55	-.08	-.07
	Overall		**-.14**	**-.24**	**.58**	**.55**	**-.08**	**-.07**
Conrod et al. (2008)	SURPS	frequency[a]	-.15	-.17	.56	.70	-.03	-.05
	Overall		**-.15**	**-.17**	**.56**	**.70**	**-.03**	**-.05**
Conrod et al. (2011)	SURPS	frequency[a]	-.11	-.02	.69	.66	.08	-.03
	Overall		**-.11**	**-.02**	**.69**	**.66**	**.08**	**-.03**
Jurk et al. (2015)	SURPS	AUDIT item 1[b]	-.01	.03	.37	.37	.02	-.04
	Overall		**-.01**	**.03**	**.37**	**.37**	**.02**	**-.04**
Malmberg et al. (2013)	SURPS	frequency[a]	-.17	-.08	.52	.85	.05	.25
	Overall		**-.17**	**-.08**	**.52**	**.85**	**.05**	**.25**
Newton et al. (2016)	SURPS	frequency[a]	-.07	.08	.48	.50	.02	-.02
	Overall		**-.07**	**.08**	**.48**	**.50**	**.02**	**-.02**
Peeters et al. (2014)	SURPS	frequency[a]	-.05	-.01	.43	.52	-.03	-.07
	Overall		**-.05**	**-.01**	**.43**	**.52**	**-.03**	**-.07**
			Binge drinking frequency					
	AS Outcome	Binge Drinking Frequency	$^{r}AS_1, BF_1$	$^{r}AS_2, BF_2$	$AS_1 \rightarrow AS_2$	$BF_1 \rightarrow BF_2$	$BF_1 \rightarrow AS_2$	$AS_1 \rightarrow BF_2$
Castellanos-Ryan et al.(2013)	SURPS	binge frequency[c]	.00	.09	.23	.62	.10	-.01
	CASI		.02	.04	.54	.62	.01	.00
	Overall		**.01**	**.07**	**.40**	**.62**	**.06**	**-.01**
Conrod et al. (2008)	SURPS	binge frequency[d]	-.11	-.27	.55	.56	-.07	-.08

	Overall		**-.11**	**-.27**	**.55**	**.56**	**-.07**	**-.08**
Conrod et al. (2011)	SURPS	binge frequency[d]	-.09	-.05	.69	.75	.05	-.03
	Overall		**-.09**	**-.05**	**.69**	**.75**	**.05**	**-.03**
Janssen et al. (2014)	SURPS	binge frequency[d]	.04	-.01	.50	.42	.03	.02
	Overall		**.04**	**-.01**	**.50**	**.42**	**.03**	**.02**
Jurk et al. (2015)	SURPS	AUDIT item 3[e]	-.02	-.02	.37	.24	.01	-.06
	Overall		**-.02**	**-.02**	**.37**	**.24**	**.01**	**-.06**
Malmberg et al. (2013)	SURPS	binge frequency[f]	-.12	-.09	.50	.71	-.08	.18
	Overall		**-.12**	**-.09**	**.50**	**.71**	**-.08**	**.18**
Newton et al. (2016)	SURPS	binge frequency[f]	-.07	.07	.48	.50	.01	-.02
	Overall		**-.07**	**.07**	.48	**.50**	**.01**	**-.02**
			Quantity					
	AS Outcome	Quantity	$^{r}AS_1, Q_1$	$^{r}AS_2, Q_2$	$AS_1 \rightarrow AS_2$	$Q_1 \rightarrow Q_2$	$Q_1 \rightarrow AS_2$	$AS_1 \rightarrow Q_2$
Castellanos-Ryan et al. (2013)	SURPS	quantity[g]	-.04	.12	.23	.70	.11	-.02
	CASI		-.03	.01	.54	.70	.05	.01
	Overall		**-.04**	**.07**	**.40**	**.70**	**.08**	**-.01**
Conrod et al. (2006)	CASI	quanitity[g]	-.22	-.18	.60	.59	.01	-.02
	Overall		**-.22**	**-.18**	**.60**	**.59**	**.01**	**-.02**
Conrod et al. (2008)	SURPS	quantity[g]	-.19	-.20	.56	.62	.00	-.05
	Overall		**-.19**	**-.20**	**.56**	**.62**	**.00**	**-.05**
Conrod et al. (2011)	SURPS	quantity[g]	-.07	.01	.68	.78	.06	-.07
	Overall		**-.07**	**.01**	**.68**	**.78**	**.06**	**-.07**
Janssen et al. (2014)	SURPS	TLFB[h]	-.01	-.09	.50	.63	-.08	-.04
	Overall		**-.01**	**-.09**	**.50**	**.63**	**-.08**	**-.04**
Jurk et al. (2015)	SURPS	AUDIT item 2[i]	-.01	-.02	.37	.37	.02	.02
	Overall		**-.01**	**-.02**	**.37**	**.37**	**.02**	**.02**
Loxton et al. (2015)	SURPS	WAU[j]	-.13	N/A	N/A	.53	N/A	.05
	Overall		**-.13**	**N/A**	**N/A**	**.53**	**N/A**	**.05**
MacKinnon et al. (2014)	SURPS	quantity[g]	-.11	-.08	.65	.59	-.04	-.03
	Overall		**-.11**	**-.08**	**.65**	**.59**	**-.04**	**-.03**
Newton et al. (2016)	SURPS	quantity[g]	-.07	.08	.48	.40	-.03	-.02

	Overall		**-.07**	**.08**	**.48**	**.40**	**-.03**	**-.02**
			Alcohol-related problems					
	AS Outcome	Alcohol-related problems	$^{r}AS_1$, ARP_1	$^{r}AS_2$, ARP_2	$AS_1 \rightarrow AS_2$	$ARP_1 \rightarrow ARP_2$	$ARP_1 \rightarrow AS_2$	$AS_1 \rightarrow ARP_2$
Castellanos-Ryan et al. (2013)	SURPS	RAPI-8 item	.00	.09	.23	.57	.07	-.01
	CASI	RAPI-8 item	.06	.10	.54	.57	.02	.04
	Overall		**.03**	**.10**	**.40**	**.57**	**.05**	**.02**
Conrod et al. (2006)	CASI	RAPI	.04	.09	.60	.63	-.09	.11
	Overall		**.04**	**.09**	**.60**	**.63**	**-.09**	**.11**
Conrod et al. (2008)	SURPS	RAPI-7 item	-.05	-.09	.56	.48	-.05	-.01
	Overall		**-.05**	**-.09**	**.56**	**.48**	**-.05**	**-.01**
Conrod et al. (2011)	SURPS	RAPI-7 item	-.01	.07	.68	.50	-.03	.01
	Overall		**-.01**	**.07**	**.68**	**.50**	**-.03**	**.01**
Krank et al. (2011)	SURPS	CRAFFT	-.06	-.09	.33	.66	-.07	-.04
	Overall		**-.06**	**-.09**	**.33**	**.66**	**-.07**	**-.04**
Kruse (2014)	SURPS	RAPI–3 years	.06	.23	.71	.80	.07	.04
		RAPI–7 days	.07	.14	.71	.56	-.01	.08
	Overall		**.07**	**.19**	**.71**	**.70**	**.03**	**.06**
Mackinnon et al. (2014)	SURPS	RAPI	.17	.17	.66	.75	-.01	.00
	Overall		**.17**	**.17**	**.66**	**.75**	**-.01**	**.00**
Moser et al. (2014)	SURPS	BYAACQ	-.06	N/A	N/A	.45	.05	N/A
	Overall		**-.06**	**N/A**	**N/A**	**.45**	**.05**	**N/A**
Netwon et al. (2016)	SURPS	RAPI-9 item	.01	.00	.48	.53	.05	-.02
	Overall		**.01**	**.00**	**.48**	**.53**	**.05**	**-.02**
Olthuis et al. (2015)	ASI-3	SIP-R	.04	-.12	.76	.73	-.11	-.11
	Overall		**.04**	**-.12**	**.76**	**.73**	**-.11**	**-.11**
Peeters et al. (2014)	SURPS	CRAFFT	-.08	.03	.43	.59	-.04	.07
	Overall		**-.08**	**.03**	**.43**	**.59**	**-.04**	**.07**

Note: **AS** = Anxiety sensitivity; **F** = Frequency; **Q** = Quantity; **BF** = Binge drinking frequency; **ARP** = Alcohol-related problems; x_1 = time 1 variable; x_2 = time 2 variable; $^{r}x_1$,$^{r}y_1$= bivariate correlation between time 1 variables; $^{r}x_2$,$^{r}y_2$= bivariate correlation between time 2 variables; $AS_1 \rightarrow AS_2$ = standardized beta for baseline anxiety sensitivity predicting follow-up anxiety sensitivity while controlling for time 1 frequency; $F_1 \rightarrow F_2$ = standardized beta for time 1 frequency predicting time 2 frequency, while controlling for time 1 anxiety sensitivity; $AS_1 \rightarrow F_2$ = standardized beta for time 1 anxiety sensitivity predicting time 2 frequency, while controlling for time 1 frequency; $F_1 \rightarrow AS_2$ = standardized beta for time 1 frequency predicting time 2 anxiety sensitivity,

while controlling for time 1 anxiety sensitivity; SURPS = Substance Use Risk Profile Scale (Woicik, Stewart, Pihl, & Conrod, 2009); CASI = Childhood Anxiety Sensitivity Index (Silverman, Fleisig, Rabian & Peterson); ASI-3 = Anxiety Sensitivity Index - Third Edition (Taylor et al., 2007); RAPI = Rutgers Alcohol Problem Index (White & Labouvie, 1989; refers to a one year time period); RAPI-7 item = 7 item short form of the RAPI (Conrod et al., 2011); RAPI-8 item = 8 item short form of the RAPI (Castellanos-Ryan, O'Leary-Barrett, Sully, & Conrod, 2013); RAPI-9 item = 9 item short form of the RAPI (Conrod, Catellanos, & Mackie, 2008); RAPI-3 year= Rutgers Alcohol Problem Index over the past three years (White & Labouvie, 1989); RAPI- 7 day = Rutgers Alcohol Problem Index over the past 7 days (Kruse, 2014); CRAFFT = brief alcohol and other drug screening test (Knight, Shrier & Bravender, 1999); BYAACQ = Brief Young Adults Alcohol Consequences Questionnaire (Kahler, Strong, & Read, 2005); SIP-R = Short Inventory of Problems-Recent (Miller, Tonigan & Longabaugh, 1995).

[a] How do often do you drink alcohol?

[b] How often do you have a drink containing alcohol?

[c] How often have you engaged in binge drinking?

[d] How often do you consume 5 or more alcoholic beverages (4 of more for girls) on one occasion?

[e] How often do you have 6 or more drinks on one occasion?

[f] How often do you consume 5 or more standard drinks on one occasion?

[g] How many drinks do you consume during a typical drinking occasion or day when you drink?

[h] TLFB = Timeline Follow Back for each day of the week. Quantity was the sum of alcohol units consumed each day of the week.

[i] How many drinks containing alcohol do you have on a typical day when you are drinking?

[j] WAU = Weekly Alcohol Units (i.e., the total number of drinks consumed each day over the week).

Supplemental Material D: Outcome Measurements

Anxiety Sensitivity

Anxiety sensitivity was assessed using three measures: the Substance Risk Profile Scale (SURPS; Woicik, Stewart, Pihl, & Conrod, 2009), the Childhood Anxiety Sensitivity Index (CASI; Silverman, Fleisig, Rabian, & Peterson, 1991), and the Anxiety Sensitivity Index-Third Addition (ASI-3; Taylor et al., 2007; see Table 1 in the main text).

Alcohol Use

Four alcohol outcomes were included in our meta-analysis: frequency, frequency of binge drinking, quantity, and alcohol-related problems.

Frequency. All studies which assessed frequency of alcohol use included similar single item questions to assess frequency. Participants were asked how often they consumed alcohol over time periods ranging from one week to 6 months. Response options included rating the number of instances of drinking on a scale from “never” to “daily, or nearly every day,” as well as indicating the actual number of drinking episodes in a specific period of time in an open-ended format.

Frequency of Binge Drinking. All studies which assessed frequency of binge drinking included similar single item questions. The definition of binge drinking varied across studies. It was defined as: five or more drinks per occasion for both sexes; six or more drinks for both sexes; or five or more drinks for men and four or more drinks for women. Participants were asked how often they engaged in binge drinking over time periods ranging from one month to six months. Response options included rating the number of instances of binge drinking on a scale from “never” to “daily, or nearly every day,” as well as indicating the actual number of binge drinking episodes in a specific period of time in an open-ended format.

Quantity of Drinking. All studies which assessed quantity of drinking included either a single item question or a timeline follow-back measure (Sobell & Sobell, 1992). Single item assessments asked participants how many alcoholic beverages they typically consumed during drinking occasions over time periods ranging from one week to 6 months. Participants indicated the number of drinks on a scale from "zero" to "10 or more" drinks per occasion. The timeline follow-back measure assessed the average number of drinks consumed per occasion over the past week.

Alcohol-Related Problems. Alcohol-related problems were assessed using various versions of the Rutgers Alcohol Problem Index (23, 7, 8, and 9 item versions; White & Labouvie, 1989), the CRAFFT screening tool (Knight et al., 1999), the Brief Young Adult Alcohol Consequences Questionnaire (Kahler, Strong, & Read, 2005), and the Short Inventory of Problems – Recent (Miller, Tonigan, & Longabaugh, 1995). All measures were scored continuously in the meta-analysis.

Supplemental Material E: Moderation Analyses

Table E1

Testing mean sample age, mean proportion of female participants, and time lag as moderators of the relationship between anxiety sensitivity and alcohol use

Moderator	Point Estimate	Standard Error	95% *CI*	*Z*	*p*-value	R^2_{analog}
Frequency						
Model (1)	—	—	—	—	—	.73
Intercept	2.52	0.83	[0.90, 4.15]	3.04	<.001***	—
Mean age	-0.18	0.16	[-0.30, 0.06]	-3.01	.003**	—
Model (2)	—	—	—	—	—	.00
Intercept	-0.05	0.14	[-0.03, 0.02]	-0.34	.731	—
% Female	0.15	0.27	[-0.38, 0.67]	0.54	.589	—
Model (3)	—	—	—	—	—	.00
Intercept	0.05	0.07	[-0.10, 0.19]	0.63	.529	—
Time lag	0.00	0.01	[-0.01, 0.01]	-0.46	.642	—
Model (4)	—	—	—	—	—	.71
Intercept	2.51	1.07	[0.40, 4.61]	2.34	.012*	—
Mean age	-0.19	0.08	[-0.35, 0.03]	-2.37	.018*	—
% Female	0.30	0.20	[-0.08, 0.68]	1.54	.124	—
Time lag	0.00	0.01	[-0.01, 0.01]	-0.21	.833	—
Frequency of Binge Drinking						
Model (1)	—	—	—	—	—	.78
Intercept	1.55	0.54	[0.50, 2.60]	2.90	.004*	—
Mean age	-0.11	0.04	[-0.19, - 0.04]	-2.89	.004**	—
Model (2)	—	—	—	—	—	.00
Intercept	0.09	0.20	[-0.31, 0.48]	0.43	.670	—
% Female	-0.14	0.36	[-0.84, 0.56]	-0.39	.698	—
Model (3)	—	—	—	—	—	
Intercept	0.04	0.06	[-0.08, 0.16]	0.68	.496	—
Time lag	0.00	0.00	[-0.01, 0.01]	-0.70	.485	—
Model (4)	—	—	—	—	—	.54
Intercept	1.35	0.07	[-0.04, 2.72]	1.92	.055	—
Mean age	-0.01	0.05	[-0.20, 0.01]	-1.85	.064	—
% Female	0.09	0.28	[-0.45, 0.64]	0.34	.734	—
Time lag	0.00	0.04	[-0.01, 0.01]	-0.60	.546	—

Note. Analyses that warranted meta-regression were only conducted for covariates with 10 or more samples; **CI** = confidence interval; ***Z*** = significance test of continuous moderators; ***p*** = statistical significance; $\boldsymbol{R^2_{analog}}$ = proportion of total between study variance explained by the

model; **% Female** = average percentage females; **Mean age** = sample mean age; **Time lag** = time between study waves in months.
*p < .05; **p < .01; ***p < .001

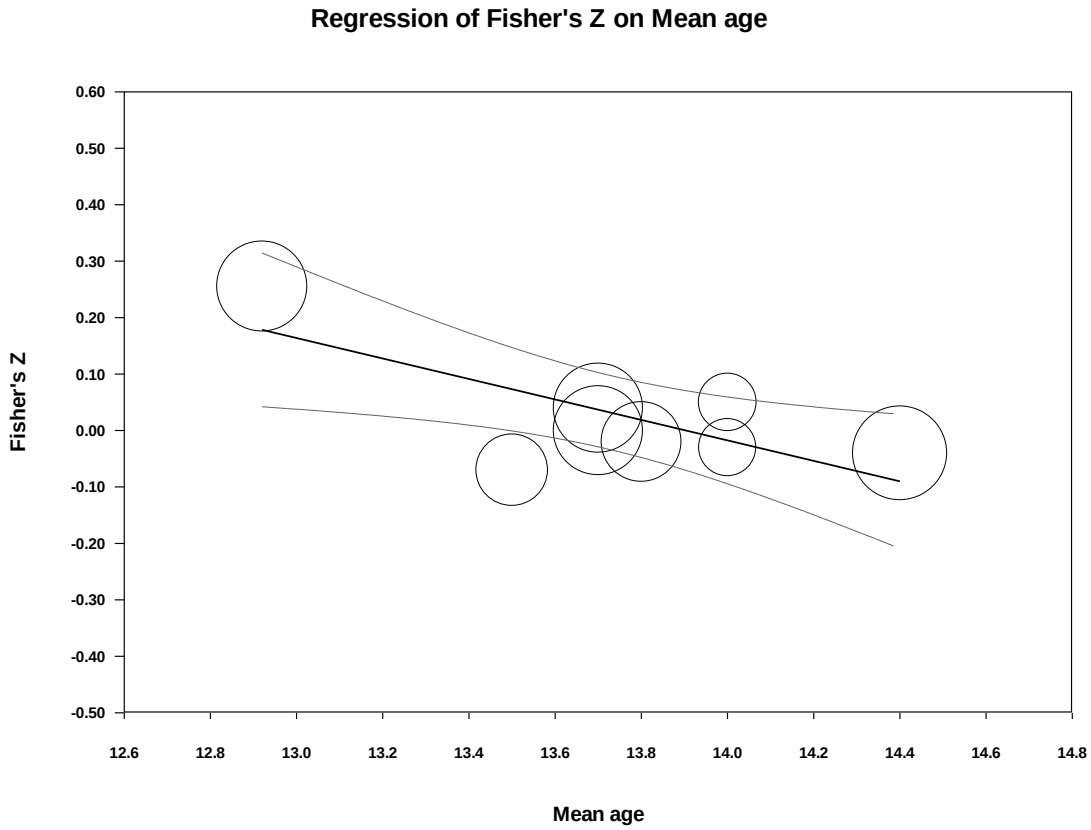

Figure E1. Anxiety sensitivity's relationship with drinking frequency regressed on mean sample age. The regression line in the middle is plotted through the predicted values from Model 1 (see Table E1). Data points represent study effects and are proportional to study weighting. The two outer lines depict the upper and lower limits of the 95% confidence interval for predicted values. Note, age range reflects the eight included studies which included frequency of alcohol consumption as an outcome.

Supplemental Material F: Funnel Plots

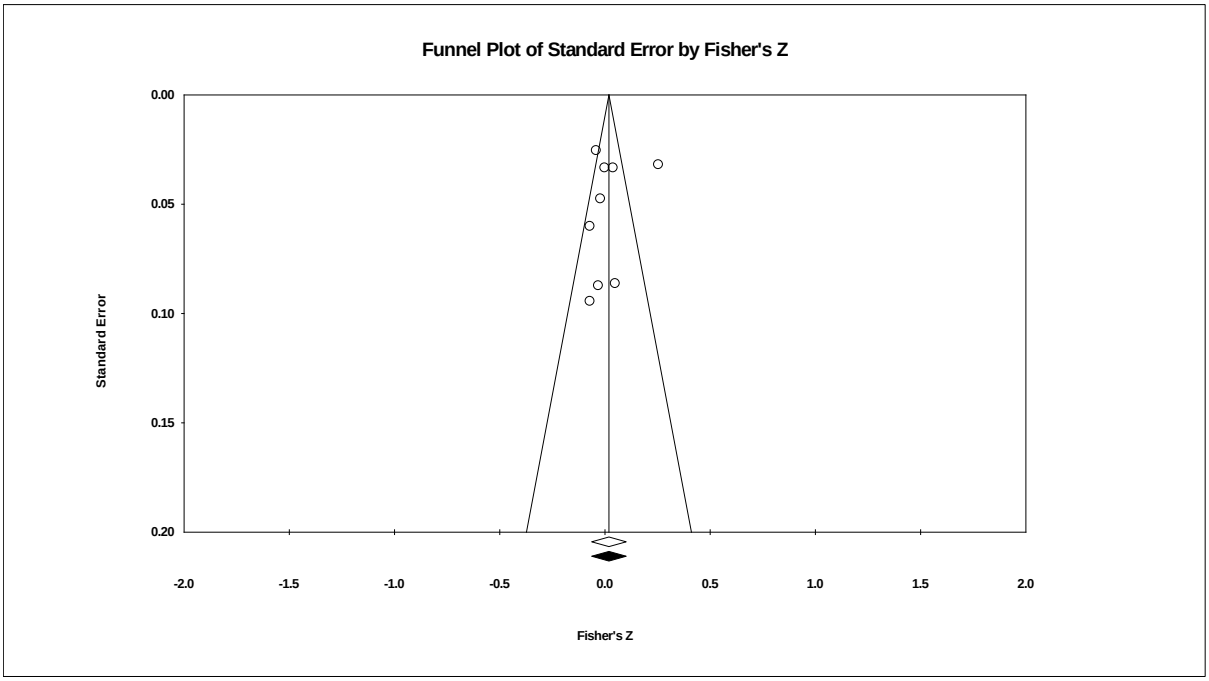

Figure F1. Funnel plot for the relationship between anxiety sensitivity and frequency with imputed studies. Open circles correspond to observed point estimates. The open diamond corresponds to the observed point estimates. The filled in diamond corresponds to the imputed point estimate. The expected direction of missing studies was specified as being to the left of the mean.

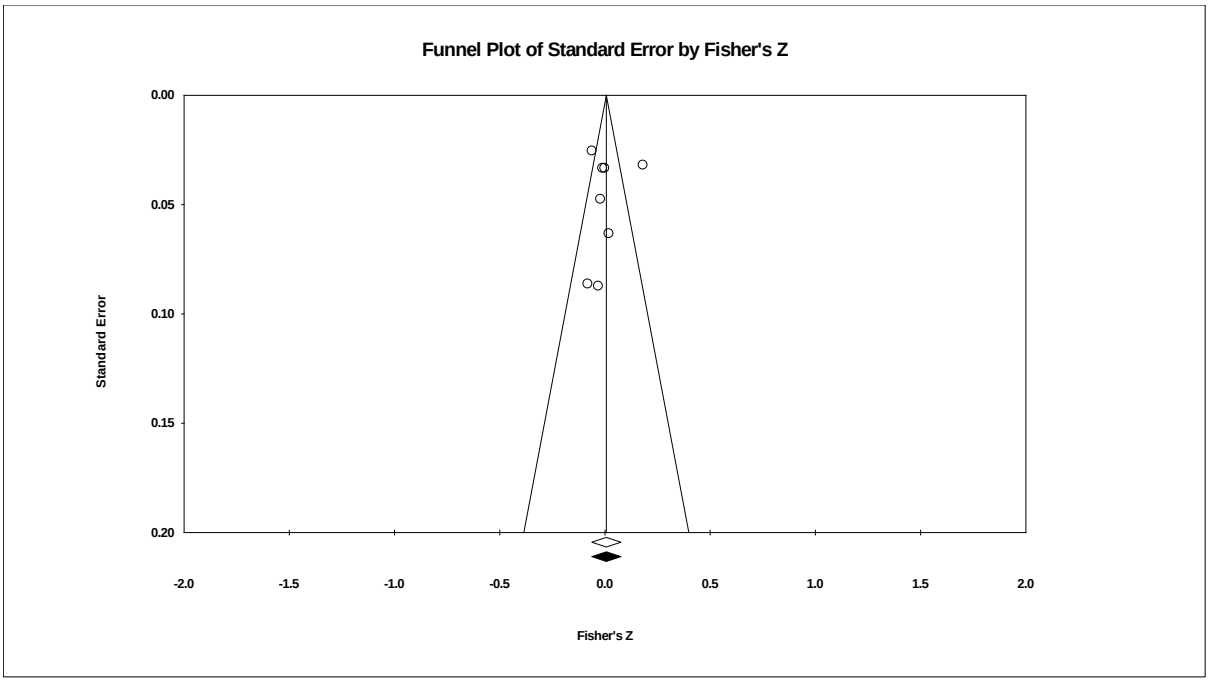

Figure F2. Funnel plot for the relationship between anxiety sensitivity and frequency of binge drinking with imputed studies. Open circles correspond to observed point estimates. The open diamond corresponds to the observed point estimates. The filled in diamond corresponds to the imputed point estimate. The expected direction of missing studies was specified as being to the left of the mean.

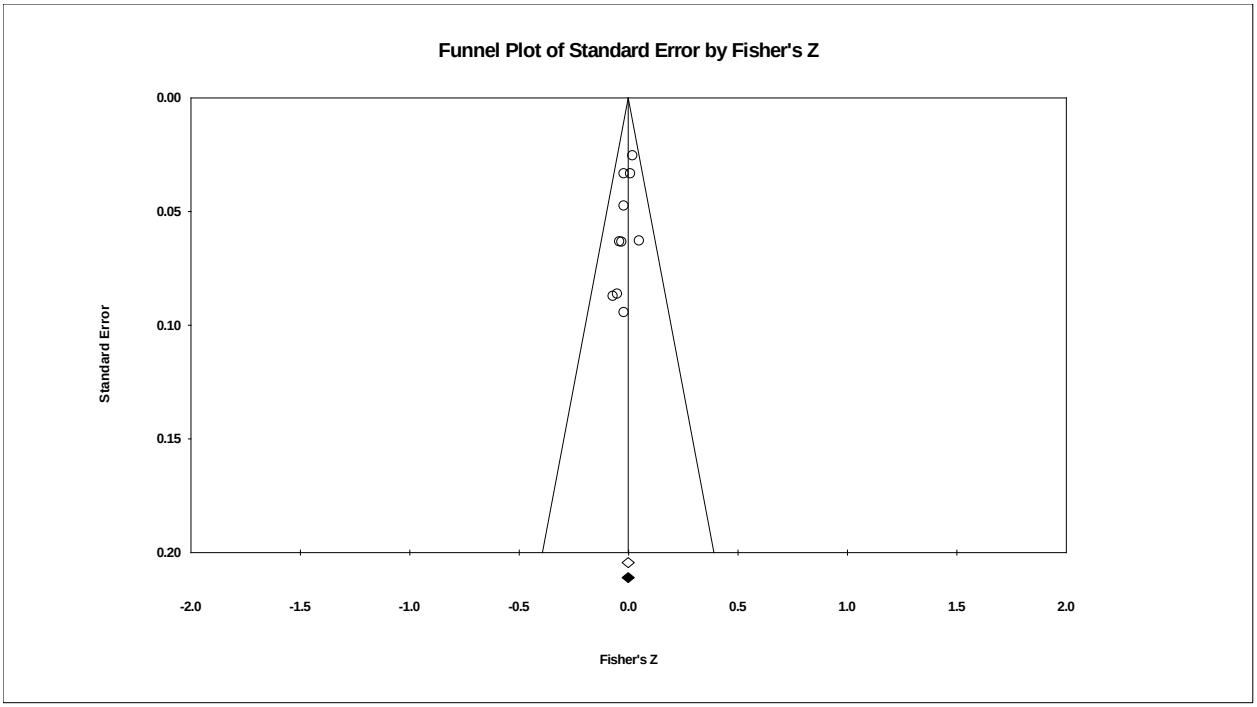

Figure F3. Funnel plot for the relationship between anxiety sensitivity and quantity with imputed studies. Open circles correspond to observed point estimates. The open diamond corresponds to the observed point estimates. The filled in diamond corresponds to the imputed point estimate. The expected direction of missing studies was specified as being to the left of the mean.

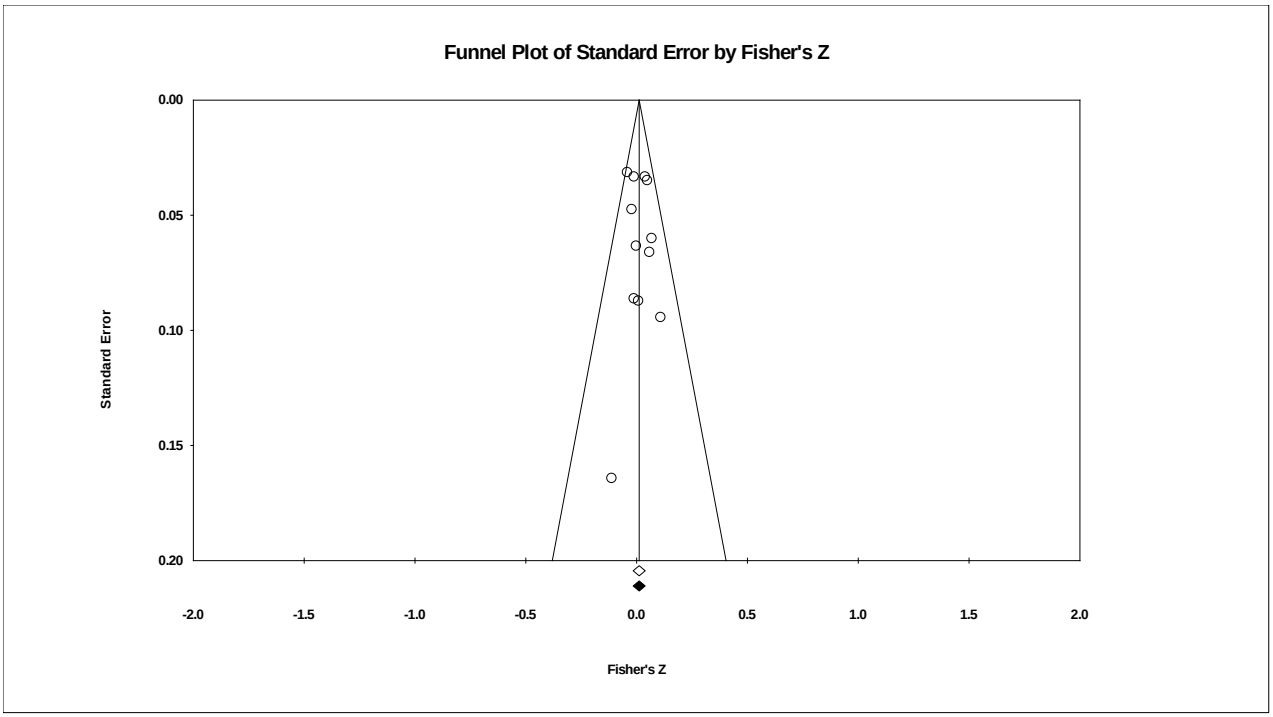

Figure F4. Funnel plot for the relationship between anxiety sensitivity and alcohol-related problems with imputed studies. Open circles correspond to observed point estimates. The open diamond corresponds to the observed point estimates. The filled in diamond corresponds to the imputed point estimate. The expected direction of missing studies was specified as being to the left of the mean.