

# A Multiple Replication Examination of Distal Antecedents to Alcohol Protective Behavioral Strategies

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**ABSTRACT. Objective:** In the present study, we examined whether we could replicate previous findings that use of protective behavioral strategies (PBSs) mediates the associations between distal antecedents and alcohol-related outcomes in an independent sample. Further, we examined a more comprehensive model to determine which constructs uniquely (i.e., controlling for other distal antecedents) relate to PBS use and alcohol-related outcomes. **Method:** Participants were recruited from a psychology department participant pool at a large, southwestern university in the United States ( $N = 628$ ). The majority of participants identified themselves as being either Hispanic ( $n = 334$ , 53.18%) or White, non-Hispanic ( $n = 212$ , 33.78%), were female ( $n = 386$ , 61.5%), and reported a mean age of 20.30 ( $SD = 3.80$ ) years. **Results:** Across five replication attempts in separate models, we found significant indirect

associations of age at first use, self-regulation, impulsivity-like traits, depressive symptoms, and conscientiousness on alcohol-related outcomes (i.e., use and problems) via PBS use. However, only the indirect associations of a second-order latent factor of self-regulation (based on premeditation, perseverance, self-regulation, and conscientiousness) and age at first use on alcohol-related outcomes via PBS use remained significant in the comprehensive model. **Conclusions:** Taken together, the replication attempts were largely successful in that nearly all associations were replicated in an independent sample of college students. However, in a comprehensive model with all distal antecedents simultaneously included, most of the direct and indirect associations failed to be supported. (*J. Stud. Alcohol Drugs*, 77, 958–967, 2016)

**H**EAVY DRINKING AMONG COLLEGE STUDENTS has been recognized as a major public health concern that has remained a consistent problem over the past two decades (Hingson et al., 2009; National Institute on Alcohol Abuse and Alcoholism, 2015). Several historical (e.g., age at drinking onset), mental health (e.g., depression), and personality-type variables (e.g., impulsivity traits, conscientiousness, self-regulation) have been found to be risk/protective factors associated with alcohol use, alcohol-related problems, and the development of an alcohol use disorder among emerging adults, including college students (Ham & Hope, 2003; Kuntsche et al., 2008; Mallet et al., 2013; Mezquita et al., 2010; Quinn & Fromme, 2010; Stone et al., 2012). Given the strength of these associations, it is imperative to understand more malleable factors that can explain these associations.

Alcohol protective behavioral strategies (PBSs) can be defined as “behaviors that are used immediately prior to, during, and/or after drinking that reduce alcohol use, intoxication, and/or alcohol-related harm” (Pearson, 2013, p.

1035). Much evidence from cross-sectional and longitudinal studies suggests that PBS use is associated with less alcohol use and/or fewer alcohol-related problems (Pearson et al., 2012a). Further, PBS use has also been found to mediate the effects of multiple interventions (Barnett et al., 2007; Larimer et al., 2007; Murphy et al., 2012), providing some evidence that the use of PBS is a proximal mechanism of changing one’s alcohol use and related outcomes (Prince et al., 2013). An important next step in PBS research is to determine the extent to which PBS use is one mechanism through which various distal antecedents relate to alcohol-related outcomes among college students.

Multiple researchers have examined whether PBS use mediates the associations between more distal antecedents (e.g., depression, personality facets) and alcohol-related outcomes. As noted in a comprehensive review of the literature (Pearson, 2013), several of these associations have only been examined in a single study: age at first use (Palmer et al., 2010), self-regulation (D’Lima et al., 2012), impulsivity-like traits (Pearson et al., 2012b), depressive symptoms (Martens et al., 2008), and conscientiousness (Martens et al., 2009). Therefore, these findings warrant replication in an independent sample. Given that findings across multiple exogenous variables may raise the question of whether any of the original findings represent unique associations because of model misspecification by variable omission (i.e., controlling for other constructs), a more comprehensive model is needed that controls for other theoretically important constructs when examining the relations between a specific distal antecedent, PBS use, and alcohol-related outcomes.

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Given that the field of psychology is currently undergoing a rather strong indictment regarding effects that are not reproducible (Simmons et al., 2011), the purpose of the present study is to examine each of these distal antecedents to PBS use in a single sample to determine to what extent previous findings replicate. In each replication attempt, we examine one distal antecedent (or one set of distal antecedents) as a predictor of PBS use, and we examine whether PBS use explains the associations between each antecedent variable and alcohol-related outcomes. Further, we examined a more comprehensive model to determine which constructs uniquely (i.e., controlling for other distal antecedents) relate to PBS use and alcohol-related outcomes. Taken together, these models are capable of lending more or less credence to the plausibility of PBS use as a mediator explaining how distal antecedents exert effects on alcohol-related outcomes.

## Method

### *Participants and procedure*

Participants were recruited from a psychology department participant pool at a large, southwestern university in the United States ( $N = 628$ ) and participated for course credit (Bravo et al., 2015; Pearson et al., 2016). Most participants were either Hispanic ( $n = 334$ , 53.18%) or White, non-Hispanic ( $n = 212$ , 33.78%), were female ( $n = 386$ , 61.5%), and reported a mean age of 20.30 ( $SD = 3.80$ ) years. On average, participants consumed 8.34 ( $SD = 8.86$ ) drinks per typical drinking week. The study was approved by the institutional review board at the participating institution.

### *Measures*

*Alcohol use.* Alcohol consumption was assessed with a modified version of the Daily Drinking Questionnaire (Collins et al., 1985). The participants were provided a 7-day grid from Monday to Sunday in which they indicated “how much and for how long you typically drank in a week during the past 30 days.” We calculated typical quantity of alcohol use by summing the number of standard drinks consumed on each day of the typical drinking week.

*Alcohol-related problems.* Alcohol-related problems were assessed using a checklist version of the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ; Kahler et al., 2005), which assessed problems experienced in the past 30 days (0 = *no*, 1 = *yes*). We summed all items to create an alcohol-related problems measure reflective of the number of distinct problems experienced in the past 30 days ( $\alpha = .90$ ). Because of experimenter error, two items were given as one item, resulting in a 23-item version of the measure. All data were analyzed including/excluding this compound item, and no differences were found in the pattern of results.

*Protective behavioral strategies.* PBS use in the past month was assessed with the 15-item Protective Behavioral Strategies Survey (PBSS; Martens et al., 2005) measured on a 6-point response scale (1 = *never*, 6 = *always*). We changed a previously reverse-coded item (“drink shots of liquor”) to be consistent with the remaining items (“avoid drinking shots of liquor”). Three subscales identified in previous work include the following: Limiting/Stopping Drinking (7 items; e.g., “Stop drinking at a predetermined time”;  $\alpha = .87$ ), Manner of Drinking (5 items; e.g., “Drink slowly, rather than gulp or chug”;  $\alpha = .84$ ), and Serious Harm Reduction (3 items; e.g., “Know where your drink has been at all times”;  $\alpha = .83$ ).

*Age at first use.* Age at first use was assessed with a single item: “How old were you the first time you drank alcohol?”

*Self-regulation.* A shortened version of the original 63-item Self-Regulation Questionnaire (Brown et al., 1999), the 31-item Short Self-Regulation Questionnaire (Carey et al., 2004) assesses behaviors such as keeping track of progress toward meeting goals and directly looking for solutions to problems measured on a 5-point response scale (1 = *strongly disagree*, 5 = *strongly agree*). Example items include, “I know how I want to be” and “I am able to resist temptation” ( $\alpha = .93$ ).

*Impulsivity-like traits.* Impulsivity-like traits were assessed by the UPPS-P Impulsive Behavior Scale, which combines the 14-item Positive Urgency Measure (Cyders et al., 2007) with the 45-item Urgency Premeditation Perseverance Sensation Seeking Impulsive Behavior Scale (UPPS; Whiteside & Lynam, 2001). All items were measured on a 4-point response scale (1 = *strongly disagree*, 4 = *strongly agree*). Higher scores on Premeditation (11 items;  $\alpha = .84$ ) and Perseverance (10 items;  $\alpha = .82$ ) represent less impulsivity, whereas higher scores on Positive Urgency (14 items;  $\alpha = .91$ ), Negative Urgency (12 items;  $\alpha = .87$ ), and Sensation Seeking (12 items;  $\alpha = .83$ ) represent more impulsivity.

*Depressive symptoms.* Depressive symptoms were assessed using the 20-item Center for Epidemiological Studies Depression–Revised (CESD-R; Eaton et al., 2004) measured on a 5-point response scale (1 = *not at all or less than 1 day*, 5 = *nearly every day for 2 weeks*). Example items include, “I felt depressed” and “I lost interest in my usual activities” ( $\alpha = .83$ ).

*Conscientiousness.* Conscientiousness was assessed using the 44-item Big Five Inventory (John et al., 1991) measured on a 5-point response scale (1 = *disagree strongly*, 5 = *agree strongly*). The conscientiousness subscale consisted of 9 items (e.g., “I see myself as someone who does a thorough job”;  $\alpha = .75$ ).

### *Statistical analyses*

Analyses were conducted using Mplus 7 (Muthén & Muthén, 1998–2012). We examined the total, direct, and indirect associations of each predictor variable on outcomes using 10,000 bias-corrected bootstrapped estimates (Efron

TABLE 1. Summary of original studies and replication results

| Name of replication attempt (authors of original study)        | Summary of original studies   | Summary of replication and extension attempts of original studies   |
|--|---|---|
| Replication 1: Age at first use (Palmer et al., 2010)          | In a sample of 309 college student drinkers, researchers found a significant indirect association of age at first use on both alcohol-related outcomes (i.e., typical drinks per week and alcohol-related problems) via PBS use.  | We replicated the indirect association of age at first use on both alcohol-related outcomes (i.e., alcohol use, alcohol-related problems) via PBS use.  |
| Replication 2: Self-regulation (D'Lima et al., 2012)           | In a sample of 249 first-year college students, researchers found support for what they termed the "self-control equals drinking control" hypothesis such that the protective association between self-regulation and alcohol-related problems was partially explained by PBS use.  | We replicated the total, direct, and indirect associations of self-regulation on alcohol-related problems in both the freshman sample (replication sample) and in a sample of college student drinkers across all years of college. Further, we found that self-regulation did have a significant indirect association on alcohol use via PBS use (extension).  |
| Replication 3: Impulsivity-like traits (Pearson et al., 2012b) | In a sample of 278 college student drinkers, in separate models, researchers found that Manner of Drinking PBS use was a significant (or "marginally" significant) mediator of the associations of each impulsivity-like trait on alcohol use; double mediation through Manner of Drinking PBS use and alcohol use on alcohol-related problems was also observed. In a combined model in which other impulsivity-like traits were controlled, premeditation, perseverance, and sensation seeking were each significantly associated with PBS use, which in turn was associated with alcohol outcomes. | Consistent with Pearson et al., we found that Manner of Drinking PBS use was the most consistent mediator of the associations of impulsivity-like traits on alcohol-related outcomes. Within a combined model, the indirect associations of Premeditation and Sensation Seeking on alcohol use via Manner of Drinking PBS use, the indirect association of these two traits on alcohol-related problems via Manner of Drinking PBS use, and the indirect association of these two traits on alcohol-related problems via Manner of Drinking PBS use and alcohol use (i.e., double-mediated association) remained statistically significant when other impulsivity traits were controlled for. |
| Replication 4: Depressive symptoms (Martens et al., 2008)      | In a sample of 686 college student drinkers, researchers found a significant indirect association of depressive symptoms on alcohol-related problems via PBS use, while controlling for consumption.  | We replicated the indirect association of depressive symptoms on alcohol-related problems via PBS use. Further, we found that depressive symptoms did have a significant indirect association on alcohol use via PBS use (extension).   |
| Replication 5: Conscientiousness (Martens et al., 2009)        | In a sample of 186 college student drinkers, researchers found a significant indirect association of conscientiousness on both alcohol use and alcohol-related problems via PBS use.  | We replicated all of the significant direct and indirect associations of conscientiousness on alcohol-related problems. Further, we found that conscientiousness did have a significant indirect association on alcohol use via PBS use (extension).  |

Note: PBS = protective behavioral strategy.

& Tibshirani, 1993), which provides a powerful test of mediation (Fritz & MacKinnon, 2007) and is robust to small departures from normality (Erceg-Hurn & Mirosevich, 2008). Parameters were estimated using maximum likelihood estimation, and missing data were handled using full information maximum likelihood, which is more efficient and has less bias than alternative procedures (Enders, 2001; Enders & Bandalos, 2001). Statistical significance was determined by 95% bias-corrected bootstrapped confidence intervals that did not contain zero.

## Results

Across all five replication attempts, we found significant indirect associations of age at first use, self-regulation, im-

pulsivity-like traits, depressive symptoms, and conscientiousness on alcohol-related outcomes (i.e., use and problems) via PBS use. A summary of the findings from original studies and replication results is presented in Table 1. To consolidate our results, we briefly discuss our findings in comparison to the original study.

### *Replication attempt 1: Age at first use*

In a sample of 309 college student drinkers, Palmer et al. (2010) found an indirect association of age at first use on both typical drinks per week and alcohol-related problems via PBS use. Table 2 compares the total, direct, and indirect associations observed in the present study to the effects reported by Palmer et al. (2010).

TABLE 2. Replication Attempt 1: Total, direct, and indirect associations of age at first use on alcohol use and alcohol-related problems comparing original study, replication attempt, and extended attempt

| Variable  | Palmer et al. (2010) |          | Replication attempt<br>(restricted sample) |                       | Extension attempt<br>(full sample) |                       |
|---|----------------------|----------|--|-----------------------|------------------------------------|-----------------------|
|   | $\beta$              | [95% CI] | $\beta$                                    | [95% CI]              | $\beta$                            | [95% CI]              |
| <b>Direct effects</b>   |                      |          |  |                       |                                    |                       |
| Age at first use $\rightarrow$ PBS use  | <b>0.26</b>          | –        | <b>0.15</b>                                | <b>[0.06, 0.23]</b>   | <b>0.10</b>                        | <b>[0.01, 0.20]</b>   |
| PBS use $\rightarrow$ alcohol use   | <b>-0.34</b>         | –        | <b>-0.29</b>                               | <b>[-0.37, -0.20]</b> | <b>-0.29</b>                       | <b>[-0.37, -0.20]</b> |
| PBS use $\rightarrow$ alcohol-related problems                                | <b>-0.34</b>         | –        | <b>-0.21</b>                               | <b>[-0.29, -0.14]</b> | <b>-0.21</b>                       | <b>[-0.29, -0.14]</b> |
| Age at first use $\rightarrow$ alcohol use                                    | <b>-0.38</b>         | –        | <b>-0.10</b>                               | <b>[-0.04, -0.00]</b> | -0.01                              | [-0.13, 0.01]         |
| Age at first use $\rightarrow$ alcohol-related problems                       | <b>-0.26</b>         | –        | -0.05                                      | [-0.31, 0.06]         | 0.02                               | [-0.10, 0.17]         |
| <b>Indirect effects</b>   |                      |          |  |                       |                                    |                       |
| Age at first use $\rightarrow$ PBS use $\rightarrow$ alcohol use              | $z = 3.86$           | –        | <b>-0.04</b>                               | <b>[-0.01, -0.00]</b> | <b>-0.03</b>                       | <b>[-0.01, -0.00]</b> |
| Age at first use $\rightarrow$ PBS use $\rightarrow$ alcohol-related problems | $z = 3.74$           | –        | <b>-0.03</b>                               | <b>[-0.14, -0.03]</b> | <b>-0.02</b>                       | <b>[-0.08, -0.01]</b> |

Notes: Significant associations are in **bold** typeface for emphasis and within the present study were determined by a 95% bias-corrected bootstrapped confidence interval that does not contain zero.  $z$  = Sobel's  $z$  test for mediation. The restricted sample consisted of 561 college student drinkers with age at first use greater than 8 (i.e., replication attempt). The full sample consisted of 582 college student drinkers (i.e., extension attempt). For the replication and extension attempts, two independent path models were conducted in which age at onset was modeled as a predictor of alcohol outcomes (i.e., consumption and problems) via protective behavioral strategy use while age, gender, and impulsivity were controlled for. Although not shown for clarity, age at onset had a significant total association on alcohol consumption ( $\beta = -.15$ , 95% CI [-0.05, -0.01]) within the restricted sample but not for the full sample ( $\beta = -.02$ , 95% CI [-0.02, .01]). Further, age at onset had a significant total association on alcohol-related problems ( $\beta = -.08$ , 95% CI [-0.38, -0.01]) within the restricted sample but not for the full sample ( $\beta = -.00$ , 95% CI [-0.14, .12]). Significant associations of the covariates are available from the authors on request. CI = confidence interval; PBS = protective behavioral strategy.

In statistical terms, we replicated the indirect association of age at first use on both alcohol-related outcomes via PBS use (while controlling for age, gender, and impulsivity). In terms of effect size estimates, we did not observe the same strength of associations between any of our variables (Table 2). However, the strength of the associations between age at first use and alcohol-related outcomes increased when restricting the range on the age at first use to match the range observed by Palmer et al. Importantly, we asked participants their age “the first time [they] drank alcohol,” whereas Palmer et al. asked about the first time they drank “without the permission of [their] parents.” Thus, they assessed self-initiated drinking whereas our assessment was less specific. This difference may have accounted for the wider range observed on this variable in our sample. By restricting the range to match the Palmer et al. study, we reason that we removed subjects who reported drinking initiated by others (i.e., with the permission of their parents), perhaps leading to our findings being more similar.

#### Replication attempt 2: Self-regulation

In a sample of 249 first-year college students, D’Lima and colleagues (2012) found support for what they termed the “self-control equals drinking control” hypothesis such that the protective association between self-regulation and alcohol-related problems was partially explained by PBS use. Specifically, PBS use accounted for 17.8% of the total association of self-regulation on alcohol-related problems. Table 3 compares the total, direct, and indirect associations observed in the present study to the effects reported by D’Lima et al. (2012).

We replicated the total, direct, and indirect associations of self-regulation on alcohol-related problems in both the freshman sample to match D’Lima et al.’s (2012) sample and in a sample of college student drinkers across all years of college. We found similarly sized total, direct, and indirect associations as reported by D’Lima et al. in our freshman subsample, and somewhat weaker associations in the full sample. In the replication and extension samples, PBS use accounted for 17.0% and 10.4% of the total association of self-regulation on alcohol-related problems, respectively. Further, we found that self-regulation did have a significant indirect association on alcohol use via PBSs; with PBS use accounting for 54.0% (freshman sample) and 20.6% (full sample) of the total association of self-regulation on alcohol use. Although we found a significant indirect association between overall self-regulatory abilities and alcohol-related outcomes via PBS use, the effect sizes indicate that PBS use alone is not sufficient to account for these associations, suggesting that the protective effect of self-regulation likely involves other protective factors.

#### Replication attempt 3: Impulsivity-like traits

In a sample of 278 college student drinkers, Pearson and colleagues (2012b) examined three types of PBS use (Stopping/Limiting Drinking, Manner of Drinking, and Serious Harm Reduction) as mediators of the associations between impulsivity-like traits (Premeditation, Perseverance, Sensation Seeking, Positive Urgency, and Negative Urgency) and alcohol-related outcomes (alcohol use, alcohol-related problems). They found that each impulsivity-like trait had a distinct pattern of relationships with alcohol-related out-

TABLE 3. Replication Attempt 2: Total, direct, and indirect associations of self-regulation on alcohol use and alcohol-related problems comparing original study, replication attempt, and extension attempt

| Variable  | D'Lima et al. (2012) |                       | Replication attempt<br>(restricted sample) |                       | Extension attempt<br>(full sample) |                       |
|---|----------------------|-----------------------|--|-----------------------|------------------------------------|-----------------------|
|   | $\beta$              | [95% CI]              | $\beta$                                    | [95% CI]              | $\beta$                            | [95% CI]              |
| <b>Direct effects</b>   |                      |                       |  |                       |                                    |                       |
| Self-regulation $\rightarrow$ PBS use   | –                    | –                     | <b>0.30</b>                                | <b>[0.18, 0.41]</b>   | <b>0.21</b>                        | <b>[0.13, 0.29]</b>   |
| PBS use $\rightarrow$ alcohol use   | –                    | –                     | <b>-0.21</b>                               | <b>[-0.35, -0.08]</b> | <b>-0.17</b>                       | <b>[-0.25, -0.08]</b> |
| PBS use $\rightarrow$ alcohol-related problems                                  | –                    | –                     | <b>-0.23</b>                               | <b>[-0.36, -0.10]</b> | <b>-0.18</b>                       | <b>[-0.26, -0.10]</b> |
| Self-regulation $\rightarrow$ alcohol use                                       | –                    | –                     | <i>-0.06</i>                               | <i>[-0.18, 0.07]</i>  | <i>-0.14</i>                       | <i>[-0.21, -0.07]</i> |
| Self-regulation $\rightarrow$ alcohol-related problems                          | <b>-0.20</b>         | <b>[-0.29, -0.12]</b> | <b>-0.32</b>                               | <b>[-0.43, -0.21]</b> | <b>-0.34</b>                       | <b>[-0.41, -0.26]</b> |
| <b>Indirect effects</b>   |                      |                       |  |                       |                                    |                       |
| Self-regulation $\rightarrow$ PBS use $\rightarrow$ alcohol use                 | –                    | –                     | <i>-0.07</i>                               | <i>[-0.11, -0.02]</i> | <i>-0.04</i>                       | <i>[-0.06, -0.02]</i> |
| Self-regulation $\rightarrow$ PBS use $\rightarrow$<br>Alcohol-related problems | <b>-0.04</b>         | <b>[-0.09, -0.00]</b> | <b>-0.07</b>                               | <b>[-0.11, -0.03]</b> | <b>-0.04</b>                       | <b>[-0.06, -0.02]</b> |

Notes: Significant associations are in **bold** typeface for emphasis and were determined by a 95% bias-corrected bootstrapped confidence interval that does not contain zero. Standardized coefficients and confidence intervals from the original study are supplied if reported. The restricted sample consisted of freshman college student drinkers ( $n = 254$ ; replication attempt). The full sample consisted of 582 college student drinkers (i.e., extension attempt). For the replication attempts (both restricted and full sample), path models were conducted in which self-regulation was modeled as a predictor of alcohol-related problems via protective behavioral strategy use while alcohol use was controlled for. Although not shown for clarity, self-regulation had a significant total association on alcohol-related problems while alcohol use was controlled for in both the restricted sample ( $\beta = -.38$ , 95% CI [-0.49, -.28]) and the full sample ( $\beta = -.37$ , 95% CI [-0.44, -.30]). Within these models, significant associations of the covariate (i.e., alcohol use) are available from the authors on request. In addition, we conducted path models where self-regulation was modeled as a predictor of alcohol use via PBS use (findings are *italicized* within the table). Although not shown for clarity, self-regulation did not have a significant total association on alcohol use in the restricted sample ( $\beta = -.12$ , 95% CI [-0.25, .01]), but it did in the full sample ( $\beta = -.18$ , 95% CI [-0.25, -.11]). CI = confidence interval; PBS = protective behavioral strategy.

comes via unique PBS components (see Table 1 for more detail). Consistent with Pearson et al. (2012b), we conducted one model examining the associations of all five impulsivity-like traits on alcohol-related outcomes via PBS use as well as separate models in which each impulsivity-like trait was examined separately. All total, direct, and indirect associations for the separate models are shown in Table S1 and for the combined model are shown in Table S2.

Consistent with Pearson et al., we found that the Manner of Drinking PBS was the most consistent facet that explains the associations of impulsivity-like traits on alcohol-related outcomes. In addition, we found other significant direct and indirect associations, not found by Pearson et al., possibly because of the larger sample size ( $N = 582$  vs.  $N = 278$ ), which provided greater statistical power (Tables S1 and S2). Although the associations of premeditation, perseverance, and sensation seeking can be largely accounted for by differential PBS use, the associations of urgency (positive and negative) on increased alcohol-related problems remain when controlling for all of these other factors. Considering that urgency, especially negative urgency, has the strongest total association on alcohol-related problems, understanding what other proximal factors may help explain these associations remains an important area of study.

#### Replication attempt 4: Depressive symptoms

In a sample of 686 college student drinkers who were referred to an alcohol intervention program, Martens et al. (2008) found a significant indirect association of depressive symptoms on alcohol-related problems via PBS use, while

controlling for alcohol use. Further, although Martens et al. did not test a mediation model with alcohol use as an outcome because of a nonsignificant association between depressive symptoms and alcohol use; we tested whether PBS use explains the relationship between depressive symptoms and alcohol use because more recent approaches indicate that mediation may be present even when total effects are not observed (e.g., Hayes, 2009; Zhao et al., 2010). We replicated the analytic methods of Martens et al. (2008) as closely as possible. Specifically, we used structural equation modeling to examine the associations between depressive symptoms (with each of the 9 CES-D subscales as indicators), PBS use (with each of the 3 PBSS subscales as indicators), and alcohol-related problems (with 4 parcels as indicators). Table S3 compares associations observed in the present study to the associations reported by Martens et al. (2008).

Consistent with Martens et al. (2008), we found a significant indirect association of depressive symptoms on alcohol-related problems via PBS use. In our sample, PBS use accounted for 13.9% of the total association of depressive symptoms on alcohol-related problems. Thus, it appears that individuals with elevated depression symptoms may be less likely to engage in PBS use, placing them at increased risk for experiencing alcohol-related problems. Further, we found that depressive symptoms did have a significant indirect association on alcohol use via PBSSs, with PBS use accounting for 22.1% of the total association of depressive symptoms on alcohol use. Across both models, PBS use only accounted for a modest amount of the total association of depressive symptoms on alcohol-related outcomes, suggesting that other key factors are needed to more fully explain these associations.

TABLE 4. Bivariate correlations among distal antecedents, PBS use, and alcohol outcomes in the comprehensive model

|                              | 1.          | 2.          | 3.          | 4.          | 5.          | 6.          | 7.          | 8.          | 9.          | 10.         | 11.         | 12.         | <i>M</i> | ( <i>SD</i> ) |
|------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|----------|---------------|
| 1. Age at first use          |             |             |             |             |             |             |             |             |             |             |             |             | 15.32    | (3.19)        |
| 2. Self-regulation           | .08         |             |             |             |             |             |             |             |             |             |             |             | 3.66     | (0.54)        |
| 3. Premeditation             | <b>.11</b>  | <b>.49</b>  |             |             |             |             |             |             |             |             |             |             | 2.94     | (0.44)        |
| 4. Perseverance              | .05         | <b>.71</b>  | <b>.52</b>  |             |             |             |             |             |             |             |             |             | 3.00     | (0.43)        |
| 5. Sensation seeking         | .03         | <b>-.11</b> | .03         | <b>-.18</b> |             |             |             |             |             |             |             |             | 2.15     | (0.48)        |
| 6. Positive urgency          | <b>-.12</b> | <b>-.56</b> | <b>-.33</b> | <b>-.32</b> | <b>-.16</b> |             |             |             |             |             |             |             | 2.06     | (0.51)        |
| 7. Negative urgency          | <b>-.07</b> | <b>-.57</b> | <b>-.29</b> | <b>-.33</b> | <b>-.06</b> | <b>.69</b>  |             |             |             |             |             |             | 2.40     | (0.50)        |
| 8. Depressive symptoms       | <b>-.10</b> | <b>-.45</b> | <b>-.15</b> | <b>-.31</b> | .04         | <b>.35</b>  | <b>.45</b>  |             |             |             |             |             | 1.88     | (0.73)        |
| 9. Conscientiousness         | <b>.12</b>  | <b>.76</b>  | <b>.46</b>  | <b>.69</b>  | <b>-.01</b> | <b>-.46</b> | <b>-.43</b> | <b>-.38</b> |             |             |             |             | 3.55     | (0.62)        |
| 10. PBS use                  | <b>.13</b>  | <b>.22</b>  | <b>.23</b>  | <b>.21</b>  | <b>.10</b>  | <b>-.16</b> | <b>-.17</b> | <b>-.14</b> | <b>.25</b>  |             |             |             | 3.61     | (1.05)        |
| 11. Alcohol use              | <b>-.04</b> | <b>-.18</b> | <b>-.19</b> | <b>-.14</b> | <b>-.07</b> | <b>.13</b>  | .09         | <b>.15</b>  | <b>-.19</b> | <b>-.20</b> |             |             | 8.29     | (9.79)        |
| 12. Alcohol-related problems | <b>-.06</b> | <b>-.43</b> | <b>-.32</b> | <b>-.28</b> | <b>-.09</b> | <b>.42</b>  | <b>.43</b>  | <b>.37</b>  | <b>-.37</b> | <b>-.32</b> | <b>.41</b>  |             | 6.32     | (5.24)        |
| 13. Gender                   | <b>-.02</b> | .00         | <b>-.05</b> | <b>-.02</b> | <b>.26</b>  | <b>-.10</b> | .06         | .06         | <b>.12</b>  | <b>.20</b>  | <b>-.19</b> | <b>-.05</b> | 1.64     | (0.48)        |

Notes: Gender was coded 1 = men, 2 = women. Significant correlations are in **bold** typeface for emphasis and were determined by a 95% bias-corrected unstandardized bootstrapped confidence interval (based on 10,000 bootstrapped samples) that does not contain zero. PBS = protective behavioral strategy.

### Replication attempt 5: Conscientiousness

In two separate models, Martens et al. (2009) demonstrated that PBS use partially explains the associations between conscientiousness and both alcohol use and alcohol-related problems. To replicate the methods of Martens et al. (2009) as closely as possible, we treated conscientiousness as a manifest (i.e., nonlatent) variable; treated PBS use as a latent variable with the three PBSS subscales as indicators; used peak drinks, heavy episodic drinking frequency, and drinks per week as indicators of a latent variable of alcohol use; and used four balanced parcels (Little et al., 2002) of the B-YAACQ as indicators of the alcohol-related problems latent variable. Table S4 compares the associations observed in the present study with the associations reported by Martens et al. (2009).

We replicated all of the significant direct and indirect associations observed by Martens et al. (2009) with regard to how conscientiousness relates to alcohol use and alcohol-related problems. In our sample, PBS use accounted for 42.7% of the total association of conscientiousness on alcohol use and 22.4% of the total association of conscientiousness on alcohol-related problems. Although Martens et al. found that conscientiousness did not have a significant direct association on alcohol use when controlling for PBS use, we found that conscientiousness had a direct association on alcohol use above and beyond its associations through PBS use. Across both models, conscientiousness had relatively strong negative associations with alcohol-related outcomes that remained even when we controlled for PBS use.

### Comprehensive model

To determine which distal constructs uniquely (i.e., controlling for other distal antecedents) relate to PBS use and alcohol-related outcomes, a comprehensive path model was conducted in which the proposed distal antecedents were modeled as predictors of alcohol-related problems via

PBS use and alcohol use. For this combined model, only data from students who consumed alcohol at least one day in the previous month ( $n = 571$ ) were included in the final analysis, and gender was entered as a covariate. Four of the distal variables (self-regulation, premeditation, perseverance, and conscientiousness) were all highly correlated with each other ( $r_s \geq .50$ ; Table 4); thus, we created a second-order “self-regulation” latent variable to reduce issues of multicollinearity (all factor loadings were  $>.50$ ). The multicollinearity of these variables is not surprising given that each of these constructs has been used to denote a capacity of self-regulation (Karoly, 1993). Another second-order latent variable was created for “urgency” due to high multicollinearity between negative and positive urgency ( $r = .69$ ). Based on recommendations by Hu and Bentler (1999), the comprehensive model provided an “acceptable” fit to the data on most indices, comparative fit index = .923, root mean square error of approximation = .098 (90% CI [.086, .110]), standardized root mean square residual = .039, but poor fit according to the Tucker–Lewis Index (.834). Although we could attempt to improve model fit iteratively by dropping nonsignificant paths, dropping specific predictors, and correlating measurement errors, the purpose of this model was to test the unique effects of each of these distal antecedents when controlling for all other variables. All total, direct, and indirect associations are shown in Table 5.

With regard to direct associations, PBS use had a significant negative relationship with both alcohol-related outcomes; however, age at first use and the latent self-regulation construct were the only distal antecedents to uniquely predict PBS use (both positive relations). As expected by these direct associations, we found significant indirect associations between self-regulation and age at first use on both alcohol-related outcomes via PBS use. Furthermore, both double-mediated associations were significant (e.g., age at first use  $\rightarrow$  PBS use  $\rightarrow$  alcohol use  $\rightarrow$  alcohol-related problems). However, PBS use only accounted for a modest amount of the total association of age at first use and

TABLE 5. Summary of total, indirect, and direct associations of distal antecedents and PBS use on alcohol outcomes in a comprehensive model

| Variables                               | Outcome variables |                     |              |                       |                          |                       |
|---|-------------------|---------------------|--------------|-----------------------|--------------------------|-----------------------|
|   | PBS use           |                     | Alcohol use  |                       | Alcohol-related problems |                       |
|   | $\beta$           | [95% CI]            | $\beta$      | [95% CI]              | $\beta$                  | [95% CI]              |
| Predictor variable: Age at first use    |                   |                     |              |                       |                          |                       |
| Total                                   | <b>0.11</b>       | <b>[0.01, 0.07]</b> | -0.02        | [-0.48, 0.27]         | 0.01                     | [-0.12, 0.15]         |
| Total indirect <sup>a</sup>             | —                 | —                   | -0.01        | <b>[-0.09, -0.01]</b> | -0.03                    | [-0.11, 0.02]         |
| PBS use                                 | —                 | —                   | -0.01        | <b>[-0.09, -0.01]</b> | <b>-0.02</b>             | <b>[-0.07, -0.01]</b> |
| Alcohol use                             | —                 | —                   | —            | —                     | 0.00                     | [-0.07, 0.05]         |
| PBS use–alcohol use                     | —                 | —                   | —            | —                     | <b>-0.00</b>             | <b>[-0.02, -0.00]</b> |
| Direct                                  | <b>0.11</b>       | <b>[0.01, 0.07]</b> | -0.01        | [-0.46, 0.31]         | 0.03                     | [-0.06, 0.18]         |
| Predictor variable: Self-regulation     |                   |                     |              |                       |                          |                       |
| Total                                   | 0.25              | [0.24, 0.77]        | -0.20        | <b>[-8.54, -0.98]</b> | <b>-0.18</b>             | <b>[-3.15, -0.44]</b> |
| Total indirect <sup>a</sup>             | —                 | —                   | -0.03        | <b>[-1.07, -0.17]</b> | <b>-0.11</b>             | <b>[-1.91, 0.48]</b>  |
| PBS use                                 | —                 | —                   | -0.03        | <b>[-1.07, -0.17]</b> | <b>-0.04</b>             | <b>[-0.81, -0.20]</b> |
| Alcohol use                             | —                 | —                   | —            | —                     | <b>-0.05</b>             | <b>[-1.31, -0.07]</b> |
| PBS use–alcohol use                     | —                 | —                   | —            | —                     | <b>-0.01</b>             | <b>[-0.19, -0.02]</b> |
| Direct                                  | 0.25              | [0.24, 0.77]        | -0.18        | <b>[-7.99, -0.47]</b> | -0.07                    | [-1.93, 0.60]         |
| Predictor variable: Sensation seeking   |                   |                     |              |                       |                          |                       |
| Total                                   | 0.08              | [-0.03, 0.38]       | -0.06        | [-2.79, 0.65]         | -0.07                    | [-1.53, 0.09]         |
| Total indirect <sup>a</sup>             | —                 | —                   | -0.01        | [-0.53, 0.00]         | -0.03                    | [-0.73, 0.01]         |
| PBS use                                 | —                 | —                   | -0.01        | [-0.53, 0.00]         | -0.01                    | [-0.38, 0.00]         |
| Alcohol use                             | —                 | —                   | —            | —                     | -0.02                    | [-0.47, 0.12]         |
| PBS use–alcohol use                     | —                 | —                   | —            | —                     | -0.00                    | [-0.09, 0.00]         |
| Direct                                  | 0.08              | [-0.03, 0.38]       | -0.05        | [-2.61, 0.79]         | -0.03                    | [-1.13, 0.36]         |
| Predictor variable: Urgency             |                   |                     |              |                       |                          |                       |
| Total                                   | 0.01              | [-0.37, 0.43]       | -0.07        | [-8.90, 2.93]         | <b>0.33</b>              | <b>[2.44, 6.03]</b>   |
| Total indirect <sup>a</sup>             | —                 | —                   | -0.00        | [-0.48, 0.42]         | -0.02                    | [-1.50, 0.57]         |
| PBS use                                 | —                 | —                   | -0.00        | [-0.48, 0.42]         | -0.00                    | [-0.39, 0.32]         |
| Alcohol use                             | —                 | —                   | —            | —                     | -0.02                    | [-1.42, 0.50]         |
| PBS use–alcohol use                     | —                 | —                   | —            | —                     | -0.00                    | [-0.08, 0.07]         |
| Direct                                  | 0.01              | [-0.37, 0.43]       | -0.07        | [-8.88, 2.95]         | <b>0.36</b>              | <b>[3.05, 6.08]</b>   |
| Predictor variable: Depressive symptoms |                   |                     |              |                       |                          |                       |
| Total                                   | -0.04             | [-0.20, 0.08]       | <b>0.11</b>  | [-0.20, 3.55]         | <b>0.14</b>              | <b>[0.29, 1.69]</b>   |
| Total indirect <sup>a</sup>             | —                 | —                   | 0.01         | [-0.07, 0.26]         | <b>0.04</b>              | <b>[-0.02, 0.65]</b>  |
| PBS use                                 | —                 | —                   | 0.01         | [-0.07, 0.26]         | 0.01                     | [-0.06, 0.19]         |
| Alcohol use                             | —                 | —                   | —            | —                     | 0.03                     | [-0.04, 0.56]         |
| PBS use–alcohol use                     | —                 | —                   | —            | —                     | 0.00                     | [-0.01, 0.05]         |
| Direct                                  | -0.04             | [-0.20, 0.08]       | 0.10         | [-0.24, 3.50]         | <b>0.10</b>              | <b>[0.08, 1.36]</b>   |
| Predictor variable: PBS use             |                   |                     |              |                       |                          |                       |
| Total                                   | —                 | —                   | <b>-0.11</b> | <b>[-1.69, -0.28]</b> | <b>-0.20</b>             | <b>[-1.41, -0.61]</b> |
| Total indirect (alcohol use)            | —                 | —                   | —            | —                     | <b>-0.03</b>             | <b>[-0.31, -0.04]</b> |
| Direct                                  | —                 | —                   | <b>-0.11</b> | <b>[-1.69, -0.28]</b> | <b>-0.17</b>             | <b>[-1.23, -0.47]</b> |

Notes: Significant associations are in **bold** typeface for emphasis and were determined by a 95% bias-corrected unstandardized bootstrapped confidence interval (based on 10,000 bootstrapped samples) that does not contain zero. PBS = protective behavioral strategy; CI = confidence interval. <sup>a</sup>Reflects the combined indirect associations via PBS use, alcohol use, and PBS use via alcohol use.

“self-regulation” on alcohol-related outcomes, suggesting that other key factors are needed to more fully explain these associations. No other distal antecedent had either a unique direct or indirect relationship with alcohol use. Nonetheless, depressive symptoms and “urgency” had significant positive associations with alcohol-related problems that remained even when controlling for PBS use and alcohol use. In sum, the results of the comprehensive model revealed that many of the direct and indirect associations that were significant in separate models did not remain significant when tested together. The comprehensive model saw failures in both the a-paths (i.e., distal antecedents → PBS use) and the indirect paths (i.e., a-path × b-path, PBS use → alcohol-related outcomes). However, the b-path (i.e., PBS use → alcohol-related outcomes) remained significant in the comprehensive model.

## Discussion

The present study sought to replicate studies that examined PBS use as a mediator of the relationship between five distinct sets of antecedents (i.e., age at first use, self-regulation, impulsivity-like traits, depressive symptoms, and conscientiousness) and alcohol-related outcomes. The replication effort was largely successful in that nearly all associations were replicated in an independent sample of college students while matching the original studies’ methodologies as closely as possible and tested in separate models. However, when we ran a comprehensive model with all distal antecedents simultaneously included, most of the direct and indirect associations failed to be supported.

We found a robust association between PBS use and alcohol-related outcomes in both the separate and comprehensive models, and our results further suggest that PBS use at least partially explains the relationships between many distal risk/protective factors and alcohol-related outcomes when tested separately. However, the comprehensive model suggests that PBS use is a more key explanatory variable for the effects of age at first use and self-regulation compared with other distal antecedents (e.g., depression, sensation seeking, urgency). Clinically, PBS use may be a particularly important intervention target for individuals who started drinking alcohol at a younger age and those with poor self-regulation abilities.

Conceptually, we can consider the relationship among these distal antecedents and specific facets of PBS use. The current and original studies used the PBSS (Martens et al., 2005), which only assesses strategies used while drinking (i.e., does not include alternatives to drinking or avoidance strategies), and assesses strategies that correspond to three subscales (i.e., Stopping/Limiting Drinking, Manner of Drinking, Serious Harm Reduction). Given the strategies included in the PBSS, our finding that self-regulation is the strongest predictor of PBS use is not surprising. Both Stopping/Limiting Drinking strategies (e.g., stop drinking at a predetermined time) and Manner of Drinking strategies (e.g., drink slowly rather than gulp drinks) necessitate self-regulation to be effective. Nearly all strategies on the list conceptually fit with the personality trait of conscientiousness. A conscientious person would be more likely to plan to use Serious Harm Reduction strategies (e.g., use a designated driver) that require making plans beforehand and following through with them at the end of a drinking episode. Further, the Manner of Drinking strategies can be considered a behavioral representation of a conscientious drinking style.

The manner in which age at first use is linked with PBS use is less clear. On the one hand, initiating drinking at a younger age may relate to using fewer PBSs because earlier age at first use is associated with developing more dysregulated drinking patterns (e.g., alcohol abuse/dependence; DeWit et al., 2000), suggesting that these individuals have difficulty controlling their drinking in general, and perhaps similarly have difficulty with implementing the use of PBSs. On the other hand, earlier initiation of use may also be associated with specific motives for drinking that are viewed as conflicting with PBS use (e.g., coping/enhancement motives; Bravo et al., 2015; Kuntsche & Müller, 2011).

Given that the comprehensive model showing that self-regulation and age at first use are the strongest predictors of PBS use when examining all constructs simultaneously has only been examined in the present study, additional research is needed to replicate these findings. Importantly, PBS use remained a strong predictor of alcohol-related outcomes in the comprehensive model, providing further evidence for the robustness of the PBS use–alcohol-related outcomes relationship. Because we did not manipulate PBS use in the

present study, we have uncovered a natural tendency for individuals with these traits to use (or not use) PBSs. As PBS use has been demonstrated to mediate intervention effects (Barnett et al., 2007; Larimer et al., 2007; Murphy et al., 2012), future research is needed to examine whether PBS-based interventions are particularly effective for individuals with the traits discussed herein. This type of analysis would provide more convincing evidence that PBS use is a mechanism through which these more distal antecedents exert their effects on alcohol-related outcomes.

We found that the direct and indirect associations via PBS use were stronger in separate models than in the comprehensive model. Similar results have been found when examining the role of PBS use as a statistical mediator between more proximal antecedents and alcohol-related outcomes including drinking motives (Bravo et al., 2015; Ebersole et al., 2012; LaBrie et al., 2011; Martens et al., 2007) and perceived norms of PBS use (Benton et al., 2008; Lewis et al., 2009; Ray et al., 2009). Importantly, all of these studies suggest that PBS use accounts for reductions in alcohol-related problems even when controlling for a wide range of other risk/protective factors.

The current replication efforts should be considered in light of their limitations. First, the current sample consisted of more participants who identified as Hispanic compared with the original samples. However, given that the replication attempts were successful, we have evidence that these relationships are robust to differences in ethnicity. Further, our data show no significant differences between Hispanic and non-Hispanic participants on any of the study variables. Second, although we attempted to replicate the original studies with as much specificity as possible, there are some instances (described throughout) in which our methods or sample deviated from the original studies. Of note, we had a relatively large sample, which provided us with more statistical power than many of the original studies that may have allowed us to detect some additional associations not found in the original studies. Third, although we were interested in examining mediational pathways, we cannot demonstrate temporal precedence, which is requisite for making causal inferences, because of the cross-sectional, non-experimental nature of both our sample and the samples included in the original studies. Last, although PBS use was a statistically significant mediator of these relationships, the effect sizes were sometimes quite small, suggesting that other factors are clearly needed to account for the associations of these risk/protective factors on alcohol-related outcomes.

### *Conclusion*

PBS use is a robust predictor of alcohol-related outcomes and a consistent mediator of the relationships between distal risk/protective factors and alcohol-related outcomes when tested in separate models. When tested together, PBS use



explained the relationship between two distal antecedents (i.e., self-regulation and age at first use) and alcohol-related outcomes. The results of the comprehensive model suggest that increasing PBS use appears beneficial regardless of individuals' specific combination of risk/protective factors, and self-regulation seems to be a promising target for future PBS research. Future longitudinal and experimental studies (e.g., randomized controlled trials) with larger samples are needed to disentangle the relationships among distal antecedents, PBS use, and alcohol-related outcomes. In each successful replication attempt, distal antecedents that were associated with greater PBS use resulted in less alcohol use and fewer related consequences, and those that were associated with less PBS use resulted in more alcohol use and related consequences. Given that our findings replicated each original study, we may feel more confident in the integrity of these associations. However, our comprehensive model directed our attention to age at first use and self-regulation as constructs that may warrant the most attention as we attempt to build and tailor PBS-based intervention and treatment efforts.

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