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Use of Alcohol Protective Behavioral Strategies among College Students: A Critical Review

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Abstract

Protective behavioral strategies (PBS) are specific behaviors one can utilize to minimize the harmful consequences of alcohol consumption. Recently, there has been an increasing amount of interest in use of PBS among college students, especially as an intervention target. The purpose of the present comprehensive review of the PBS literature was to examine the measurement of PBS and summarize the quantitative relationships between PBS use and other variables. The review found inconsistency across studies in terms of how use of PBS is operationalized and found only two PBS measures with good psychometric properties that have been replicated. Although several antecedents to PBS use were identified, most were only examined in single studies. Moderators of the predictive effects of PBS use on outcomes have similarly suffered from a lack of replication in the literature. Of all 62 published reports reviewed, 80% reported only cross-sectional data, which is unfortunate given that PBS use may change over time and in different contexts. In addition, only two attempted to minimize potential recall biases associated with retrospective assessment of PBS use, and only two used an approach that allowed the examination of both within-subject and between-subject effects. In terms of the gaps in the literature, there is a dearth of longitudinal studies of PBS use, especially intensive longitudinal studies, which are integral to identifying more specifically how, when, and for whom use of PBS can be protective.

Keywords

Protective Behavioral Strategies; Drinking Control Strategies; Self-Control; Alcohol-Related Problems; Alcohol Use; College Students

Among college students, alcohol use contributes to a wide range of negative consequences ranging in severity from social/interpersonal problems to injury and death (Hingson, Zha, & Weitzman, 2009). Behavioral strategies that can be used to minimize the harm associated with alcohol use have received an increasing amount of attention in the past few decades. Although the measurement of these strategies initially emerged based on self-control theory and self-help manuals (Merbaum & Rosenbaum, 1980; Miller & Muñoz, 1982; Vogler & Bartz, 1982; Werch, 1986), the emergence and acceptance of the harm-reduction approach to treatment of alcohol misuse (Dimeff, Baer, Kivlahan & Marlatt, 1999, 2002; Marlatt & Witkiewitz, 2002, 2010) has led to increased interest in these behavioral strategies. As PBS

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use has been shown to mediate intervention effects (Barnett et al., 2007; Larimer et al., 2007; Murphy et al., 2012), increasing the use of these behavioral strategies among college students seems to be a progressively more common intervention target. Given this trend, it is important to conduct a comprehensive review of the literature to determine gaps in our knowledge regarding the use of these strategies.

Protective Behavioral Strategies

Broadly defined, protective behavioral strategies (PBS) are behaviors that reduce the negative consequences experienced from drinking (Martens, Pedersen, LaBrie, Ferrier, & Cimini, 2007). They have also been referred to as behavioral self-control strategies (Werch & Gorman, 1986; Werch, 1988), drinking control strategies (Sugarman & Carey, 2007) and alcohol reduction strategies (Bonar et al., 2011). Although there is significant variability in how PBS are operationalized, most PBS measures include strategies related to limiting alcohol intake by setting drinking limits (e.g., “Determine not to exceed a set number of drinks”; Martens et al., 2005), consuming non-alcoholic drinks in addition to alcoholic drinks (“Alternating alcoholic and nonalcoholic beverages when you are drinking”; Sugarman & Carey, 2007), and choosing not to engage in behaviors that lead to drinking quickly (“Avoid drinking games”; Delva et al., 2004; Martens et al., 2005; Novik & Boekeloo, 2011). Some PBS are unrelated to actual alcohol intake and more directly related to ensuring one’s safety like planning safe transportation (“Use a designated driver”; Martens et al., 2005) and preventing the ingestion of unknown substances (“Never left a drink unattended”; Novik & Boekeloo, 2011). Some PBS are related to reducing the potentially negative impact of peers on one’s drinking (“Drink an alcohol look-alike”; Novik & Boekeloo, 2011), and other PBS are related to enhancing the protective impact of peers on one’s drinking (“Have a friend let you know when you’ve had enough”; Delva et al., 2004; Martens et al., 2005; Novik & Boekeloo, 2011). Although not included in all PBS measures, some measures include items related to avoiding alcohol use altogether (“Avoid situations where there was alcohol”; Novik & Boekeloo, 2011; “Choose to participate in enjoyable activities that do not include alcohol consumption”; Sugarman & Carey, 2007).

Despite the variability in the operationalization of PBS, there is mounting evidence that there is an inverse relationship between distinct types of PBS use and alcohol-related outcomes (i.e., alcohol use and alcohol-related problems). In fact, nearly every study in the present review supports the notion that individuals who report using more PBS also report drinking less and/or experiencing fewer alcohol-related problems. Specifically, PBS use has been shown to be negatively correlated with typical and heaviest drinking frequency in the past 30 days (Pearson, Kite, & Henson, 2012), typical and heaviest quantity of drinking (Martens et al., 2005; Pearson et al., 2012), number of heavy episodic drinking episodes (Martens et al., 2007), and estimated blood alcohol concentration from one’s heaviest recent drinking episode (Sugarman & Carey, 2007). Further, PBS use has been shown to be inversely related to various individual alcohol-related problems (Araas & Adams, 2008) as well as various composite alcohol problems measures (Benton et al., 2004; Murphy et al., 2012; Pearson et al., 2012).

Purpose of the Present Review

Overall, there is strong support for the fact that multiple types of self-reported PBS use are negatively correlated with self-reported alcohol use/problems. The present review addresses two important issues that are essential to moving research on PBS forward. First, the present review examines the measurement of PBS to resolve inconsistencies regarding the operational definition of PBS, develop a more precise definition of PBS, and compare different measures of PBS use in terms of their psychometric testing (see Prince, Carey, &

Maisto, 2013, for a recent methodological review). Second, given the range of research examining antecedents to PBS use and moderators of the effects of PBS use on alcohol-related outcomes, the literature is examined to summarize its nomological network, or the overall pattern of relationships between PBS use and other demographic and psychological constructs. In this regard, longitudinal and experimental (e.g., intervention) studies are given special attention given their ability to lead to stronger causal inferences and determine if PBS use may be a mechanism of change in alcohol use. Overall, the review is concluded by identifying significant gaps in our knowledge regarding PBS and providing suggestions for future research.

Identification of Studies

In the present review, multiple databases (APA PsycNet, Web of Science, and Google Scholar) were used to conduct online searches for relevant published studies using terms known to the author to describe PBS ('protective behavior strategies' OR 'protective behavioral strategies' OR 'drinking control strategies', AND 'alcohol OR drinking'). Then, additional studies were found from searching the reference lists for relevant studies. Finally, a search through all studies that cite any of the studies that developed a measure of PBS was conducted to ensure adequate coverage. Given that there were few studies examining non-college student populations, and the measurement of PBS tended to be different, the present review focused on studies using college student samples, including incoming college students and specific populations within the college student population (e.g., student athletes, females). Given the primary aims of the present review (to examine the measurement of PBS and summarize the quantitative relationships between PBS use and other variables), qualitative papers were not included in the present review, nor were studies that used measures that were not unambiguously assessing PBS use. For example, if the PBS measure was restricted to only alcohol avoidance strategies (e.g., Howard, Griffin, & Boekeloo, 2008), or was only examined in combination with other non-PBS variables (e.g., restraint, Collins, Koutsky, Morsheimer, & MacLean, 2001; legal risk behaviors, Leedy & Leffingwell, 2006; alcohol use, Vader, Walters, Prabhu, Houck, & Field, 2010) such that specific relationships between PBS use and other variables could not be examined, the studies were not included in the present review. There is emerging work that has extended the examination of PBS to other domains that is also not included in the present review (e.g., condom-related PBS; Lewis, Kaysen, Rees, & Wood, 2010). These studies are mentioned here as they do provide valuable insights into use of PBS, but simply do not provide the data of interest in the present review. Finally, it is important to note that the literature searches ended in the beginning of February 2013, so published articles that were not yet available to the author at that time were not included in the present review.

Using the criteria described above, 62 published studies were identified. It is important to note that some of these studies included multiple samples (Benton et al., 2007; Kite, Pearson, & Henson, 2013) and some of the samples were used in multiple reports (e.g., Harris, Walters, & Leahy, 2008; Walters, Roudsari, Vader, & Harris, 2007; Walters, Vader, Harris, & Field, 2009; Walters, Vader, Harris, & Jouriles, 2009), so it is difficult to know exactly how many independent samples were reported across these studies.

Measurement of PBS

PBS were defined previously as behaviors that reduce the negative consequences experienced from drinking. The problem with this conceptual definition is that PBS are defined entirely by an outcome that they are presumed to effect. In this sense, the definition is tautological. If a particular protective behavioral strategy is found to be unrelated to negative consequences from drinking, is it still a protective behavioral strategy? The trouble

in providing a more precise definition is that the operational definitions of PBS vary across studies, leading to slightly different conceptual definitions. Although some have used the more narrow operational definition of PBS as strategies used immediately prior to, during, and after drinking (Martens et al., 2005), others have used a broader definition of PBS to also include strategies to avoid drinking altogether (Sugarman & Carey, 2007).

Collapsing across several different variants of many of these scales, at least 11 different PBS measures were found: the Protective Behavioral Strategies Survey (PBSS; Martens et al., 2005), the National College Health Assessment measure (NCHA; Delva et al., 2004), the College Alcohol Survey measure (CAS; Benton et al., 2004), the Protective Strategy Questionnaire (PSQ; Palmer et al., 2010), the Protective Behavioral Strategies Measure (PBSM; Novik & Boekeloo, 2011), the Strategy Questionnaire (SQ; Sugarman & Carey, 2007), the Self-Control Questionnaire (SCQ; Werch & Gorman, 1986), and four unnamed measures (Borden et al., 2011; Luebke et al., 2009; Nguyen et al., 2011; Ray et al., 2009). Measurement information is summarized in Table 1.

Most of these PBS measures had multiple variants when one considers different response scales used, different time windows given, and different subsets of items used in analyses. Across all measures, there were several different types of response scales including multi-point contingent frequency, absolute frequency, and degree of truth response scales, as well as dichotomous yes/no response scales. The most common response scale was a contingent frequency response scale, which reflects frequency estimates that are specifically contingent on the occurrence of another behavior. In this case, the frequency of PBS use “when drinking or ‘partying’” with responses ranging from “never” to “always.” An absolute frequency response scale requests the participant to report the number of times they used each PBS during the given assessment window. A degree of truth response scale requests participants to report how true each item is for them. Finally, the yes/no responses were used to describe the use of each PBS on a specific day or occasion. Considering the effects of these variations on validity is important because previous work has demonstrated strong concurrent validity of PBS use when assessed using a contingent frequency response scale, but not with an absolute frequency response scale (Kite, Pearson, & Henson, 2013). Presumably, this difference occurs because an absolute frequency response scale conflates frequency of alcohol use with frequency of PBS use.

An important consideration for selecting a PBS measure to be used in research is the degree to which it has been subjected to rigorous psychometric testing. Although most of these measures reported some form of psychometric testing (i.e., factor analysis), only four measures (collapsing across variants of measures) have been examined using both exploratory factor analysis (EFA, including principal components analysis, PCA) and confirmatory factor analysis (CFA): Protective Behavioral Strategies Measure (PBSM; Novik & Boekeloo, 2012), Strategy Questionnaire (SQ; Sugarman & Carey, 2007), Protective Strategy Questionnaire (PSQ; DeMartini et al., 2013), and the Protective Behavioral Strategies Survey (PBSS; Martens et al., 2005). Although EFA is useful to examine the underlying factor structure of a measure in a specific sample, it is inherently exploratory, and more confirmatory techniques (i.e., CFA) are needed to confirm the goodness-of-fit of a hypothesized factor structure. Thus, we review the psychometric testing and concurrent validity of these four measures in further detail.

PBSS

To form the PBSS, Martens et al. (2005) developed 25 items from reviewing the literature for “potential strategies that could be used by individuals during or immediately prior to drinking in an effort to limit their consumption or consequences resulting from such consumption” (p. 699). Using an exploratory factor analysis (EFA) with principal axis

extraction and promax rotation, Martens et al. settled on a three-factor solution: Limiting/Stopping Drinking (7 items; “Leave the bar/party at a predetermined time”, “Drink water while drinking alcohol”), Manner of Drinking (5 items; “Avoid mixing different types of alcohol”, “Avoid trying to “keep up” or out-drink others”), and Serious Harm Reduction (3 items; “Use a designated driver”, “Make sure you go home with a friend”). Subsequent studies using CFA have found the original factor structure of the PBSS to have adequate fit when the strong correlation between two of the items are accounted for by either correlating the item disturbances (Martens et al., 2007) or dropping one of the items (Pearson et al., 2012a). Despite overall support for the factor structure of the PBSS, at least one study calls into question the original three factor structure of the PBSS, suggesting there may be a four-factor structure for males (Walters et al., 2007). It should be noted that Walters et al. (2007) used exploratory rather than confirmatory factor analysis techniques. Each of the PBSS subscales has been shown to be negatively associated with alcohol use and alcohol-related problems (Martens et al., 2005, 2007; Pearson et al., 2012a). In fact, in the only study known to the author that compared different PBS measures in terms of factor structure and concurrent validity, the PBSS was found to outperform the SQ and the PBSM (Pearson et al., 2012a).

Variants of the PBSS

The PBSS is the most widely used PBS measure as evidenced by the fact that the majority of studies in the present review used the PBSS (36 studies; ~58%). Unfortunately, many of these studies used some variation of the PBSS, rather than the original PBSS published by Martens et al (2005). Specifically, at least nine different variants of the PBSS have been used. In the original scale development article, Martens et al. (2005) reported using a 5-point contingent frequency response scale, but Martens et al. (2007) reported using a 6-point contingent frequency response scale in a follow-up study that used CFA to examine the factor structure of the PBSS in an independent sample. Therefore, researchers have frequently used both 5-point (16 studies) and 6-point (15 studies) response scales for the PBSS. Although no specific time window (i.e., period of time for which one is asked to report on their behavior) is given for most studies using the PBSS (24 studies), some researchers have used a 3-month time window (5 studies), or time windows limited to a single day or single occasion (4 studies). For the latter studies, yes/no response scales were used to assess use of each PBS for each day using a daily diary (Pearson, D’Lima, & Kelley, 2013), use of each PBS for each day of the past week using a 7-day retrospective recall (Lewis et al., 2012), and use of each PBS for a single occasion in the past 7 days (Frank, Thake, & Davis, 2012) or for one’s 21st birthday (Neighbors, Lee, Lewis, Fossos, & Walter, 2009). Lewis and colleagues (2009, 2010) added percentage values to anchors such that the “never” response was accompanied with “0%” and the “always” response was accompanied with “100%”. Lewis et al. (2010) added two additional items to the PBSS, and Kulesza et al. (2010) used all 25 original PBSS items, including the 10 items that were dropped following factor analysis (Martens et al., 2005). These multiple variants of the PBSS demonstrate the difficulty of synthesizing the PBS literature given that not only are completely different measures being used to measure PBS, but the same measure is being given in many different ways. Importantly, it is unknown how these variations affect reliability and validity.

PSQ

Although the 16-item PSQ had been developed (Palmer, 2004) and used in published research previously (Palmer, Corbin, & Cronce, 2010; Palmer, McMahon, Rounsaville, & Ball, 2010), no formal psychometric testing had been done until recently (DeMartini et al., 2013). DeMartini et al. split a college student sample to conduct a PCA with a varimax rotation with one split, and a CFA with the other split. Using parallel analysis to determine the number of components to extract, two factors were extracted: Direct Strategies (6 items;

“Space my drinks out over time”, “Alternate alcoholic drinks with non-alcoholic drinks”) and Indirect Strategies (4 items, “Have a reliable designated driver”, “Preplan transportation to get home”). This two-factor structure fit the data well based on a CFA of the college student sample, which was also replicated in an independent young adult sample. In a path analytic model, the Direct Strategies were shown to be directly related to reduced alcohol use and only indirectly related to alcohol-related problems via alcohol use, whereas the Indirect Strategies were found to be directly related to alcohol-related problems, even though they were not significantly related to alcohol use. Therefore, the factor structure of the PSQ is simple, well-fitting, and produces two factors that are differentially related to alcohol-related outcomes. However, only one published report has used this version of the PSQ, so more research is needed to identify the usefulness of the PSQ.

PBSM

The PBSM was developed as part of a dissertation (Griffin, 2008) and published a few years later (Novik & Boekeloo, 2011). Twenty-two items were created based on previous measures of PBS (Benton et al., 2004; Delva et al., 2004; Werch, 1990) and responses from focus groups (“What do students do to stay safe when they are going out to drink?”; Howard et al., 2007). EFA with procrustes rotation was used to examine the factor structure across gender (men vs. women) and racial groups (white vs. non-white), and the two factor structure was supported across these groups: Limits PBS (9 items; “Eat before and/or during drinking”, “Keep track of how many drinks you were having”) and Avoidance PBS (8 items; “Avoid drinking games”, “Avoid situations where there was alcohol”). Although the dissertation reported negative correlations with alcohol-related outcomes (Griffin, 2008), no such tests of concurrent validity are in the published scale development article (Novik & Boekeloo, 2011). Further, a CFA found that this factor structure did not hold in an independent sample (Pearson, Kite, & Henson, 2012a).

SQ

Similarly, the SQ was developed by combining items from a previous measure (Werch & Gorman, 1986), strategies mentioned in skills-based interventions (e.g., Dimeff, Baer, Kivlahan, & Marlatt, 1999; Kivlahan, Marlatt, Fromme, Coppel, & Williams, 1990; Miller and Muñoz, 2005), and answers to an open-ended question asking participants to describe “drinking reduction strategies that they used in the past month” (Sugarman & Carey, 2007, p. 340), resulting in a total of 27 items. PCA with an oblique rotation was used to extract three PBS factors: Selective Avoidance of Heavy Drinking Activities and Situations (7 items; “Choose not to participate in drinking games when given the opportunity”, “Refusing drinks”), Strategies Used While Drinking (10 items; “Eating before and while you are drinking”, “Drinking slowly”), and Alternatives to Drinking (4 items; “Choose to participate in enjoyable activities that do not include alcohol consumption”, “Practicing ways to be more comfortable in social settings without using alcohol”). Although studies have found that the Selective Avoidance and Alternatives to Drinking are generally negatively correlated with alcohol-related outcomes, Strategies Used While Drinking have been shown to be positively related to alcohol-related outcomes (Pearson et al., 2012a; Sugarman & Carey, 2007, 2009). Further, a CFA also found that the factor structure of the SQ failed to fit adequately in an independent sample (Pearson et al., 2012a). However, it should be noted that based on three studies that manipulated the response scale used for the SQ and the PBSS, it appears that the positive relationship between the SQ Strategies Used While Drinking subscale and alcohol-related outcomes is due to the use of the original absolute frequency response scale, which conflates the frequency of alcohol use with the frequency of PBS use (Kite, Pearson, & Henson, 2013). Using the same contingent frequency response scale as used with the PBS measures reviewed above, the SQ showed promise of having equal or stronger relationships with alcohol-related outcomes than the PBSS. Given that

changing the response scale had such a dramatic effect on the predictive relationships of the SQ subscales, additional work is needed to test the factor structure of the SQ using a contingent frequency response scale.

Broad vs. narrow operational definition

One important goal of reviewing the different measures of PBS in the present review was to determine whether PBS should be limited to including strategies used immediately prior to, during, or after drinking, or whether they should also include strategies related to avoiding alcohol altogether. The former is considered a more narrow operational definition than the latter definition, which is broader in scope. As such, the item content of each of the PBS measures was examined to identify whether alcohol avoidance strategies were included (i.e., broad operational definition) or excluded (i.e., narrow operation definition). As shown in Table 1, four of the measures used the broad operational definition by including alcohol avoidance strategies. Interestingly, some authors have excluded the avoidance strategies and used the more narrow operational definition when using at least two of these measures (NCHA: Araas & Adams, Dams-O'Connor et al., 2006; Martens et al., 2005; PBSM: D'Lima, Pearson, & Kelley, 2012). This use of the more narrow definition appears to be most consistent with current use of the term PBS. In fact, only 13 of the 62 studies (~21%) used the broader definition, and this includes studies that had only one or two alcohol avoidance strategies (e.g., NCHA, Sutfin et al., 2009). Although this fact certainly does not reflect a pure consensus, it does suggest that most PBS researchers find the more narrow definition more useful for their research aims. The more narrow definition has a number of benefits in terms of how PBS are described as well as how PBS are measured. In terms of its conceptual definition, the narrow operational definition allows PBS to be described as safe drinking habits and controlled drinking strategies. In terms of measurement, the narrow operational definition more easily lends itself to measurement using a contingent frequency response scale. Specifically, if the strategies are limited to behaviors when individuals do consume alcohol, then participants can be asked how often they use such strategies *when drinking*. Given that avoidance strategies can be used repeatedly throughout a night and/or throughout a week, it is less clear how these can be assessed using a contingent frequency response scale. When Kite et al. (2013) used a contingent frequency response scale for the SQ (which includes alcohol avoidance strategies), the instructions asked how often participants used the strategies "when drinking or 'partying'". Although such instructions allow alcohol avoidance strategies to be assessed on a contingent frequency response scale, it is possible and likely that such alcohol avoidance strategies could occur outside of the context of 'partying.'

Limitations of psychometric testing

It should be noted that even when psychometric testing has been conducted, authors have often used total scores rather than subscale scores in analyses for various reasons. For example, although Benton et al. (2004) conducted a PCA with promax rotation on the 10 PBS items from the College Alcohol Survey (CAS) that suggested a two-factor solution (i.e., two subscales with five items each), they decided to use a single total score given that the internal consistency on one of the factors was 'low' ($\alpha = .65$). Multiple studies using the PBSS have used structural equation modeling in which a single latent variable is examined with the three subscales as factor indicators (e.g., LaBrie, Lac, Kenney, & Mirza, 2011; Lewis, Rees, Logan, Kaysen, & Kilmer, 2010; Martens, Ferrier, & Cimini, 2007). The problem with this practice is that the latent factor is defined solely by the correlated portion of the three subscales, and the remaining variability is treated as measurement error. Although the uncorrelated part of the three subscales is partially due to measurement error, it is largely due to the fact that each subscale reflects distinct types of behaviors that tend to co-occur, which also tend to occur relatively independently of the behaviors that form the

other two subscales. Therefore, despite the fact that psychometric testing reveals distinct types of PBS and validity testing demonstrates that these different PBS have unique predictive relationships with alcohol-related outcomes, many authors have decided to collapse across these distinct types of PBS to examine overall PBS use. By conflating distinct types of PBS into a single factor, this practice obscures the meaning of the latent factor and makes it impossible to uncover unique patterns of relationships between different types of PBS and outcome variables.

Measurement summary

To summarize the state of PBS measurement, the narrow definition of PBS is by far the most common, which allows PBS to 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. In interventions, they can be described as “ways to stay safe while drinking” or safe drinking strategies. Two PBS scales have factor structures that have been replicated in independent samples using both exploratory and confirmatory techniques: the PBSS and PSQ. Although the form of the PSQ subjected to psychometric testing has only been used in a single published report, the PBSS has been used in at least 36 studies, with at least three of these studies explicitly examining and supporting its three factor structure. The items on the Direct Strategies subscale of the PSQ are similar to the items on the Limiting/Stopping Drinking and Manner of Drinking subscales of the PBSS, and the items on the Indirect Strategies subscale of the PSQ are similar to the items on the Serious Harm Reduction subscale of the PBSS. Additional research using each of these PBS measures will be able to determine the degree of convergence in findings using these different measures.

Summarizing the Nomological Network

Summaries of the PBS-related findings of the 62 studies included in the present review are included in the Appendix. It is important to note that PBS use was not a primary focus of all of these studies, so these summaries are not aimed to summarize the most important or significant findings from each study; rather, an attempt was made to describe the most unique, significant findings regarding the relationship between PBS use and other variables.

Although the relationship between PBS use and alcohol-related outcomes appears to be rather well-established (a point that is reconsidered in later sections), there has been a limited range of research into the antecedents to PBS use. To better situate PBS use into psychological theory, it is important as a first step to define its nomological network, or the way in which PBS use relates to other constructs. Figure 1 summarizes the significant relationships between PBS use and demographic and psychological variables, including putative antecedents to PBS use, moderators of the relationships between PBS use and alcohol-related outcomes, and consequences of PBS use. Potential antecedents or predictors of PBS use are examined in order from strongest to weakest empirical support.

Antecedents/Predictors of PBS Use

Gender

Of all variables examined as a predictor of PBS use, the most evidence exists for the effect of gender. Specifically, women have been found to use more PBS when examined as a single factor (Benton et al., 2004; Benton, Benton, & Downey, 2006; Benton, Downey, Glider, & Benton, 2008; Borden et al., 2011; D’Lima, Pearson, & Kelley, 2012; Ehret, Ghaidarov, & LaBrie, 2013; Frank, Thake, & Davis, 2012; Palmer, McMahon, Rounsaville, & Ball, 2010;), multiple factors (Nguyen, Walters, Syatt, & DeJong, 2011) including all PSQ subscales (DeMartini et al., 2013), all PBSS subscales (LaBrie, Lac, Kenney, & Mirza, 2011; Lewis, Rees, & Lee, 2009; Lewis, Rees, Logan, Kaysen, & Kilmer, 2010), and all SQ

subscales (Pearson & Henson, 2013). Of all the studies reviewed, only four studies report *any* non-significant gender differences in PBS use, and each of these studies found some significant gender differences (Pearson, Kite, and Henson, 2012a; Sutfin et al., 2009; Walters et al., 2007; Werch, 1990). Overall, there is overwhelming evidence that women use more PBS than men. However, only one of these studies examined measurement invariance by gender before making mean comparisons, which is a necessary to determine whether factor scores are comparable across men and women. Although DeMartini et al. (2013) provided evidence that the PSQ is gender invariant, research is needed to determine if other PBS measures are gender invariant. Also, no studies reported examining PBS use as a statistical mediator of the effect of gender on alcohol-related outcomes, which is a logical extension based on these results.

Drinking motives

Motivation models of alcohol use (Cooper, 1994; Cox & Klinger, 1988) posit that drinking motives are the most proximal antecedent to alcohol use involvement, and that different drinking motives (or reasons for drinking) are associated with different patterns of alcohol consumption. Based on the Cox-Klinger model, Cooper devised a self-report measure of drinking motives (Drinking Motives Questionnaire-Revised, DMQ-R) derived from crossing two primary dimensions: source of motivation (internal vs. external) and type of reinforcement (positive vs. negative). Internally motivated, positively reinforcing motives are associated with enhancing one's mood, thus are referred to as enhancement motives. Internally motivated, negatively reinforcing motives are associated with ameliorating one's negative mood, thus are referred to as coping motives. Externally motivated, positively reinforcing motives are associated with drinking to improve social interactions, thus are referred to as social motives. Externally motivated, negatively reinforcing motives are associated with drinking to avoid negative social interactions or avoid peer disapproval, thus are referred to as conformity motives. Overall, negatively reinforcing motives (coping and conformity) have been found to be most directly associated with alcohol-related problems, whereas positively reinforcing motives (enhancement and social) are most directly associated with alcohol use (Cooper, 1994; Kuntsche et al., 2005; Read et al., 2003).

In two separate SEM models, Martens, Ferrier, and Cimini (2007) examined a PBS latent variable (with the three PBSS subscales as factor indicators) as a mediator of the predictive effects of three of the drinking motives mentioned previously on alcohol use and alcohol-related problems: social motives, enhancement motives, and coping motives. They found that PBS use mediated the effects of social and enhancement motives on alcohol use and alcohol problems, but not the effects of coping motives. They found that these results held across volunteer and mandated college students. Similarly, LaBrie et al. (2011) used SEM and found that the predictive effect of a drinking motives latent variable (with the four DMQ-R subscales as factor indicators; Cooper, 1994) on an alcohol use latent variable (with drinks per week, hours per week, and days per week as factor indicators) was significantly mediated by the PBS latent variable. The robust predictive relationship between drinking motives and alcohol use ($\beta = .58$) was significantly diminished when controlling for PBS use ($\beta = .17$), which accounted for about 70% of the total effect of drinking motives on alcohol use. Also, this relationship held across gender and racial groups (Caucasian and Asian). Finally, in a sample of lesbian, gay, bisexual, and transgender (LGBT) college students, Ebersole, Noble, and Madson (2012) found that PBS use (total score of the PBSS) partially mediated the predictive effects of enhancement motives and coping with depression motives on alcohol-related problems, but they did not find mediated effects for social, coping with anxiety, or conformity motives. Thus, across all of these three studies, some drinking motives were associated with lower PBS use, which in turn was related to more alcohol use and/or alcohol problems. However, all of these studies used cross-sectional designs, so full

tests of mediation (MacKinnon, 2008) were not possible. Additional support for the drinking motives-PBS use relationship comes from bivariate correlations reported in Osberg et al. (2010). However, more research is needed to examine which specific drinking motives might be mediated by specific types of PBS.

PBS descriptive norms

Much research demonstrates the robust relationship between perceived drinking norms (i.e., descriptive norms) and alcohol use (Borsari & Carey, 2001, 2003). Numerous theoretical perspectives posit that behavior is at least partially determined by perceptions regarding what is normative (e.g., normative focus theory, Cialdini et al., 1990; Theory of Planned Behavior, Ajzen, 2011). Following in this tradition, two studies examined descriptive norms of PBS as predictors of PBS use. Benton, Downey, Glider, and Benton (2008) split a very large stratified random sample (i.e., stratified based on gender and year in school) into two approximate halves of college student drinkers ($n = 6139$ and $n = 6658$) who were recruited from five different universities. In both samples, they found a modest correlation between PBS descriptive norms and PBS use ($r = .32$ and $.33$). Further, in both samples, these PBS descriptive norms predicted PBS use when controlling for gender, alcohol use, alcohol-related problems, and 2-way interactions between PBS descriptive norms and these variables. Lewis, Rees, and Lee (2009) examined both same-sex and opposite-sex PBS descriptive norms using the three PBSS subscales. They found modest correlations between same-sex PBS descriptive norms and PBS use across the three subscales ($r = .35$, Limiting/Stopping Drinking, $r = .26$, Manner of Drinking, $r = .49$, Serious Harm Reduction), whereas the relationships between opposite-sex PBS descriptive norms and PBS use was non-significant ($r = .02$, Limiting/Stopping Drinking, $r = -.01$, Manner of Drinking) or weakly negatively related ($r = -.08$, Serious Harm Reduction). The same pattern of results were found in multiple regressions controlling for gender, alcohol use, alcohol problems, drinking attitudes, same-sex and opposite-sex alcohol use descriptive and injunctive norms. Together, these studies suggest that PBS descriptive norms predict one's own use of PBS, especially gender-specific PBS descriptive norms. These results suggest that PBS norms-based interventions may be an effective means of increasing PBS use, which is an important avenue for future research.

Other PBS beliefs

In addition to descriptive norms, the Theory of Planned Behavior (TPB; Ajzen 1991, 2011) posits that behaviors are determined by attitudes, subjective norms (i.e., injunctive norms), perceived behavioral control (similar to self-efficacy), and behavioral intentions. Most of the support for the predictive relationships between these variables and PBS use come from a single study that examined PBS attitudes, PBS self-efficacy, PBS subjective norm, and PBS perceived effectiveness for four types of PBS (Ray, Turrisi, Abar, & Peters, 2009). Using their own unnamed measure of PBS, Ray et al. (2009) conducted an EFA and settled on a four-factor structure: Pacing (4 items; "I pace my drinks to 1 or fewer per hour"), Setting Limits (5 items; "I keep track of how many drinks I had"), Social (3 items; "I walk home with a friend or group of friends"), and Diluting (4 items; "I switch between alcoholic and non-alcoholic beverage"). For the sake of comparison, the Pacing and Diluting subscales were similar in content to the Manner of Drinking subscale from the PBSS, the Setting Limits subscale was similar to the Limiting/Stopping Drinking subscale from the PBSS, and the Social subscale was similar to the Serious Harm Reduction subscale from the PBSS. For each PBS item, participants also completed subjective norm, attitude, self-efficacy, and perceived effectiveness items in addition to PBS use. For all four subscales, PBS subjective norm, PBS attitude, PBS self-efficacy, and PBS perceived effectiveness were positively correlated with PBS use, and negatively correlated with alcohol use and alcohol-related problems. Werch (1990) provides additional support that perceived effectiveness of PBS is

positively related to actual PBS use. A single study provides support for a positive relationship between PBS intentions and PBS use (Neighbors et al., 2009). Overall, the relationships between PBS-related beliefs, PBS intentions, and PBS use are limited given that only one or two studies have examined these relationships. Further, other than the one study examining PBS intentions and PBS use (Neighbors et al., 2009), all of these relationships have been examined cross-sectionally, which does not allow for a full test of the theoretical model (e.g., TPB; Ajzen, 2011). Interventions specifically targeting TPB constructs would allow the strongest test of a TPB-based model of PBS use, and could help determine the clinical utility of assessing PBS beliefs.

Health beliefs

The Health Belief Model (HBM; Janz & Becker, 1984) posits that health behaviors are determined by perceived susceptibility, severity, benefits, and barriers. Werch (1990) used single-item measures to assess each of these health belief variables: “Belief that I could develop alcohol-related problems” (susceptibility), “Belief that serious problems can result from drinking” (severity), “Belief that there are benefits from limiting drinking” (benefits), and “Belief that I can learn to limit my drinking” (barriers). PBS use (i.e., external self-control strategies) was trichotomized to create low, moderate, and high PBS use groups. There were significant group differences with severity and benefits showing a monotonic increase in agreement from low to high PBS groups. This single study provides some limited support for the relationships between HBM variables and PBS use. Additional research examining these HBM variables using reliable, multi-item inventories is needed to determine the extent to which HBM variables can explain variability in PBS use, which would suggest whether interventions targeting these variables would be advantageous.

Individual difference variables

The relationships between several individual difference variables (including personality traits) and PBS use have been examined. PBS use has been shown to mediate the predictive effects of depression symptoms on alcohol-related problems (Martens et al., 2008), age of drinking onset on alcohol use and problems (Palmer et al., 2010), self-regulation on alcohol problems (D’Lima, Pearson, & Kelley, 2012), good self-control (but not poor regulation) on alcohol use (Pearson, Kite, & Henson, 2012b), impulsivity-like traits on alcohol use and/or alcohol problems (Pearson, Kite, & Henson, 2013), and conscientiousness on alcohol use and problems (Martens et al., 2009). Family history of alcoholism (Walters et al., 2007) and beliefs regarding the importance of drinking to the college experience (Osberg et al., 2010) have also been shown to be negatively related to PBS use. As none of these predictive effects have been examined in multiple studies, there is only weak evidence to support these relationships, and more foundational research is needed to determine if these findings may be able to inform interventions (e.g., personality-targeted alcohol interventions; Conrod, Castellanos-Ryan, & Mackie, 2011).

Moderators of the Relationships between PBS Use and Alcohol-Related Outcomes

In addition to identifying antecedents to PBS use, it is important to identify factors that may moderate the relationship between PBS use and alcohol-related outcomes. Moderation analyses, which are essentially tests of interactions, can provide a better understanding of the boundary conditions associated with an effect. In other words, these interaction tests can suggest when and for whom the use of PBS is strongly related (or unrelated) to alcohol-related outcomes.

Gender

Unlike research that has very strongly supported the idea that women use more PBS than men, the role of gender as a moderator of the effects of PBS use on alcohol-related outcomes is equivocal. For example, Benton et al. (2004) found that PBS use reduced the association between alcohol use and alcohol problems for both men and women, but the relationship was stronger for men. In contrast, Lewis et al. (2010) found that PBS use was negatively associated with sex-related negative alcohol consequences for women, but not for men. Sutfin et al. (2009) found that 8 out of 10 individual PBS items showed stronger correlations (in terms of size, not statistical tests) with alcohol-related problems for women compared to men. Thus, additional research is needed to determine whether gender moderates the relationships between PBS use and alcohol-related outcomes.

Alcohol use

In multiple studies, PBS use has been found to moderate the relationship between alcohol use and alcohol-related problems such that the positive relationship between alcohol use and problems is reduced among individuals who report higher PBS use (Benton et al., 2004; Benton, Benton, & Downey, 2006; Borden et al., 2011). Although two of these studies (Benton et al., 2004; Borden et al., 2011) had rather large sample sizes that could allow for the detection of very small interaction effects, Benton et al. (2006) replicated the alcohol use by PBS use interaction in two modest sample sizes. Future research is needed to examine whether these alcohol use by PBS interactions are restricted to specific types of PBS by using multidimensional PBS measures.

Health variables

LaBrie and colleagues (2009, 2010) have examined mental health, physical health, and social health as moderators of the relationship between PBS use and alcohol-related outcomes. In a sample of first-year female college students, they found that PBS use was most strongly related to reduced alcohol use and problems among individuals with poor mental health. In a larger sample including both men and women, LaBrie, Kenney, and Lac (2010) found that the negative relationship between PBS use and alcohol use was strongest among individuals with high social health, and the negative relationship between PBS use and alcohol-related problems was stronger among individuals with poor mental health and poor physical health. Thus, it appears that overall measures of health may moderate the relationship between PBS use and alcohol-related outcomes, but the only effect that replicated across both studies was the interactive effect with mental health on alcohol-related problems. It is important for future research to use a more diverse array of measures of psychopathology to distinguish the unique role of distinct variables as moderators of the predictive effects of PBS use on alcohol-related outcomes, which may imply that the efficacy of PBS-based interventions will depend on individuals' particular co-occurring mental health issues.

Other variables

The remaining moderators have each only been examined in single studies, so additional research is needed to determine whether these interaction effects will replicate. Drinking refusal self-efficacy (DRSE) when experiencing social pressure (social DRSE) and negative emotions (emotional DRSE) moderated the effect of PBS use on alcohol use and alcohol problems, such that the PBS use-alcohol outcome relationship was stronger for individuals with low DRSE. Although previous studies examined drinking motives as mediators of the effects of PBS use on alcohol-related outcomes, Patrick, Lee, and Larimer (2011) examined drinking motives by PBS use interactions. They found that the negative relationship between PBS use and abuse/dependence consequences was strongest among individuals with high

coping motives, and the negative relationships between PBS use and social, personal, and overall consequences were strongest among individuals with high conformity motives. In a student athlete sample, Weaver, Martens, and Smith (2012) found that use of Serious Harm Reduction PBS and Manner of Drinking PBS buffered against the positive effect of negative urgency on alcohol use and alcohol problems, respectively. Thus, using specific types of PBS seemed to be particularly protective for individuals with poor impulse control and a tendency to act impulsively when experiencing negative affect (i.e., high negative urgency). Zeigler-Hill, Madson, and Ricedorf (2012) found a three-way interaction between gender, self-esteem, and PBS use that showed that the protective effect of PBS use on alcohol-related outcomes was stronger among men with high self-esteem compared to men with low self-esteem, whereas PBS was similarly protective with women with high and low self-esteem. In the only study in the present review to examine a moderated mediation model, the predictive effect of global self-regulation on alcohol-related problems was mediated by PBS use, but this indirect effect was limited to individuals with low to average levels of self-regulation (D'Lima et al., 2012). Although these moderation effects have yet to be replicated, the overall pattern appears to be that PBS use is more protective for individuals at increased risk of experiencing alcohol-related consequences (i.e., poor mental/physical health, high urgency, low self-regulation, low DRSE, high coping/conformity motives), which provides very preliminary support for targeted PBS interventions for 'at-risk' populations.

Review of Evidence for PBS as a Mechanism of Change

Randomized controlled trials

Not only are PBS proposed to be a proximal antecedent to alcohol-related outcomes, they are presumed to be a mechanism of change in alcohol use (Kazdin, 2007), thus it should mediate intervention effects that are expected to manipulate PBS use. Currently, at least three RCTs with college students have been shown to have significant effects on alcohol-related outcomes that were significantly mediated by PBS use. Larimer et al. (2007) found that the effect of a mailed personalized feedback intervention on alcohol use involvement (a standardized composite of peak BAC, past month frequency of alcohol use, number of drinks per week, and past year frequency of alcohol use) at 12-month follow-up was fully mediated by an increase in PBS use from baseline to 12-month follow-up. In a mandated college student sample, Barnett et al. (2007) found that the effect of a Brief Motivational Interview (BMI) on drinks per day at 12-month follow-up was significantly mediated by PBS use at 3-month follow-up. With a rather small sample, Murphy et al. (2012) found that the effect of a BMI containing a behavioral economic supplement on alcohol-related problems at 6-month follow-up was significantly mediated by the change in PBS from baseline to 1-month follow-up. Using an online parent-based intervention (i.e., no direct contact with students), Donovan, Wood, Frayjo, Black, and Surette (2012) found that the intervention significantly increased parents' communication with their children regarding PBS use, and was related to increased PBS use over time. Given RCTs' experimental design, these studies provide some of the strongest evidence for the causal relationship between PBS use and alcohol-related outcomes. Important, the mediated effects via PBS use provide preliminary support for PBS use as a mechanism of changing one's alcohol use and/or experience of alcohol-related problems. However, not all interventions have found PBS to mediate intervention effects. Three RCTs were shown to have no significant effect on PBS use (Kulesza, Apperson, Larimer, & Copeland, 2010; Neighbors, Lee, Lewis, Fossos, & Walter, 2009; Walters, Vader, Harris, Field, & Jouriles, 2009); therefore, PBS use failed to mediate intervention effects in these studies. Thus, when interventions have been shown to successfully modify PBS use, PBS use has been found to be a significant mediator of intervention effects. Interventions that fail to show significant changes in PBS use do not

call into question the relationship between PBS use and alcohol-related outcomes, rather they call into question the methods used to successfully change PBS use.

Other experimental designs

Walters et al. (2009) found that an immediate assessment group that completed study questionnaires at baseline, 3-month, 6-month, and 12-month follow-ups reported more PBS use (as well as lower alcohol use) compared to a delayed assessment group that only completed the 12-month follow-up. This study suggests that PBS use may increase over time due to assessment reactivity. Sugarman and Carey (2009) used an experimental design to examine the effect of providing college students with simple instructions to reduce alcohol use or increase PBS use. Overall, those instructed to reduce alcohol use did in fact reduce alcohol use, and those instructed to increase PBS use reported increased PBS use, but this increase in PBS use was not accompanied by reductions in alcohol use. None of the PBS change scores (from the SQ) were significantly correlated with alcohol use change scores. These findings could be due to demand characteristics or any of the measurement issues previously reviewed regarding the SQ. Alternatively, these studies together may be accounted for by the limited validity of self-reported PBS use, suggesting that PBS use be assessed more precisely (see 'Recall bias' and 'Method bias' sections below).

Non-experimental longitudinal designs

Using a single-group design to test the efficacy of a screening and brief intervention, Martens, Cimini et al. (2007) found that participants reported higher PBS and lower alcohol use at a 6-week follow-up, but change in PBS use (i.e., change scores) was not significantly correlated with alcohol outcomes. Using the data from a nonefficacious peer intervention (Cimini et al., 2009) with baseline, 6-month and 12-month follow-ups, Martens, Martin, Littlefield, Murphy, and Cimini (2011) examined the prospective relationships between PBS use and alcohol-related outcomes and correlated PBS use change scores with alcohol use change scores. Overall, prospective correlations between PBS use and alcohol use were similar to the cross-sectional correlations reported, but the prospective correlations between PBS use and alcohol-related problems were appreciably weaker (e.g., 3 of 9 correlations were non-significant). In multiple regressions controlling for the other PBS subscales, only Manner of Drinking change scores were predictive of less drinks per week at 6- and 12-month follow-ups, whereas only Serious Harm Reduction change scores were predictive of alcohol problems at 6- and 12-month follow-ups. Using a brief PBS measure in a sample of females, Luebke, Varvel, and Dude (2009) found that PBS use did not predict alcohol use or alcohol problems concurrently at baseline or 4-month follow-up, but baseline PBS use prospectively predicted less alcohol problems at 4-month follow-up when controlling for age, baseline alcohol problems, quantity and frequency of alcohol use, and risk-amplifying behaviors. Overall, these longitudinal designs offer mixed evidence that PBS predicts alcohol-related outcomes prospectively, which could be due to instability of PBS use over time (i.e., individuals using more PBS at 6-month follow-up may not be using more PBS at 12-month follow-up) or unexplored maturational effects (i.e., PBS use may be differentially associated with outcomes depending on drinking history).

Designs with daily PBS reports

Two studies have used multi-level modeling to disaggregate the relationships between PBS use and alcohol-related outcomes into within-subject and between-subject effects. The first study by Lewis et al. (2012) did not use a longitudinal design *per se*, rather they collected daily reports of PBS in the past 7 days using the PBSS, which was centered around one's 21st birthday. Both between-subject and within-subject effects were found for PBS use on alcohol-related outcomes. Specifically, 1) average (i.e., between-subject) and daily (i.e., within-subject) Manner of Drinking PBS were related to less alcohol use and fewer negative

alcohol consequences; 2) average Limiting/Stopping Drinking PBS were associated with fewer negative alcohol consequences, whereas the daily variation was actually related to more alcohol use/problems; and 3) average and daily Serious Harm Reduction PBS were both associated with more alcohol use, with the daily assessment also relating to more alcohol problems. Thus, this study not only found some within-subject and between-subject negative relationships between PBS use and alcohol outcomes, but also found some within-subject and between-subject positive relationships. Despite the enormous benefits of multi-level modeling to examine both within-subject and between-subject effects, the estimation of the within-subject effects depended on retrospective recall, and thus could be biased. To overcome this limitation, another study used a 15-day daily diary design to examine the relationship between daily PBS use and alcohol-related outcomes (Pearson, D'Lima, & Kelley, 2013). Similar to Lewis et al. (2012), they found both within-subject and between-subject relationships between PBS use and alcohol-related outcomes. Specifically, 1) average Manner of Drinking PBS were related to less alcohol use and less positive consequences from drinking, and daily variation was related to less alcohol use, 2) average Limiting/Stopping Drinking PBS were related to less alcohol use, whereas the daily variation was related to more alcohol use and more positive consequences from drinking; and 3) average Serious Harm Reduction PBS were related to increased alcohol use and positive consequences, and daily variation was related to more alcohol use/problems as well as more positive consequences from drinking. Thus, both studies examining both within-subject and between-subject effects found certain strategies (e.g., Serious Harm Reduction PBS) to exhibit positive relationships with alcohol use/problems. Although their very definition suggests that these strategies are protective, in the very least, these relationships suggest the importance of examining moderators of their effects and/or reconsidering how alcohol-related outcomes are being operationalized. One explanation for the counterintuitive positive associations between PBS use and alcohol-related outcomes is that individuals may only use certain PBS when in high-risk drinking situations. For example, many individuals may only plan a designated driver when they intend to get intoxicated (i.e., legally drunk). Thus, it may be important to examine event-specific intentions and specific context of drinking to understand the associations between PBS use and alcohol-related outcomes at the event-level.

Identifying Gaps in Knowledge

In the review of the different PBS measures and a brief, yet broad, review of antecedents, moderators, and consequences of PBS use, many of the important gaps in the literature have already been identified. Additional knowledge gaps are considered here. Despite the benefits of finding converging effects using alternative operationalizations of a construct, inconsistency in the assessment of PBS has limited the degree to which PBS research has moved forward in a cumulative fashion. Although rational reasons may lead one researcher, for example, to examine PBS including vs. excluding alcohol avoidance strategies, the assessment of PBS in many studies has been less than ideal and weight needs to be applied to the specific operational definition used when discussing how results fit into the larger literature. Although the present review identified well over a dozen potential predictors of PBS use, very few of these have been examined in multiple studies. The replication of moderation effects is even rarer in the literature, which is particularly troubling considering general issues regarding the replicability of interaction effects.

Ecological bias

One critically important limitation in the vast majority of the studies reviewed concerns the use of cross-sectional designs. Although it is rather standard for authors to note their cross-sectional design as a study limitation due to the inability to demonstrate temporal precedence, and thus an inability to make strong causal inferences, there are other concerns

with this design that warrant mention. First, when an interventionist recommends that an individual increase their PBS use, they are assuming that there is a within-subject relationship between PBS use and alcohol-related outcomes. In other words, if an individual increases their use of PBS, they will experience less alcohol-related harm. However, the vast majority of studies have used between-subjects designs, which are only able to demonstrate that individuals who tend to use more PBS generally experience less alcohol-related problems. Although researchers commonly make within-subject inferences based on between-subject findings, this leap of faith reflects an ecological inference fallacy (Robinson, 1950). Research using multi-level modeling has shown that the finding of within-subject effects and between-subject effects operating in opposite directions is not entirely uncommon (Raudenbush & Byrk, 2002).

Recall bias

Another serious concern associated with nearly every study in the present review is that both PBS use and alcohol-related outcomes are measured only using retrospective self-report measures. As shown in Table 1, many of the PBS measures do not provide any time window for their assessment, so participants are asked how often they use PBS in general. Although the literature on the problems caused by recall bias is vast, and beyond the scope of the present study, a few studies in the domain of alcohol use are particularly relevant. Using a large random sample of Danish adults, Ekholm (2004) used a 7-day retrospective recall of alcohol use, and found a systematic decrease in the number of drinks reported as the recall period increased. For example, participants reported consuming more alcohol last Saturday if Saturday was yesterday rather than 7 days ago. Other studies have found similar effects (Gmel & Daepfen, 2007). If recall bias can be observed with alcohol in a period as short as 7 days, then what might the bias be when asked to summarize alcohol use or PBS use in the past 3 months? Further, research comparing daily reports of alcohol use with retrospective reports show significant differences (Patrick & Lee, 2010; Toll, Cooney, McKee, & O'Malley, 2006; Searles, Helzer, & Walter, 2000; Searles, Helzer, Rose, & Badger, 2002). Only three studies in the present review used a method that may reduce the potential influence of retrospective memory biases in the reporting of PBS use. Frank et al. (2012) and Neighbors et al. (2009) limited recall to a single drinking occasion, and Pearson et al. (2013) used a daily diary design. Thus, it is critically important to examine the relationship between PBS use and alcohol-related outcomes using prospective daily diary designs, or ecological momentary assessment (EMA; Shiffman, 2009). Although Pearson et al. (2013) took advantage of the daily diary design, the study involved a relatively small sample ($n = 40$), and did not compare daily measures of PBS use to typical self-report measures. Research is needed to identify the level of concordance or discordance between daily reports of PBS use and global retrospective self-reports.

Method bias

Another related bias that presents a problem when only retrospective self-reports are used is common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). The critique of using only retrospective self-report for all measures could be directed at the vast majority of alcohol research, but given current technology, researchers are capable of circumventing this problem. Using EMA designs is one way to obtain self-reports that are likely more accurate, and using objective measures of alcohol intake would limit other self-report biases. For example, an increasing number of researchers are using transdermal alcohol sensors (Barnett et al., 2011; Dougherty et al., 2012) to obtain real-time estimates of blood alcohol concentrations. Although the author is unaware of any published studies that have done so, emerging technology and methodology (i.e., ambulatory assessment, Ebner-Priemer & Trull, 2009) makes the use of real-time breath alcohol concentrations (BrAC) possible.

Weak tests of PBS use as a mechanism of change

Kazdin and Nock (2003) proposed seven criteria to be used to demonstrate a mechanism of change in psychotherapy studies, and offered specific recommendations for how researchers can comprehensively study mechanisms of change. Multiple RCTs have shown PBS use to mediate intervention effects, which supports the “experiment” (i.e., PBS is manipulated using an experimental design), “strong association” (i.e., PBS mediates the intervention effect), “temporal relation” (i.e., changes in PBS use precede changes in alcohol use), and “consistency” (i.e., mediation effects were replicated) criteria (Barnett et al., 2007; Larimer et al., 2007; Murphy et al., 2012). However, none of these interventions were primarily targeted toward changing PBS use, making them relatively weak experimental tests of PBS as a mechanism of change. Likewise, given the use of traditional macro-longitudinal designs, the evidence for a “temporal relation” is weak as there are no experimental studies that have measured both PBS use and alcohol use more continuously. These studies did not report comprehensive assessment of other potential mechanisms of change, giving little support for the “specificity” criterion (i.e., PBS is the specific mechanism rather than a correlated construct). A dose-response relationship best illustrates the “gradient” criterion, which has not been demonstrated. Finally, as the examination of PBS has stemmed from largely pragmatic perspective, additional integration with psychological theory is needed to support the “plausibility and coherence” criterion. To summarize, although some data are supportive of PBS use as a mechanism of changing alcohol use and/or reducing alcohol-related problems, much additional work is needed to support each of the seven criteria proposed by Kazdin and Nock.

Moving forward

To date, the field of PBS has crawled forward slowly and incrementally. This author proposes that the use of intensive longitudinal designs in which EMA or ambulatory assessment methods are used to assess the real-time relationships between PBS use and alcohol-related outcomes is critical to most rapidly close the gaps in knowledge regarding how PBS use relates to outcomes. Although traditional longitudinal and experimental designs remain important and critically informative, combining EMA methods within these studies would provide richer data regarding the process by which PBS use reduces alcohol use and/or alcohol-related consequences. For example, an RCT of an intervention in which PBS use is expected to be one of the mechanisms of change could use a measurement-burst design, which collects EMA data prior to, immediately after, and at follow-ups, which would provide more accurate information regarding the within-person relationships between PBS use and alcohol-related outcomes, and would allow less biased tests of the relationship of the intervention on PBS use.

Conclusion

In the present review, the literature on PBS use in the college student population was summarized. The review of various PBS measures demonstrates that the vast majority of studies have operationally defined PBS to include behaviors that are used immediately prior to, during, and/or after drinking that reduce alcohol use, intoxication, and/or alcohol-related harm. Although some studies have also included alcohol avoidance strategies (i.e., avoiding alcohol use altogether), this author recommends the exclusion of alcohol avoidance strategies from PBS measures to provide greater conceptual clarity to the PBS construct. Rather, alcohol avoidance strategies can be conceptualized as distinct from PBS, yet complementary in terms of protecting individuals from harm. The measurement review also revealed only two existing measures that have relatively strong psychometric support: the Protective Behavioral Strategies Survey (PBSS; Martens et al., 2005), and the Protective Strategy Questionnaire (PSQ; DeMartini et al., 2013). However, it is unlikely that these are

the ‘final’ measures of PBS use, and future research should continue to strengthen the measurement of PBS by using both EFA and CFA. Although several putative antecedents to PBS use have been examined, many of these predictive effects have not been replicated and most rely on cross-sectional designs with very limited ability to make causal inferences. The same replication and design issues limit what we know regarding moderators of the effects of PBS on alcohol-related outcomes. Intervention, experimental, and longitudinal research have given mixed evidence for PBS use as a mediator of intervention effects, and PBS use as a prospective predictor of alcohol-related outcomes. As more studies using these designs are published, it should begin to become clearer how these relationships unfold over time. Although the present review was restricted to studies focused on college students, this focus was pragmatic based on the availability of studies. Reviews including other populations are critical to determining the extent to which the findings from the college student literature generalize to other populations. There is no clear reason to believe that PBS use would only be effective for college students, so extensions to other populations reflect a logical next step for future research. Despite the unique contributions that can be provided by comprehensive reviews of a literature, a quantitative research synthesis (i.e., meta-analysis) is sorely needed to better examine heterogeneity across studies and quantify the effects of PBS use on alcohol-related outcomes. Overall, research shows PBS use as a promising way to reduce alcohol use and the negative consequences from drinking.

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Appendix

Summary of Findings from Studies on Protective Behavioral Strategies

Study Authors	Summary of PBS-related findings
1. Araas & Adams (2008)	Using a large, random sample from the National College Health Assessment, found that higher use of PBS was associated with less likelihood of experiencing seven distinct alcohol-related problems when controlling for gender and alcohol consumption variables
2. Barnett, Murphy, Colby, & Monti (2007)	In a randomized controlled trial (RCT), found that use of PBS at 3 months mediated the effect of a Brief Motivational Interview (vs. a computer-delivered intervention) on drinks per drinking day at 12 months.
3. Benton, Schmidt, Newton, Shin, Benton, & Newton (2004)	Using two large samples collected from four Midwestern universities, found that PBS use buffered the effect of alcohol use on both 'more common consequences' and 'less common consequences' across both samples. A three-way interaction showed that this buffering effect on 'more common consequences' was stronger for men compared to women in both samples, and for 'less common consequences' in only one sample.
4. Benton, Benton, & Downey (2006)	In two modest samples, found that PBS use buffered the effect of alcohol use and alcohol-related problems when controlling for attitude toward risks.
5. Benton, Downey, Glider, & Benton (2008)	Using two large samples collected from five Midwestern universities, found that descriptive norms of PBS use were significantly correlated with PBS use, and predicted PBS use when controlling for gender, alcohol use, and alcohol problems. Both men and women perceived that others used less PBS than they reported, and an interaction effect shows this discrepancy was larger among women.

Study Authors	Summary of PBS-related findings
6. Borden, Martens, McBride, Sheline, Block, & Dude (2011)	Using a large sample from 13 public universities in Missouri, found that PBS use buffered the effect of binge-drinking on alcohol-related problems based on four different measures of binge-drinking.
7. Cimini, Martens, Larimer, Kilmer, Neighbors, & Monserrat (2009)	Tested three peer-facilitated brief alcohol interventions among mandated college students that were found to have no significant effects at 6-month follow-up. Correlated change scores between three facets of PBS use with peak drinking, drinks per week, alcohol problems, and descriptive norms. Found that change in each PBS subscale was significantly negatively correlated with change in one to three alcohol-related outcomes, and change in Manner of Drinking PBS was negatively correlated with descriptive norms.
8. Dams-O'Connor, Martens, & Anderson (2006)	Found that women who wanted to lose weight were more likely to experience three of seven alcohol-related problems (physically injure self, done something regretted, have forced intercourse) than women who did not report a desire to lose weight. Found that among the women who wanted to lose weight, PBS use was associated with less likelihood of experiencing two of three alcohol-related problems examined (physically injure self, done something regretted).
9. Delva, Smith, Howell, Harrison, Wilke, & Jackson (2004)	In a random sample, found bivariate relationships between PBS use and alcohol-related problems for both men and women, but PBS use was only significantly negatively related to alcohol-related problems after controlling for binge drinking for women.
10. DeMartini, Palmer, Leeman, Corbin, Toll, Fucito, & O'Malley (2013)	Used PCA and CFA to evaluate the factor structure of the Protective Strategies Questionnaire (PSQ) in a college student and young adult sample, finding two factors: indirect and direct PBS. Demonstrated measurement invariance (configural, metric, and scalar) across men and women. Across both samples, found that direct PBS predicted alcohol use, which fully mediated their effects on alcohol problems, and indirect strategies predicted alcohol problems directly (not mediated by alcohol use).
11. D'Lima, Pearson, & Kelley (2012)	With a cross-sectional survey, found that PBS use partially mediated the predictive effects of self-regulation on alcohol-related problems when controlling for alcohol use (mediation model), found that PBS use was mostly negatively related to alcohol problems for individuals with low self-regulation (moderation model), and the PBS use mediated the predictive effects of self-regulation on alcohol-related problems when controlling for alcohol use for individuals with low to average levels of self-regulation (i.e., moderated mediation).
12. Donovan, Wood, Frayjo, Black, & Surette (2012)	Found that an online, parent-based intervention (compared to an e-newsletter) increased parents' communication with their children (incoming college students) regarding PBS use, and the students also reported using more PBS.
13. Ebersole, Noble, & Madson (2012)	In a sample of lesbian, gay, bisexual, and transgender students, found that PBS use partially mediated the predictive effects of enhancement motives and coping with depression motives on alcohol-related problems (but not social, coping with anxiety, or conformity motives).
14. Ehret, Ghaidarov, & LaBrie (2013)	In a relatively large sample, found that PBS use predicted less alcohol use and alcohol-related problems when controlling for gender, greek status, drinking motives, and drinking refusal self-efficacy. Further, found antagonistic interactions such that the predictive effects of PBS use on alcohol use and alcohol-related problems was weakest among those with high social and emotional drinking refusal self-efficacy, respectively.
15. Frank, Thake, & Davis (2012)	Examined the relationships between PBS use, alcohol use, and alcohol-related problems during a specific drinking occasion with the past 7 days. Examined PBS at the item, subscale, and total scale level, finding that although the total scale and some subscales were related to less alcohol use and alcohol-related problems, some subscales and some items were unrelated or even positively related to alcohol outcomes.
16. Haines, Barker, & Rice (2006)	With a large sample, found that use of six specific PBS was associated with less alcohol-related harm, and that use of PBS is common among college students.
17. Harris, Walters, & Leahy (2008)	In a modest sample, PBS use was weakly positively correlated with a confidence in one's ability to change their drinking, but unrelated to two other measures of readiness to change.
18. Kite, Pearson, & Henson (2013)	Found that use of an absolute frequency response scale on PBS measures results in counterintuitive positive correlations between PBS use and alcohol-related outcomes, whereas use of a contingent frequency response scale results in consistent negative correlations between PBS use and alcohol-related outcomes.
19. Kulesza, Apperson, Larimer, & Copeland (2010)	With a relatively small sample size, compared 10- and 50-minute motivational interviews to assessment-only control in an RCT. Although they found an intervention

Study Authors	Summary of PBS-related findings
	effect on alcohol use, none of the groups showed changes in PBS use at 4 week follow-up.
20. LaBrie, Kenney, Lac, Garcia, & Ferraiolo (2009)	With a relatively small sample of first-year college women, found moderation effects such that the PBS use was related to less alcohol use (total drinks, maximum drinks, binge episodes) and alcohol problems, especially among those with poorer mental health, and PBS use was related to less maximum drinks, especially among those with stronger social health.
21. LaBrie, Kenney, & Lac (2010)	In a large sample, found moderation effects such that PBS use was related to less alcohol use, especially among those with stronger social health, and related to less alcohol problems, especially among those with poorer physical and mental health
22. LaBrie, Lac, Kenney, & Mirza (2011)	In a relatively large sample, found that a PBS latent variable partially mediated the effect of a drinking motives latent variable on an alcohol use latent variable, and that the PBS-alcohol use relationship was stronger in females than males.
23. Larimer et al. (2007)	In a large RCT of personalized mailed feedback, found that change in PBS use from baseline to 12-month follow-up mediated the effect of the intervention on 12-month alcohol use.
24. Lewis, Rees, & Lee (2009)	Found that gender-specific PBS descriptive norms predicts PBS use when controlling for gender, alcohol use, alcohol problems, attitudes toward drinking, same-sex and opposite-sex descriptive and injunctive norms.
25. Lewis, Rees, Logan, Kaysen, & Kilmer (2010)	With a modest sample size, found that a PBS latent variable predicted less sex-related alcohol consequences for women only, and that this predictive effect was mediated by number of drinks typically consumed during sexual behavior, at least for women.
26. Lewis, Patrick, Lee, Kaysen, Mittman, & Neighbors (2012)	Using seven-day retrospective daily reports to examine the associations between PBS use and alcohol use/problems during college students' 21st birthday week, found both between-subject and within-subject effects for PBS use on alcohol-related outcomes.
27. Luebbe, Varvel, & Dude (2009)	With a modest sample of females, PBS did not predict alcohol use/problems concurrently at baseline or 4-month follow-up, but PBS use predicted less alcohol consequences at 4-month follow-up when controlling for age, baseline alcohol problems, quantity and frequency of alcohol use, and risk-amplifying behaviors..
28. Martens, Taylor, Damann, Page, Mowry, & Cimini (2004)	Found that PBS use predicted five of six alcohol-related problems measured (physically injured another person, been involved in a fight, did something you later regretted, forgot where you were or what you did, had unprotected sex) when controlling for gender and alcohol use
29. Martens, Ferrier, Sheehy, Corbett, Anderson, & Simmons (2005)	Reported the development of the Protective Behavioral Strategies Survey (PBSS). Used principal axis extraction with promax rotation to identify three PBS factors: Limiting/Stopping Drinking, Manner of Drinking, and Serious Harm Reduction. Each PBS subscale had a unique effect on at least one of the five alcohol-related outcomes examined.
30. Martens, Ferrier, & Cimini (2007)	In separate models, found that a PBS latent variable mediated the effects of social and enhancement (but not coping) motives on drinks per week and an alcohol problems latent variable.
31. Martens, Cimini, Barr, Rivero, Vellis, Desemone, & Horner (2007)	Using a single-group design, found that participants' PBS use significantly increased at 6 weeks following a brief intervention. Change scores were not significantly correlated with alcohol use/problems change scores.
32. Martens, Pedersen, LaBrie, Ferrier, & Cimini (2007)	Confirmed the factor structure of the PBSS using CFA, and showed measurement invariance across mandated vs. volunteer ad northwest vs. west coast samples.
33. Martens, Martin, Hatchett, Fowler, Fleming, Karakashian, & Cimini (2008)	With a mandated college student sample, found that a PBS latent variable partially mediated the predictive effect of a depression latent variable on an alcohol problems latent variable.
34. Martens, Karakashian, Fleming, Fowler, Hatchett, & Cimini (2009)	Found that a PBS latent variables fully (and partially) mediated the predictive effects of conscientiousness on an alcohol use latent variable (and an alcohol problems latent variable).
35. Martens, Martin, Littlefield, Murphy, & Cimini (2011)	Using a panel design (design, 6-month follow-up, 12-month follow-up), found that changes in two of the three subscales predicted less alcohol use/problems at follow-up.

Study Authors	Summary of PBS-related findings
36. Murphy, Dennhardt, Skidmore, Borsari, Barnett, Colby, & Martens (2012)	In a small RCT comparing the efficacy of brief motivation interviewing (BMI) with and without a behavioral economic supplement (SFAS), found that change in PBS from baseline to 1 month partially mediated the effect of SFAS+BMI intervention on alcohol-related problems.
37. Neighbors, Lee, Lewis, Fossos, & Walter (2009)	In an RCT testing the efficacy of an event-specific personalized feedback intervention, found that PBS use on one's 21 st birthday predicted a lower BAC when controlling for BAC intentions, PBS intentions, perceived drinking norms, and the intervention effect, but it did not mediate the intervention effect given that the intervention did not affect PBS use.
38. Nguyen, Walters, Wyatt, & DeLong (2010)	In an extremely large cross-sectional sample of incoming college students completing AlcoholEdu for College, found that there was a significant decline in the use of PBS from nine weeks pre-matriculation to four-weeks post-matriculation, and a concomitant increase in alcohol use during this timeframe.
39. Novik & Boekeloo (2011)	Reported the development of the Protective Behavioral Strategies Measure (PBSM). Used exploratory factor analysis with procrustes rotation to identify two PBS factors: Limits PBS and Avoidance PBS, which seemed to function well across men and women as well as whites and non-whites..
40. Osberg, Atkins, Buchholz, Shirshova, Swiantek, Whitley, Hartman, & Oquendo (2010)	Across two samples, found that PBS use was negative correlated with beliefs regarding the role of drinking to the college experience as assessed by the College Life Alcohol Salience Scale (CLASS).
41. Palmer, McMahon, Rounsaville, & Ball (2010)	Controlling for gender, individuals who reported never experiencing unwanted sexual contact reported higher PBS use than individuals who did reported unwanted sexual contact.
42. Palmer, Corbin, & Cronce (2010)	Found that PBS use partially mediated the predictive effect of age of first use on alcohol use and alcohol-related problems.
43. Patrick, Lee, & Larimer (2011)	In a sample of first-year students, found moderation effects such that PBS use predicted alcohol-related problems, especially among individuals with higher coping motives (for abuse/dependence symptoms) or higher conformity motives (for social and personal consequences)
44. Pearson, Kite, & Henson (2012a)	Compared three measures of PBS in terms of factor structure and concurrent validity, finding that the PBSS outperformed two other measures (PBSM and SQ).
45. Pearson, Kite, & Henson (2012b)	Found that PBS use mediated the predictive effect of Good Self-Control on alcohol-related outcomes, but not the predictive effect of Poor Self-Control
46. Pearson, Kite, & Henson (2013)	Found that PBS use partially mediated the predictive effects of impulsivity-like traits on alcohol-related outcomes.
47. Pearson, D'Lima, & Kelley (2013)	Using a 15-day daily diary, found both between-subject and within subject effects of PBS use on alcohol use, alcohol problems, and positive consequences from drinking.
48. Pearson & Henson (2013)	Found that PBS use was negatively correlated with alcohol use and alcohol-related problems, and one type of PBS predicted one of two alcohol problems measures when controlling for gender, four alcohol use measures, and unplanned drinking.
49. Ray, Turrissi, Abar, & Peters (2009)	Tested a model in which PBS self-efficacy and PBS perceived effectiveness were predictors of PBS attitudes and PBS subjective norms, which in turn predicted PBS use, which predicted alcohol outcomes. Found support for these relationships across four types of PBS.
50. Ray, Stapleton, Turrissi, & Phillion (2012)	Used latent profile analysis to find three latent classes defined by four PBS subscales and three risk behavior subscales, which were related to alcohol-related outcomes in predictable ways.
51. Sugarman & Carey (2007)	Reported the development of Strategy Questionnaire (SQ). Used principal factor analysis with oblique rotation to identify three PBS factors: Selective Avoidance (of Heavy Drinking Activities and Situations), Strategies Used While Drinking, and Alternatives to Drinking. Found that Selective Avoidance and Alternatives were negatively correlated with drinks per week and average BAC, whereas Strategies Used While Drinking was positively correlated with drinks per week and average BAC.
52. Sugarman & Carey (2009)	Found that students increased their PBS use over a 2-week follow-up period when instructed to do so, but this increase in PBS use was not related to a decrease in alcohol use or problems.

Study Authors	Summary of PBS-related findings
53. Sutfin, Light, Wagoner, McCoy, Thompson, Rhodes, & Spitler (2009)	Found negative correlations between six out of ten individual PBS items and alcohol-related problems for men, and nine out of ten individual PBS items for women. Women reported using each strategy more than men, but only four of the ten reached statistical significance.
54. Walters, Roudsari, Vader, & Harris (2007)	Found that parent history of alcoholism predicted less PBS use. Based on an exploratory factor analysis, found three PBS factors for women, but four PBS factors for men.
55. Walters, Vader, Harris, Field, & Jouriles (2009)	In an RCT comparing motivational interviewing alone, personalized normative feedback alone, and their combination (MI+PF) to assessment-only control, found that PBS did not mediate the intervention effects of the combined MI+PF intervention.
56. Walters, Vader, Harris, & Jouriles (2009)	In an experimental test of assessment reactivity, found that individuals assessed at baseline, 3, 6, and 12 month follow-ups reported more PBS use than those in the delayed assessment group.
57. Weaver, Martens, & Smith (2012)	In a sample of college student athletes, found moderation effects such that specific types of PBS use buffered the predictive effects of negative urgency on alcohol use (Serious Harm Reduction) and alcohol-related problems (Manner of Drinking)
58. Werch & Gorman (1986)	Reported the development of the Self-Control Questionnaire (SCQ). Used principal components analysis with varimax rotation to identify seven PBS factors (i.e., external self-control): Rate Control, Self-Reinforcement and Punishment, Alternatives, Avoidance, Limiting Driving and Cash, Controlling Time and Food, and Awareness.
59. Werch & Gorman (1988)	Found that six of the seven PBS subscales predicted at least one of the five types of alcohol-related problems (illness, drinking and driving, school, legal, other) based on a series of stepwise regression models.
60. Werch (1990)	Found monotonic increases in PBS use with those who believed serious problems can result from drinking (severity) and beliefs that there are benefits from limiting drinking (perceived benefits), and beliefs that PBS can be effective at reducing drinking and prevent problems were related to higher PBS.
61. Yusko, Buckman, White, & Pandina (2008)	Found that PBS was significantly correlated with alcohol use and alcohol problems among student athletes, but only correlated with alcohol use among non-athletes; however, there was not a significant interaction between athlete status and PBS use and alcohol-related outcomes.
62. Ziegler-Hill, Madson, & Ricedorf	Found a three-way interaction of gender, self-esteem, and PBS use in predicting alcohol use and alcohol-related problems. The negative predictive effect of PBS on alcohol outcomes was not significant for men with low self-esteem, but was significant for men with high self-esteem, and women with both high and low self-esteem.

Highlights

- Reviews studies on protective behavioral strategies (PBS) among college students
- Measurement of alcohol PBS is inconsistent across studies
- Alcohol PBS is consistently negative correlated with alcohol-related problems
- It is less clear what the antecedents to PBS are and moderators of its effects
- Gaps in the literature are identified to provide suggestions for future research

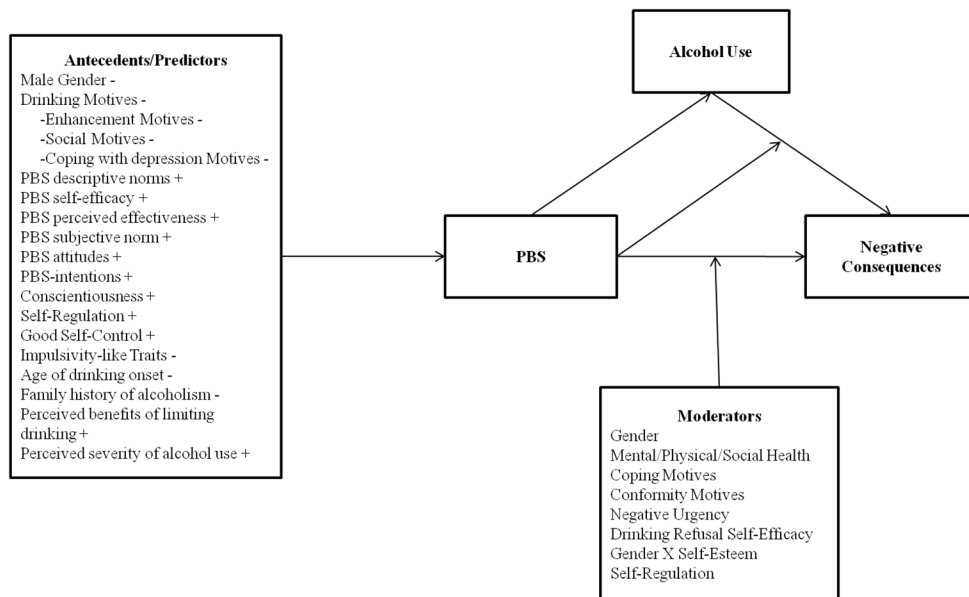


Figure 1. Graphical depiction of the nomological network of protective behavioral strategies (PBS)
Note. + indicates a positive association between an antecedent variable and PBS use, - indicates a negative association between an antecedent variable and PBS use.

Table 1

Measurement of Protective Behavioral Strategies

Scale	# of items	Response Scale	Time Window	Factor Analysis	Defined	Studies
PBSS	15	6-point contingent (C)	None reported	CFA	Narrow	Cimini, Martens, Larimer, Kilmer, Neighbors, & Monserrat (2009) Donovan, Wood, Frayjo, Black, & Surette (2012) Ebersole, Noble, & Madson (2012) Kite, Pearson, & Henson (2013) LaBrie, Kenney, Lac, Garcia, & Ferraiolo (2009) Martens, Cimini, Barr, Rivero, Vellis, Desemone, & Horner (2007) Martens, Ferrer, & Cimini (2007) Martens, Karakashian, Fleming, Fowler, Hatchett, & Cimini (2009) Martens, Martin, Hatchett, Fowler, Fleming, Karakashian, & Cimini (2008) Martens, Pedersen, LaBrie, Ferrer, & Cimini (2007) Martens, Martin, Littlefield, Murphy, & Cimini (2011) Weaver, Martens, & Smith (2012) Ziegler-Hill, Madson, & Riceford (2012)
PBSS	15	5-point C	None reported	EFA and CFA	Narrow	Ehret, Ghaidarov, & LaBrie (2013) LaBrie, Kenney, & Lac (2010) LaBrie, Lac, Kenney, & Mirza (2011) Martens, Ferrer, Sheeny, Corbett, Anderson, & Simmons (2005) Murphy, Dennyhardt, Skidmore, Borsari, Barnett, Colby, & Martens (2012) Osberg, Atkins, Buchholz, Shirshova, Swiantek, Whitley, Hartman, & Oquendo (2010) Pearson, Kite, & Henson (2012a) Pearson, Kite, & Henson (2012b) Pearson, Kite, & Henson (2013)
PBSS	15	5-point C	Past 3 months	EFA	Narrow	Harris, Walters, & Leahy (2008) Walters, Roudsari, Vader, & Harris (2007) Walters, Vader, Harris, & Field (2009) Walters, Vader, Harris, & Jouriles (2009)
PBSS	15	5-point C (added % values to anchors)	None reported	None reported	Narrow	Lewis, Rees, & Lee (2009)
PBSS	17	5-point C (added % values to anchors)	Past 3 months		Narrow	Lewis, Rees, Logan, Kaysen, & Kilmer (2010)
PBSS	25	5-point C	None reported	None reported	Narrow	Kulesza, Apperson, Larimer, & Copeland (2010)
PBSS	15	Yes/no	Past 24 hours	None reported	Narrow	Pearson, D'Lima, & Kelley (2013)
PBSS	15	Yes/no	Each day of past week	None reported	Narrow	Lewis, Patrick, Lee, Kaysen, Mittman, & Neighbors (2012)
PBSS	15	Yes/no	Single occasion	None reported	Narrow	Frank, Thake, & Davis (2012) Neighbors, Lee, Lewis, Fossos, & Walter (2009)
NCHA	8	5-point C	Past 12 months	None reported	Narrow	Araas & Adams (2008) Dams-O'Connor, Martens, & Anderson (2006) Martens, Taylor, Damann, Page, Mowry, & Cimini, (2004)
NCHA	10	6-point C (don't drink included)	Past 12 months	EFA	Broad	Larimer et al. (2007) Patrick, Lee, & Larimer (2011)

Scale	# of items	Response Scale	Time Window	Factor Analysis	Defined	Studies
NCHA	10/9	5-point C	Last school year	None reported	Broad	Delva, Smith, Howell, Harrison, Wilke, & Jackson (2004)
NCHA	10	5-point C	Past 3 months	None reported	Broad	Sutfin, Light, Wagoner, McCoy, Thompson, Rhodes, & Spittler (2009)
NCHA	10	5-point C	None reported	None reported	Broad	Yusko, Buckman, Shite, & Pandina (2008)
NCHA	6	6-point C	Last school year	EFA	Narrow	Haines, Barker, & Rice (2006)
CAS	10	5-point C	None reported	EFA	Narrow	Benton, Schmidt, Newton, Shin, Benton, & Newton (2004) Benton, Benton, & Downey (2006)
CAS	9	4-point C (N/A option)	None reported	None reported	Narrow	Benton, Downey, Glider, & Benton (2008)
PSQ	16	7-point C	None reported	None reported	Narrow	Palmer, McMahon, Rounsaville, & Ball (2010) Palmer, Corbin, & Cronce (2010)
PSQ	10	7-point C	None reported	EFA and CFA	Narrow	DeMartini, Palmer, Leeman, Corbin, Toll, Fucito, & O'Malley (2013)
PBSM	17	5-point C	Since arriving on campus	EFA and CFA	Broad	Novik & Boekeloo (2011) Pearson, Kite, & Henson (2012a)
PBSM	12	5-point C	Since arriving on campus	EFA	Narrow	D' Lima, Pearson, & Kelley (2012)
SQ	21	6-point absolute (A)	Past 2 weeks	EFA and CFA	Broad	Pearson, Kite, & Henson (2012a) Sugarman & Carey (2007) Sugarman & Carey (2009)
SQ	21	6-point C	None reported	None reported	Broad	Kite, Pearson, & Henson (2013) Pearson & Henson (2013)
SQ	21	6-point A	Past 3 months	None reported	Broad	Kite, Pearson, & Henson (2013)
SCQ	37	4-point C	None reported	EFA	Broad	Werch & Gorman (1986) Werch & Gorman (1988)
SCQ	14	5-point C	None reported	None reported	Broad	Werch (1990)
SCQ	22	5-point C	None reported	None reported	Broad	Barnett, Murphy, Colby, & Monti (2007)
None	16	5-point C	None reported	EFA	Narrow	Ray, Turrisi, Abar, Peters (2009) Ray, Stapleton, Turrisi, & Philion (2012)
None	7	5-point C	Past year	CFA	Narrow	Borden, Martens, McBride, Sheline, Bloch, & Dude (2011)
None	6	5-point true	None reported	None reported	Narrow	Luebke, Varvel, & Dude (2009)
None	12	7-point C	None reported	EFA	Narrow	Nguyen, Walters, Wyatt, & DeJong (2011)

Note. PBSS = Protective Behavioral Strategies Survey, NCHA = National College Health Assessment; CAS = College Alcohol Survey; PSQ = Protective Strategy Questionnaire; PBSM = Protective Behavioral Strategies Measure; SQ = Strategy Questionnaire; SCQ = Self-Control Questionnaire. Bolded studies reflect the studies that reported some form of factor analysis (includes principal components analysis, exploratory factor analysis, and confirmatory factor analysis). Underline studies reflect the scale development paper.