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# Planning limits or inhibiting risky alcohol consumption? Towards a deeper understanding of Protective Behavioral Strategies in students through factorial and latent profile analyses

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## ABSTRACT

**Objective:** Protective Behavioral Strategies (PBS) are cognitive-behavioral strategies that are promising to reduce risky alcohol consumption and binge drinking (BD) among students. This research investigates 1) the multidimensional nature of PBS by establishing a stable typology, assessing variations in PBS effectiveness, and 2) psychosocial risk factors influencing PBS use.

**Methods:** Two complementary studies were conducted among university students ( $N_{S1} = 1252$ ;  $N_{S2} = 896$ ). In both, factorial structure and gender invariance of PBS were tested. Study 1 used a variable-centered approach with multivariate regression models to assess the links between PBS types, drinking outcomes, and psychosocial determinants. Study 2 applied a person-centered approach, utilizing a latent profile analysis to identify distinct profiles of PBS users and non-users based and their characteristics in terms of PBS utilization, psychological determinants, and alcohol-related outcomes.

**Results:** Firstly, both studies confirmed the four-type PBS typology and demonstrated gender invariance. Secondly, certain PBS types, such as modification of drinking practices (MOD) and planning consumption limits (PLD), were the most protective against risky drinking behaviors but were the less utilized. Thirdly, profiles combining all four PBS types showed the lowest risk, though they comprise a minority of students. Fourthly, psychosocial determinants, particularly drinking identity, inhibited MOD and PLD use.

**Conclusions:** Findings highlight the value of a multidimensional PBS framework. Interventions should target diversity in PBS strategies and address psychosocial barriers to promote effective use, offering new insights for reducing excessive drinking among students.

## 1. Introduction

Despite prevention campaigns, alcohol consumption and binge drinking (BD) are widespread among students. BD characterized by rapid and intense intoxication (Gierski et al., 2018), and a threefold increase in alcohol use disorders (AUD) among 18–25-year-olds (Bonnaire et al., 2021). Given its personal, social, and academic risks (e.g., Townshend et al., 2014), BD remains a public health concern. In this perspective, Protective Behavioral Strategies (PBS) have emerged as possible promising self-control techniques to reduce alcohol intake, including BD, and related consequences (Grazioli et al., 2015; Pearson, 2013). However, these associations are mostly based on correlational

studies (Prince et al., 2013), and interventions aiming to increase PBS use have shown mixed efficacy in reducing alcohol consumption (e.g., LaBrie et al., 2015; Sugarman and Carey, 2009; Peterson et al., 2021). Yet, a major limitation is treating PBS as unidimensional, despite evidence of distinct PBS dimensions with varying use (Treloar et al., 2015). Yet, the exact number and nature of PBS remain unclear (e.g., Grazioli et al., 2019) and understanding their multidimensionality may be essential for more effective prevention. This research aims to clarify PBS structure among students, examine usage and alcohol-related consequences differences, and investigate whether psychosocial determinants of consumption inhibit the use of certain PBS.

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### 1.1. PBS dimensions

PBS are defined as cognitive-behavioral strategies that individuals can implement before and/or during drinking (Arterberry et al., 2013; Schwebel et al., 2021). Generally, PBS are categorized into three categories: stopping/limiting drinking (SLD), modifying drinking behavior (MOD), and reducing serious harm associated with drinking (SHR) (Martens et al., 2007; Treloar et al., 2015). However, some studies suggest a more nuanced four-strategy model, splitting SLD into two distinct categories: planning limits on drinking (PLD) and mixing alcoholic with non-alcoholic drinks (MIX) (Grazioli et al., 2019). While data-driven, this distinction is easily theoretically justified, as PLD and MIX strategies involve fundamentally different behaviors. Further, literature suggests that PBS dimensions may vary by gender (Blanchard et al., 2021): three categories in female samples (Walters et al., 2007) and four in male samples (Grazioli et al., 2019; Walters et al., 2007). However, these studies do not directly test gender-related factorial differences (i.e., measurement invariance), and additional data are needed given their limited number. This research first aims to clarify whether PBS is best described by three or four dimensions while testing measurement invariance across genders. Clarifying a stable and coherent PBS dimensionality is essential, as various PBS categories may differ in effectiveness and frequency of use among students.

### 1.2. PBS different objectives and alcohol-related consequences

PBS were originally conceptualized to serve two purposes: (1) reduce/control alcohol consumption and (2) limit its negative consequences (Martens et al., 2005). Indeed, frequent PBS use has been associated with lower alcohol consumption, heavy drinking episodes and alcohol-related problems (Araas & Adams, 2008; Benton et al., 2004). However, different PBS categories may contribute to these goals in different ways. For example, SHR strategies (e.g., use a designated driver) may be more closely linked to reducing negative consequences, while PLD strategies (e.g., set a maximum number of drinks) may be more directly aimed at controlling alcohol intake. Consequently, understanding the multidimensionality of PBS by differentiating them based on their effectiveness in reducing consumption or mitigating consequences is essential for guiding more targeted prevention interventions.

### 1.3. PBS and psychosocial determinants of consumption

Despite their potential, PBS remain underutilized by students, with a usage varying depending on strategy (Dekker et al., 2018). For instance, SHR strategy seems to be used more frequently than MOD or PLD (Treloar et al., 2015). Thus, commonly used PBS are associated with reducing consequences, while the less used are aligned with limiting consumption. This discrepancy in use may stem from psychological determinants of alcohol use and BD, which may conflict with PBS targeting consumption reduction but not—or less—with harm reduction strategies.

Student alcohol consumption, particularly BD, is inherently social (Maurage et al., 2020). While individual factors have been identified, recent research highlights psychosocial predictors of BD and alcohol use in young adults (Bakkali et al., 2023; Mange et al., 2021), including drinking social identity (i.e., how strongly individuals view themselves as drinkers), social norms (i.e., perceived propensity of close relations to approve or engage in alcohol consumption), and some drinking motives (i.e., reasons to drink, namely as social and enhancement). Beyond refining the PBS dimensionality, our research explores the psychosocial determinants of alcohol use as potential barriers to PBS adoption. Differentiating PBS dimensions based on their risk factors is crucial for developing more effective interventions to promote PBS.

### 1.4. Research overview

This research aims to provide a deeper understanding of the multi-dimensional nature of PBS among students by: (1) establishing a stable and data-relevant PBS factorial structure, (2) exploring whether these dimensions vary in their use and effectiveness in reducing consumption or mitigating its negative consequences, and (3) investigating the role of psychosocial determinants of alcohol use as risk factors for PBS utilization.

We addressed our first objective by testing the PBS factorial structure and its gender invariance in two studies. To address our second and third objectives in a comprehensive and innovative manner, we employed a variable-centered approach (Study 1) and a person-centered approach (Study 2). Study 1 employed multivariate regression models to assess (1) the specific links between PBS dimensions and both consumption and alcohol-related outcomes (risk of AUD, BD practice and consequences), and (2) the specific links between drinking psychosocial determinants (social norms about consumption, motivations to drink and drinker social identity) and PBS dimensions. Study 2 used latent profile analysis (LPA) to identify, for the first time, distinct profiles of PBS users and non-users, related to their psychological characteristics (alcohol use determinants) and protective roles (alcohol-related outcomes).

## 2. Study 1

### 2.1. Method

#### 2.1.1. Participants

The participants were 1,252 volunteer university students<sup>1</sup> who received the questionnaire link through the university's mailing list (see Supplementary Material A.1. for the inclusion process). Participants, aged 18–34 years ( $M = 20.19$ ,  $SD = 2.34$ ), included 818 women and 434 men. All had consumed alcohol at least once in the past 12 months and completed entirely the PBS scale.

#### 2.2. Material and measures

All items are available online at [https://osf.io/hm8nx/?view\\_only=c882b46c157f456ca0a6d1600a06325b](https://osf.io/hm8nx/?view_only=c882b46c157f456ca0a6d1600a06325b).

#### 2.3. Protective Behavioral strategies use

The PBSS-20 (Protective Behavioral Strategies Scale, Grazioli et al., 2019) is a 20-item scale validated in French that assesses PBS use in the past year. Participants rated each item on a 6-point Likert scale (1 = "Never", 6 = "Always") to indicate how often they typically use each strategy when drinking alcohol. Mean scores will be computed for each dimension identified in the subsequent factorial analyses.

#### 2.4. Alcohol: Drinking practices and consequences

Risky alcohol consumption was assessed using the French version of the Alcohol Use Disorders Identification Test (AUDIT; Gache et al., 2005;  $\alpha = 0.805$ ). This 10-item tool identifies excessive alcohol consumption and the risk of developing an AUD (Babor et al., 2001).

A BD score was calculated (Townshend and Duka, 2002), accounting for drinking intensity (Q1; average number of standard drinks consumed per hour), frequency of drunkenness (Q2; number of times the individual has been drunk over a specific period), and proportion of drunkenness (Q3, percentage of drinking occasions that led to drunkenness). The

<sup>1</sup> Response rate (10.95%) and ratio between completed response and included participants (34.29%) were similar to previous studies carried out among college students (e.g., Ehret et al., 2013; Lannoy et al., 2020; Mauduy et al., 2023; Neighbors, et al., 2006).

score is calculated as follows:  $(4 \times Q1) + Q2 + (0.2 \times Q3)$  (Mange et al., 2021).

Negative consequences of alcohol consumption in the past year were measured with the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ; Kahler et al., 2005; 24 items,  $\alpha = 0.851$ ).

### 2.5. Psychosocial variables related to alcohol use

Drinking motivations were assessed using the Drinking Motives Questionnaire-Revised (DMQ-R; Cooper, 1994; 12 items), identifying social ( $\alpha = 0.857$ ), coping ( $\alpha = 0.880$ ), enhancement ( $\alpha = 0.766$ ), and conformity ( $\alpha = 0.852$ ) motives.

Drinking social norms were assessed with six items ( $\alpha = 0.737$ ). Three measured injunctive norms (perceived approval of excessive drinking by peers), other measured descriptive norms (perceived frequency of excessive drinking among peers) (Borsari & Carey, 2001).

Drinking social identity was assessed with two items (Mange et al., 2021;  $r = 0.392$ ), measuring the extent to which participants perceived alcohol consumption as part of their identity and self-concept.

### 2.6. Statistical analyses

#### 2.6.1. Internal structure analyses of PBSS-20

To determine the most accurate PBS dimensionality, exploratory (EFA) and confirmatory factor analyses (CFA) were conducted using JASP 0.16.4 (JASP Team, 2022). EFA used Maximum Likelihood with Promax rotation. The retained model was determined via scree plot. CFA used Diagonally Weighted Least Squares estimation. Model fit was assessed with CFI/TLI  $\geq 0.95$  and RMSEA  $\leq 0.05$  indicating good fit (Boateng et al., 2018), while CFI/TLI  $\geq 0.90$  and RMSEA  $\leq 0.08$  were still acceptable (Brown, 2006).

#### 2.6.2. Gender invariance for PBSS-20 internal structure

Multigroup CFAs (using the lavaan package; Rosseel, 2012, in R Studio 2023.06.0; RStudio Team, 2020) tested gender measurement invariance on the identified model through three nested models: configural, metric, and scalar invariance, compared sequentially (Steenkamp & Baumgartner, 1998). Invariance was assessed using CFI and RMSEA thresholds (Boateng et al., 2018; Cheung & Rensvold, 2002), with CFI differences  $\leq 0.010$  and RMSEA differences  $\leq 0.015$  between models (Mauduy et al., 2023). The  $\chi^2$  difference test (DIFFTEST) procedure was also applied due to WLSMV estimation, requiring non-significance (Asparouhov & Muthén, 2006), though cautiously interpreted due to sample size sensitivity ( $N > 300$ ; Chen, 2007). Invariance is supported if at least one criterion is met: non-significant  $\chi^2$  difference, CFI<sub>diff</sub>  $\leq 0.010$ , or RMSEA<sub>diff</sub>  $\leq 0.015$  (Mauduy et al., 2023).

#### 2.6.3. Difference in PBS dimensions

First, a repeated measure analysis of variance (ANOVA) using Jasp 0.16.4 (JASP Team, 2022) were performed with PBS factors (within-subjects) and gender (between-subjects) as independent variables, allowing to assess (1) overall differences in use across PBS dimensions, (2) differences in overall PBS use between men and women, and (3) whether the frequency of PBS use across dimensions varied by gender. Second, two multivariate analyses (lavaan package; Rosseel, 2012) were conducted, one to examine the effects of PBS factors on alcohol-related consequences and consumption indicators, and one to assess the effect psychosocial and sociodemographic variables on each PBS factor.

### 2.7. Results

#### 2.7.1. Internal structure analyses of PBSS-20

In the 20 original items included in the EFA, three (i.e., “avoid combining alcohol with marijuana” and “eat before or during drinking” initially in SHR strategy and “put extra ice on your drink” in the MIX

subscale of SLD scale) did not load adequately on any factor (less than 0.30; Boateng et al., 2018). The remaining 17 items aligned with their respective factors, loadings ranging from 0.317 to 1.025, supporting a 4-factor model. Factor correlations ranged from 0.458 to 0.582. We then tested this 4-factor solution in a CFA ( $\chi^2 = 404.772$ ,  $df = 113$ ; CFI = 0.988, TLI = 0.986, RMSEA = 0.047, 90 %CI [.042, 0.051]), which indicate satisfactory fit indices (Boateng et al., 2018). Due to the existence of a 3-factor solution in the literature (Treloar et al., 2015), we also tested it. It fits the data worse ( $\chi^2 = 1472.760$ ,  $df = 167$ ; CFI = 0.953, TLI = 0.946, RMSEA = 0.081, 90 %CI [.078, 0.085]). Thus, we considered the four-factor model as the optimal solution to fit the data, which partitioned PBS consistently with the proposal of Grazioli et al. (2019) into: serious harm reduction strategies (SHR), mixing nonalcoholic drinks with alcohol strategies (MIX), modifying the manner of drinking (MOD) and planned limits on drinking strategies (PLD). Factor loadings and internal consistencies are shown in Table 1.

#### 2.7.2. Gender invariance for PBSS-20 internal structure

Configurational ( $\chi^2 = 506.815$ ;  $df = 226$ , CFI = 0.959; RMSEA = 0.059, 90 %CI [.054, 0.064]), metric ( $\chi^2 = 539.392$ ;  $df = 239$ , CFI = 0.967; RMSEA = 0.052, 90 %CI [.047, 0.057]), and scalar invariance ( $\chi^2 = 707.941$ ;  $df = 303$ , CFI = 0.952; RMSEA = 0.056; 90 %CI [.051, 0.060]) all showed good fit for the 4-factor, 17-item model. No significant difference appeared between configural and metric models ( $\chi^2$ diff = 14.892, CFI<sub>diff</sub> = 0.008; RMSEA<sub>diff</sub> = 0.007). Although metric and scalar models showed a significant difference, suggesting lack of partial measurement invariance, RMSEA difference remained

**Table 1**  
Standardized Factor Loadings (Standard Errors).

Item	Study 1	Study 2
<b>Manner of Drinking (MOD)</b>	<b><math>\alpha = 0.764</math></b>	<b><math>\alpha = 0.740</math></b>
5. Avoid drinking games	0.625 (0.040)	0.624 (0.052)
18. Avoid mixing different types of alcohol	0.673 (0.040)	0.638 (0.050)
19. Drink slowly, rather than gulp or chug	0.659 (0.037)	0.577 (0.050)
11. Avoid “pre-gaming”	0.578 (0.046)	0.584 (0.057)
20. Avoid trying to keep up or drink-out others	0.646 (0.042)	0.630 (0.055)
<b>Serious Harm Reduction (SHR)</b>	<b><math>\alpha = 0.682</math></b>	<b><math>\alpha = 0.704</math></b>
1. Use a designated driver	0.342 (0.056)	0.410 (0.069)
8. Make sure that you go home with a friend	0.631 (0.050)	0.602 (0.056)
9. Know where your drink has been at all times	0.495 (0.056)	0.554 (0.065)
6. Only go out with people you know and trust	0.490 (0.044)	0.593 (0.063)
12. Refuse to ride in a car with someone who has been drinking	0.448 (0.049)	0.450 (0.072)
14. Make sure you drink with people who can take care of you if you drink too much	0.689 (0.051)	0.678 (0.060)
<b>SLD: Planned Limits on Drinking subscale (PLD)</b>	<b><math>\alpha = 0.719</math></b>	<b><math>\alpha = 0.697</math></b>
2. Determine not to exceed a set number of drinks	0.706 (0.040)	0.654 (0.053)
4. Have a friend let you know when you have had enough to drink	0.485 (0.051)	0.437 (0.061)
7. Leave the bar/party at predetermined time	0.628 (0.043)	0.610 (0.055)
13. Stop drinking at predetermined time	0.730 (0.042)	0.753 (0.048)
<b>SLD: Mixing Non-alcoholic drinks with Alcohol subscale (MIX)</b>	<b><math>\alpha = 0.851</math></b>	<b><math>\alpha = 0.833</math></b>
3. Alternate alcoholic and non-alcoholic drinks	0.730 (0.041)	0.873 (0.054)
15. Drink water while drinking alcohol	0.795 (0.044)	0.812 (0.060)

Note. SLD = Stopping/Limiting Drinking subscale. Study 1: 1,252 participants; Study 2: 896 participants.

acceptable ( $\chi^2_{diff} = 265.828$ ,  $CFI_{diff} = 0.015$ ;  $RMSEA_{diff} = 0.004$ ), supporting gender invariance for loadings and intercepts (see Supplementary Material A.2.). Men and women therefore have a similar understanding of the different PBS factors.

### 2.7.3. Difference in use of PBS dimensions

The ANOVA confirmed significant differences of use between PBS dimensions regardless of gender;  $F(3, 2685) = 992.095$ ,  $p < 0.001$ ,  $\eta^2_p = 0.270$ . As depicted in Fig. 1 and confirmed by Bonferroni post-hoc tests, PBS SHR was the most widely used ( $M = 5.039$ ,  $SD = 0.853$ ), PBS PLD was the least used ( $M = 2.970$ ,  $SD = 1.206$ ), and PBS MIX ( $M = 4.291$ ,  $SD = 1.464$ ) and MOD ( $M = 3.624$ ,  $SD = 1.140$ ) were moderately used (on a 6-point scale, 1 = “Never”, 6 = “Always”). The analysis also revealed a significant interaction between PBS factors and gender ( $F(1, 1250) = 47.0$ ,  $p < 0.001$ ), indicating that men reported significantly lower use than women across all four PBS dimensions (see Supplementary Material A.3. for post-hoc comparisons across PBS dimensions and A.4. for gender-specific differences within each PBS dimension).

### 2.7.4. Effects of each PBS dimensions on alcohol-related outcomes

MOD strategies are the most strongly linked to all variables, showing a significant impact on AUDIT (22 % of the variance explained compared to the 30.9 % explained by all the four PBS), BD (22.6 % of variance explained compared to 28.4 %), and consequences (21.4 % of variance explained over 28.9 %). Moreover, SHR and MIX strategies had small negative links across most variables, while PLD strategies showed no significant link. In summary, MOD, followed by SHR strategies, demonstrate the strongest protective effects against risky consumption and its outcomes (see Table 2 for all statistics).

### 2.7.5. Psychosocial and sociodemographic correlates of each PBS

MOD strategies are the most predicted ( $R^2 = 0.348$ ), showing small to moderate negative associations with norms, drinking social identity, social and enhancement motives and a positive association with age. PLD strategies ( $R^2 = 0.185$ ) are also negatively predicted by norms, drinker identity, and coping and enhancement motives. SHR strategies ( $R^2 = 0.186$ ) are negatively associated with drinker identity, social, coping and enhancement motives, and age. Lastly, MIX strategies are the less predicted ( $R^2 = 0.107$ ) and only show negative links with drinking social identity and social motives (see Table 3 for statistical details).

## 2.8. Discussion

This first study helped establish the PBS factorial structure most

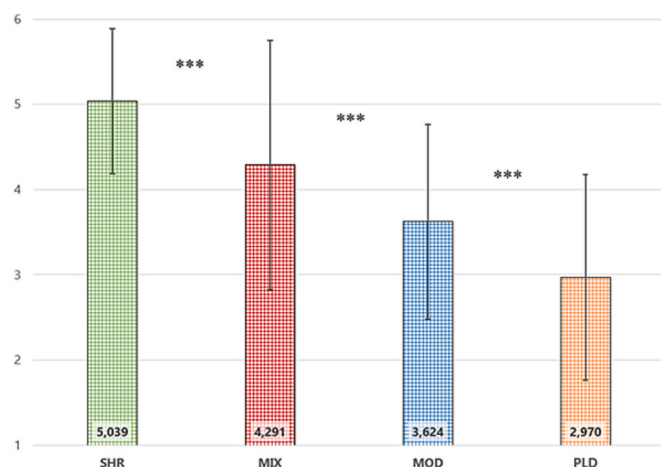


Fig. 1. Mean frequency of use for each PBS dimension ( $\pm$  standard deviation), across all participants, in Study 1. Note. Reported means are raw means computed from scores on a 6-point response scale. \*\*\*  $p < .001$

suitable for both sexes, despite the various PBSS-20 factorial models proposed to date (e.g., Grazioli et al., 2019). The four-factor model demonstrated excellent fit indicators, encompassing SHR, MIX, PLD and MOD strategies. However, three items related to consuming alcohol with ice, food, or marijuana were excluded due to poor factor loadings as they did not load on a fifth factor.

Further, a variable-centered approach highlights the differing protective roles of PBS in relation to alcohol-related outcomes and psychosocial determinants. While the most frequently used strategies (SHR and MIX) and the least-used strategies (especially MOD) are associated with reduced negative consequences and risky alcohol consumption, MOD and PLD appear to be more broadly shaped by psychosocial factors, with their use decreasing as drinking norms, motives, and drinking social identity strengthen. In complement, if SHR is also influenced by gender and drinker identity, the overall number of significant psychosocial predictors was lower, highlighting the differing mechanisms through which individuals might adopt these strategies. Given the multidimensional nature of PBS and their varied outcomes and correlates, identifying optimal PBS combinations use, through a person-centered approach that emphasize by who and how the different dimensions of PBS are used, could improve their effectiveness. Thus, Study 2 aims to address this point, while also limiting the risk of inflated cross-validation from Study 1 by replicating, on an independent sample, the four-factor PBS dimensionality to confirm its stability.

## 3. Study 2

### 3.1. Method

#### 3.1.1. Participants

The inclusion process and criteria were the same as in Study 1, leading to 896 participants aged 18–34 years ( $M = 20.40$   $SD = 2.36$ ), with 553 women and 343 men.

#### 3.1.2. Material and measures

The material was identical to that employed in Study 1 (see Supplementary Material A.5), except for the assessment of drinking social identity, supplementing the previous 2 items with 3 others concerning the importance of alcohol consumption in defining one's personality and in daily life (Bakkali et al., 2023;  $\alpha = 0.923$ ).

### 3.2. Statistical analyses

#### 3.2.1. Internal structure of PBSS-20 and gender invariance

Using the same methods as in Study 1, a CFA has been performed to confirm the fit and accuracy of the 4-factor model and gender invariance.

**3.2.1.1. Profiles of PBS users.** LPA with posterior probabilities (i.e., the probability of profile membership) was conducted using Mplus 8.11 (Muthén & Muthén, 2017) to identify profiles based on the four PBS use. Model selection was based on Akaike's Information Criterion (AIC; Akaike, 1987) and Bayesian Information Criterion (BIC; Schwarz, 1978). Higher entropy values ( $>0.80$ ) indicated better classification accuracy (Celeux & Soromenho, 1996).

**3.2.1.2. Differences between profiles.** To determine the differences in consumption variables, in outcomes and in socio-psychological and sociodemographic between the different profiles, ANOVAs were conducted within a single model incorporating posterior probabilities to account for classification uncertainty (Vermunt, 2010).

**Table 2**

Summary of the results:  $\beta$  [lower CI; upper CI] of the multivariate regression analysis calculated on consumption outcomes with the PBSS-20 subscale (17 items) as predictors (Study 1).

	AUDIT	BD score	Consequences total score (BYAACQ)
Protective Behavioral Strategies (PBS)			
SHR	-0.163*** [-1.436; -0.620]	-0.167*** [-6.954; -2.364]	-0.180*** [-1.182; -0.571]
MIX	-0.162*** [-0.789; -0.396]	-0.089** [-2.379; -0.507]	-0.136*** [-0.543; -0.230]
MOD	-0.363*** [-2.000; -1.426]	-0.378*** [-9.019; -6.731]	-0.274*** [-1.612; -1.188]
PLD	-0.024 [-0.329; 0.114]	-0.033 [-1.633; 0.327]	0.034 [-0.0540; 0.291]
<b>Total R-square value explained by PBS</b>	<b>0.309</b>	<b>0.284</b>	<b>0.289</b>

Note. *B* is the standardized estimate.

\*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ .

**Table 3**

Summary of the results:  $\beta$  [lower CI; upper CI] of the multivariate regression analysis calculated on consumption determinants with the PBSS-20 subscale (17 items) as outcomes (Study 1).

	SHR	MIX	MOD	PLD
<b>Sociodemographic variables</b>				
Age	-0.089** [-0.052; -0.008]	0.033 [-0.018; 0.056]	0.184*** [0.059; 0.108]	-0.059† [-0.060; 0.001]
Gender (women = -0.5; men = 0.5)	-0.264*** [-0.581; -0.346]	-0.003 [-0.210; 0.192]	-0.062* [-0.284; -0.011]	-0.065* [-0.323; -0.012]
<b>Subjective social norms</b>				
Descriptive norms	-0.047 [-0.090; 0.016]	-0.058 [-0.172; 0.015]	-0.039 [-0.116; 0.034]	-0.034 [-0.126; 0.048]
Injunctive norms	0.008 [-0.039; 0.050]	0.017 [-0.062; 0.100]	-0.072* [-0.122; -0.005]	-0.107** [-0.173; -0.032]
<b>Social identity</b>				
Drinker social identity	-0.125** [-0.128; -0.025]	-0.102** [-0.188; -0.028]	-0.081* [-0.121; -0.012]	-0.099** [-0.150; -0.027]
<b>Motivations to drink (DMQ-R)</b>				
Social	-0.097* [-0.047; -0.000]	-0.178*** [-0.117; -0.033]	-0.159*** [-0.081; -0.024]	-0.060 [-0.055; 0.012]
Coping	-0.089* [-0.045; -0.003]	-0.062 [-0.063; 0.006]	-0.037 [-0.036; 0.009]	-0.074* [-0.055; -0.004]
Enhancement	-0.094* [-0.047; -0.000]	-0.075 [-0.073; 0.009]	-0.339*** [-0.141; -0.087]	-0.242*** [-0.123; -0.054]
Conformity	0.025 [-0.015; 0.032]	0.060 [-0.005; 0.076]	0.055 [-0.004; 0.056]	0.035 [-0.016; 0.052]
<b>Total R-square value explained by variables</b>	<b>0.186</b>	<b>0.107</b>	<b>0.348</b>	<b>0.185</b>

Note. *B* is the standardized estimate.

\*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ ; †  $p < 0.065$ .

### 3.3. Results

#### 3.3.1. Internal structure of PBSS scale and measurement invariance for gender

CFAs confirmed that the four-factor model exhibited a superior fit compared to the three-factor model (see factor loadings in Table 1). Fit indicators were good and confirmed the established model ( $\chi^2 = 386.369$ ,  $df = 113$ ; CFI = 0.982, TLI = 0.979, RMSEA = 0.053, 90 %CI [.047, 0.059]).

All forms of gender invariance—configurational ( $\chi^2 = 506.125$ ;  $df = 226$ , CFI = 0.939; RMSEA = 0.066, 90 %CI [.061, 0.072]), metric ( $\chi^2 = 556.830$ ;  $df = 239$ , CFI = 0.946; RMSEA = 0.061, 90 %CI [.055, 0.067]), and scalar ( $\chi^2 = 681.867$ ;  $df = 303$ , CFI = 0.930; RMSEA = 0.062, 90 %CI [.057, 0.067])—demonstrated acceptable fit. Despite significant differences between configurational and metric invariance in  $\chi^2$ , CFI and RMSEA differences remained acceptable (CFIdiff = 0.007; RMSEAdiff = 0.005). Regarding metric and scalar invariance, RMSEA difference remained acceptable (RMSEAdiff = 0.001), confirming that factor loadings and intercepts are invariant across gender.

#### 3.3.2. Profiles of PBS users

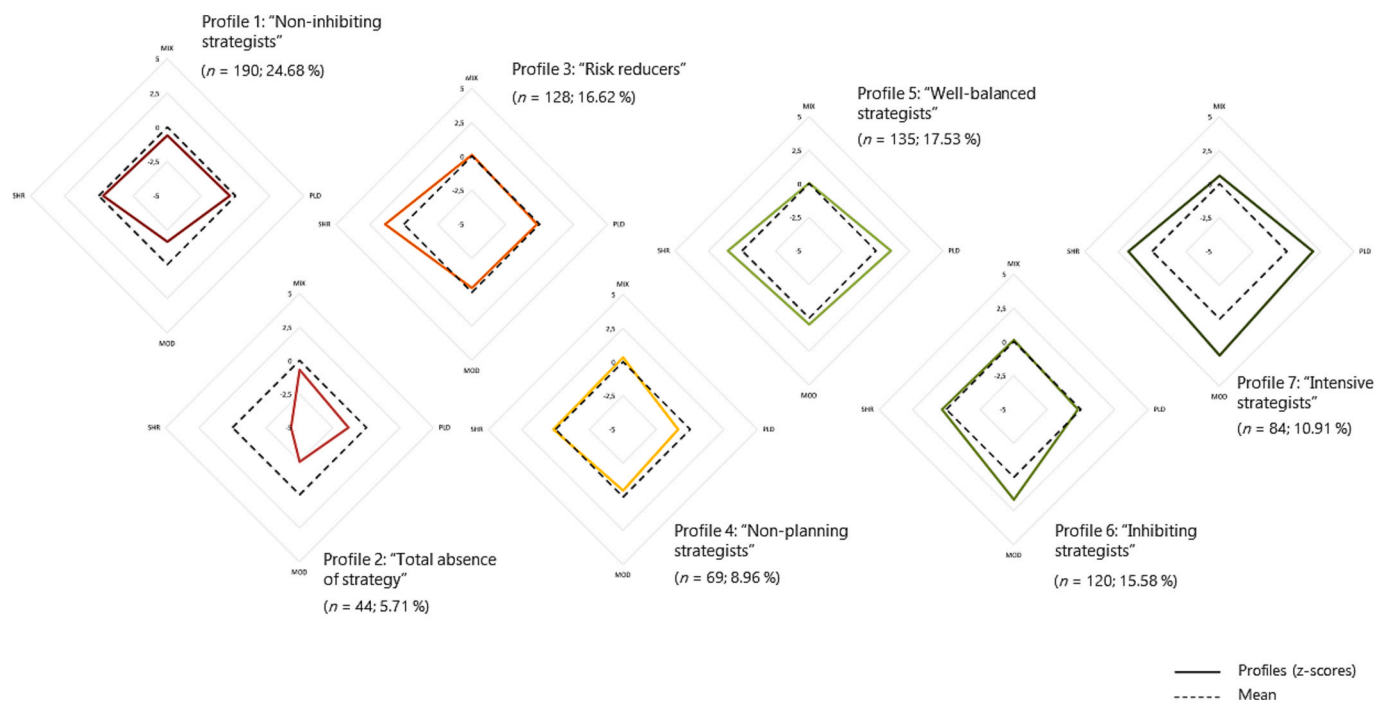
The LPA revealed a seven-profile optimal solution (AIC = 8736.154;

BIC = 9275.136, entropy = 0.795). These profiles, representing 5.71 % to 24.68 % of the sample (see Fig 2), reflect various SHR, MIX, MOD, and PLD strategy combinations. Fig 2 visualizes these profiles using radar plots of standardized means, highlighting distinct PBS usage patterns. The black line at 0 represents the reference point for average strategy use during consumption occasions. Profiles are defined and named based on whether their usage of each strategy is above or below this threshold, while also considering their relative differences, indicating either a notable reliance on a specific strategy or a relative underuse compared to the others.

For all details, variable means and comparisons across profiles, see Table 4.

#### 3.3.3. Differences in alcohol-related indicators between profiles

Despite some significant results (detailed comparisons between profiles are in Supplementary Materials A.6.), the pattern of mean comparisons across profiles did not support clear or theoretically interpretable differences, likely due to the influence of posterior probabilities on class assignment. Therefore, we will compare the profiles using descriptive analyses based on predefined cut-offs. Thresholds of AUDIT and BD scores indicate that profiles 1 and 2 are at risk of a use disorder (score > 8 indicates a misuse, >12 indicates alcohol



**Fig. 2.** The seven profiles of PBS users. *Note.* The seven profiles were determined according their pattern in PBS use, i.e., SHR (serious harm reduction); MIX (mixing alcohol and non-alcoholic drinks); MOD (modifying the manner of drinking) and PLD (planning limits on consumption).

dependence; Babor et al., 2001), profiles 5 to 7 are considered to be made up of light drinkers (Townshed & Duka, 2002) and profiles 1 to 3 are made up of binge drinkers (score < 16; while score > 24 indicates BD practice; Townshed & Duka, 2002). These associations lead us to consider profile 7 “intensive strategists” as the most protected profile, followed by profile 6 “inhibiting strategists” and profile 5 “well-balanced strategists”. The profiles identified as the most protected (i.e., 5 to 7) stand out for their use of MOD strategies as their standardized scores for this strategy are positive (i.e., above the threshold of zero).

### 3.3.4. Differences in psychosocial correlates between profiles

While low drinking norms are not strictly necessary for being a low-risk profile (e.g., profile 5 “well-balanced strategists” shows similar motives to profile 1 “non-inhibiting strategists”), low drinking motives characterize the most protected profile of intensive strategists. Conversely, high-risk profiles tend to report elevated scores on both motives and norms. Drinking social identity showed less consistent or less pronounced differences across profiles (see Supplementary Material A.6).

## 4. General discussion

This research aims to explore the multidimensional nature of PBS among students by establishing a stable PBS dimensionality, assessing its effectiveness in reducing alcohol use and consequences, and examining psychosocial risk factors for PBS utilization. Findings confirm the four-factors structure: (1) serious harm reduction (SHR), (2) mixing non-alcoholic drinks with alcohol (MIX), (3) modifying the manner of drinking (MOD; i.e., inhibiting risky consumption) and (4) planning limits (PLD). This division, previously theorized (Grazioli et al., 2019), is now established for both genders despite differences in drinking patterns (Blanchard et al., 2021). Women recurrently use PBS more than men (Taberbero et al., 2019; Walters et al., 2007) and SHR remains the most widely used PBS across genders, suggesting that risk-reduction campaigns (focusing on immediate consequences) have been effective in promoting these strategies. MOD and PLD, otherwise, remain the least-used strategies. Integrating variable- and person-centered approaches,

profiles of PBS (non-)users were established for the first time, revealing 1) that psychosocial determinants of alcohol consumption might be risk factors for non-use of certain PBS, and 2) that PBS protective role varies depending on whether they aim to reduce consumption or mitigate its outcomes. These whole results support the relevance of dividing the SLD strategy into two distinct strategies in understanding PBS: MIX and PLD have very different roles, uses and barriers. Beyond that dimensionality clarification, this research has two major implications.

First, the most commonly used strategies (SHR and MIX) show their strongest negative correlations with negative alcohol-related consequences and drinker identity, but remain insufficient to prevent risky drinking. These strategies, varying widely across profiles, are also employed by high-risk AUD and binge drinker profiles (e.g., profile 3, the “risk-reducers”).

Conversely, the least used strategies (MOD and PLD) are more characteristic of light drinkers with low-risk consumption. Differences in usage and protection may stem from psychological disincentives inherent to known determinants of alcohol use (i.e., social norms and motives; Mange et al., 2021). Such factors may inhibit the MOD and PLD use more than SHR, as these strategies conflict with students’ drinking motivations and goals. Thus, future research on PBS, which are described as self-control strategies (Arterberry et al., 2013), would benefit from the theoretical field of self-control (Fujita, 2011) to explore conflicts between PBS use and consumption motivations. According to this literature, MOD and PLD may conflict with other goals that students pursue (Inzlicht et al., 2020) or hold less value than the most widely used strategies (Berkman et al., 2017).

Second, LPA identified the most protective profile as those combining intensively all PBS dimensions. However, only few students effectively combine these strategies to mitigate excessive drinking, underscoring the need to promote broader PBS utilization. Profiling PBS use patterns enables targeted prevention efforts, emphasizing the importance of diversifying and employing strategies consistently. Interventions could, as a priority, address drinking motivations, which seems to be key factors linked in protected profiles, to promote greater use of PLD – and above all – MOD strategies. These strategies may be harder to adopt when drinking is strongly motivated by powerful goals,

**Table 4**  
Details concerning latent profiles analyses and mean comparisons between the seven strategists' profiles.

		1 <i>n</i> = 190; 24.68 %	2 <i>n</i> = 44; 5.71 %	3 <i>n</i> = 128; 16.62 %	4 <i>n</i> = 69; 8.96 %	5 <i>n</i> = 135; 17.53 %	6 <i>n</i> = 120; 15.58 %	7 <i>n</i> = 84; 10.91 %	
		<b>Non-inhibiting strategists</b>	<b>Total absence of strategy</b>	<b>Risk reducers</b>	<b>Non-planning strategists</b>	<b>Well-balanced strategists</b>	<b>Inhibiting strategists</b>	<b>Intensive strategists</b>	
	min-max	Mean ( <i>SD</i> )	Mean ( <i>SD</i> )	Mean ( <i>SD</i> )	Mean ( <i>SD</i> )	Mean ( <i>SD</i> )	Mean ( <i>SD</i> )	Mean ( <i>SD</i> )	Comparisons
<b>Protective Behavioral Strategies' use</b>									
SHR	1.000 – 6.000	4.369 (0.117)	2.192 (0.341)	5.274 (0.073)	4.624 (0.336)	5.091 (0.157)	4.696 (0.127)	5.475 (0.076)	
MIX	1.000 – 6.000	3.255 (0.157)	3.072 (0.500)	4.476 (0.165)	4.858 (0.243)	4.340 (0.197)	4.484 (0.137)	5.335 (0.100)	
MOD	1.000 – 6.000	2.559 (0.078)	2.095 (0.232)	3.332 (0.133)	3.237 (0.146)	3.797 (0.154)	4.487 (0.182)	5.085 (0.101)	
PLD	1.000 – 6.000	2.314 (0.110)	1.574 (0.121)	2.509 (0.220)	1.928 (0.163)	3.568 (0.169)	2.484 (0.109)	4.253 (0.177)	
<b>Sociodemographic variables</b>									
Age	18.000 – 34.000	19.589 (0.134)	21.955 (0.403)	20.362 (0.175)	19.583 (0.222)	19.586 (0.155)	22.991 (0.337)	19.857 (0.209)	1 < 2 = 3 = 4 = 5 = 6 > 7
Gender (female = -0.5; male = 0.5)	0.009 (0.073)	0.479 (0.133)	-0.749 (0.058)	0.349 (0.116)	-0.342 (0.080)	-0.295 (0.086)	-0.635 (0.086)	1 > 2 = 3 < 4 = 5 = 6 = 7	
<b>Social norms about consumption</b>									
Injunctive norms	1.000 – 7.000	5.721 (0.066)	5.217 (0.157)	5.543 (0.092)	5.436 (0.137)	5.238 (0.092)	5.453 (0.112)	5.075 (0.144)	1 > 2 = 3 = 4 = 5 = 6 = 7
Descriptive norms	1.000 – 7.000	5.901 (0.059)	5.403 (0.138)	5.962 (0.076)	5.789 (0.106)	5.404 (0.089)	5.526 (0.091)	5.366 (0.121)	1 = 2 < 3 = 4 = 5 = 6 = 7
<b>Motivations to drink</b>									
Social	3.000 – 15.000	11.265 (0.157)	8.687 (0.479)	8.560 (0.224)	11.335 (0.215)	9.854 (0.195)	6.484 (0.245)	5.047 (0.206)	1 = 2 = 3 = 4 = 5 = 6 = 7
Coping	3.000 – 15.000	7.157 (0.243)	6.559 (0.527)	5.582 (0.229)	3.969 (0.204)	5.841 (0.229)	5.184 (0.254)	3.623 (0.151)	N/A
Enhancement	3.000 – 15.000	11.851 (0.120)	9.201 (0.534)	9.624 (0.205)	7.741 (0.343)	8.613 (0.216)	6.842 (0.233)	4.942 (0.188)	1 > 2 = 3 = 4 = 5 = 6 = 7
Conformity	3.000 – 15.000	5.602 (0.200)	4.248 (0.308)	4.159 (0.162)	4.360 (0.257)	4.814 (0.191)	4.617 (0.225)	3.362 (0.112)	1 > 2 = 3 = 4 = 5 = 6 > 7
<b>Drinker identity</b>									
Social identity	1.000 – 7.000	3.027 (0.122)	2.474 (0.251)	1.507 (0.067)	1.580 (0.107)	1.806 (0.085)	1.871 (0.113)	1.057 (0.017)	N/A
<b>Risky alcohol consumption</b>									
AUDIT – total scale	0.000 – 30.000	13.581 (0.457)	9.142 (0.942)	6.015 (0.302)	5.983 (0.410)	6.934 (0.346)	5.712 (0.387)	2.488 (0.134)	1 > 2 = 3 = 4 = 5 = 6 > 7
Binge drinking	1.320 – 192.000	44.2293 (1.878)	34.334 (4.672)	29.236 (1.905)	21.820 (1.802)	15.336 (0.835)	10.501 (0.699)	6.067 (0.494)	1 = 2 = 3 = 4 = 5 = 6 = 7
<b>Consumption consequences</b>									
Total score	0.000 – 24.000	9.532 (0.342)	6.944 (0.863)	4.570 (0.248)	5.056 (0.407)	5.473 (0.309)	3.278 (0.252)	1.063 (0.150)	1 = 2 = 3 = 4 = 5 = 6 = 7

Note. The report comparisons are those between the closest profiles; pairwise equalities may hide significant differences between more distant groups (details of post-hoc tests are provided in Table A.9. in the supplementary material). SD = standard deviation.

such as enhancement, social facilitation or coping. In contrast, some other variables, such as drinking norms and especially drinking social identity showed more variable associations, suggesting that their relevance as intervention targets may require further investigation. Combined findings from both variable- and person-centered approaches highlight MOD's specific protective role in reducing AUD risk and in preventing BD.

4.1. Limitations

Our research has several limitations. First, although the four-PBS structure showed good fit across both studies, the MIX strategy only comprises two items, which may weaken its reliability and validity. A broader item would better capture the construct and ensure stable measurement (Fabrigar et al., 1999; Costello & Osborne, 2005). Second, in Study 1, the CFA was conducted on the same sample used for the EFA, which may inflate the apparent model fit. However, this limitation is offset by the successful replication of the structure in an independent

sample in Study 2. Third, the correlational design prevents establishing causal relationships between variables. Experimental designs would allow for a more definitive assessment of the causal determinants of PBS, particularly in light of some inconsistent results, such as the role of drinker social identity between Study 1 and Study 2. Fourth, PBS profiles were derived from a single sample of university students, restricting the generalizability of our findings. Moreover, both the present study and Grazioli et al.'s (2015) four-factor solution were conducted in European contexts, whereas the original psychometric studies used US samples. It is possible that cultural differences in drinking norms and social contexts may influence PBS structure and usage. Future research should examine the stability of these profiles in various university settings and cultural contexts.

5. Conclusion

A key strength of this research is its dual approach, combining variable- and person-centered analyses to investigate the multidimensional

PBS concept. Despite confirming low PBS use among students, our findings highlight the efficacy of specific strategies, particularly when combined, in reducing alcohol consumption and related harms. Strategies like MOD and PLD characterize profiles with lower BD and AUD risks, while SHR and MIX strategies effectively minimize negative consequences. These results suggest that targeted interventions addressing drinkers' motives, especially for high-risk profiles, could significantly reduce risky behaviors by promoting more intensive and balanced PBS use.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT (GPT-4o mini version) in order to assist with the rephrasing of isolated sentences to improve their readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

## 6. Ethics

Both studies were notified and authorized by the "Comité Local d'Éthique de la Recherche" with the registration n°202411071713080000170000390. Participants were contacted by email between September and November 2021 (Study 1) and 2022 (Study 2) and invited to complete a computerized questionnaire using Limesurvey.

## CRedit authorship contribution statement

**Maelle Fleury:** Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Formal analysis, Conceptualization. **Maxime Mauduy:** Writing – review & editing, Visualization, Validation, Project administration, Methodology, Formal analysis, Conceptualization. **Jessica Mange:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Data availability statement

All materials have been made publicly available via the Open Science Framework and can be accessed at: [https://osf.io/hm8nx/?view\\_only=c882b46c157f456ca0a6d1600a06325b](https://osf.io/hm8nx/?view_only=c882b46c157f456ca0a6d1600a06325b).

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.addbeh.2025.108377>.

## Data availability

Data will be made available on request.

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