

RESEARCH ARTICLE



Applying the temporal self-regulation theory to understand sugar-sweetened beverage consumption among Chinese college students

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ABSTRACT

Objective: Worldwide, there is a growing trend that college students are consuming more and more sugar-sweetened beverages (SSBs). In order to develop effective intervention strategies, it is important to explore what social-cognitive factors impact on college students' SSB consumption. Building on the temporal self-regulation theory (TST), the current study aimed to examine the effects of intention, behavioral prepotency, and self-regulatory capacity on SSB consumption among college students.

Design: Data were collected from five hundred Chinese college students online. Participants self-reported their intention, behavioral prepotency (environmental cues and habits), self-regulatory capacity, and behaviors of SSB consumption.

Results: Study findings showed that intention, behavioral prepotency, and self-regulatory capacity accounted for 32.9% of variance in SSB consumption. In terms of the direct effects, intention, behavioral prepotency, and self-regulatory capacity were significantly associated with the SSB consumption among college students. In addition, self-regulatory capacity and habits but not the environmental cues showed significant moderation effects on the intention-SSB consumption path, indicating that individual factors rather than environmental cues influenced the intention-behavior path of SSB consumption among college students.

Conclusion: Findings of the current study demonstrated that the TST can be used to explain and understand the impacts of social-cognitive factors on college students' SSB consumption. Future research can apply TST to develop effective intervention programs targeting the reduction of SSB consumption among college students.



ARTICLE HISTORY

Received 31 October 2022

Accepted 19 April 2023

KEYWORDS

Sugar-sweetened beverages; SSB consumption; temporal self-regulation theory; intention; behavioral prepotency; self-regulatory capacity

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Sugar-sweetened beverages (SSBs) are non-alcoholic beverages with added caloric sweeteners, including soft drinks, cordials, energy drinks, sports drinks, fortified waters, and fruit and vegetable drinks (US Department of Health and Human Services and US Department of Agriculture, 2015). Currently, there is a growing trend of high SSB consumption worldwide and a major contribution from the population of adolescents and young adults (Della Corte et al., 2021; Gan et al., 2021; Singh et al., 2019). Indeed, college students tend to have particularly high SSB consumption rates (Bawadi et al., 2019; Huffman & West, 2007; West et al., 2006), with a mean contribution of SSBs to daily energy intake to be up to 480 kcal (Bawadi et al., 2019). Given that excessive SSB consumption can lead to various adverse health outcomes, including obesity, type 2 diabetes, cardiovascular diseases, and so on (Haque et al., 2020; Hu & Malik, 2010; Imamura et al., 2015; Keller & Della Torre, 2015; Woodward-Lopez et al., 2011), it is recommended that daily consumption of free sugars is limited to less than 10% of total daily energy intake, with approximately 50 grams or 12 teaspoons (World Health Organization, 2015). On the other hand, excessive SSB consumption can cause heavy public health burdens and it is an urgent task to find cost-effective solutions to overcome this SSB pandemic (Liu et al., 2022). An important approach is through providing theory-informed interventions to individuals, such as college students, to change their social cognitions on SSB consumption. Accordingly, key social-cognitive factors that are related to college students' SSB consumption should be examined in order to develop theory-based effective interventions.

Psychological theories have been used to explain and understand key social-cognitive factors related to SSB consumption (McAlpine & Mullan, 2022; Moran & Mullan, 2021; Zoellner et al., 2012). One of the most frequently used social-cognitive theories is the Theory of Planned Behavior (TPB; Ajzen, 1991), which states that intention is the strongest predictor of behavior, while intention to perform a particular behavior (e.g. SSB consumption) is determined by individual's attitude toward the action, subjective norm and perceived behavioral control. However, a key limitation of TPB and other motivational theories is that they focused on the motivational stage while the important volitional/self-regulatory stage was neglected (Fulham & Mullan, 2011; Sniehotta et al., 2005). For example, Liddelow, Mullan, et al. (2021) found that the TPB significantly was significantly associated with intention but not the actual behavior of medication adherence. On the other hand, the variance of behavior explained by intention is inconsistent, with a wide range of 0–27% (McAlpine & Mullan, 2022; McEachan et al., 2011; Moran & Mullan, 2021; O'Boyle et al., 2001; Rich et al., 2015). In terms of SSB consumption, even intention is a significant predictor of behavior, it can only account for 7–18% variance in behavior (McAlpine & Mullan, 2022; Moran & Mullan, 2021; Zoellner et al., 2012). This indicates a relatively large intention-behavior gap of SSB consumption. Nonetheless, intention serves as a good starting point to understand the behavior of SSB consumption among college students.

To address the problems related to the intention-behavior gap, temporal self-regulation theory (TST; Hall & Fong, 2007) was developed by including two post-intention factors (i.e. behavioral prepotency and self-regulatory capacity) that not only show direct effects on behaviors but also moderate the intention-behavior relations. Behavioral prepotency refers to the likelihood of performing a given behavior and can be dictated by internal biology drives, environmental cues, and past behavior (Hall & Fong, 2007).

However, there is a lack of unanimous operational definition of behavioral prepotency. For example, Black et al. (2017) measured three components (habits, environmental cues, and past behavior) of behavioral prepotency and then construct a composite score. In contrast, other researchers viewed these three components as three separate aspects of behavioral prepotency (e.g. Evans et al., 2017; McAlpine & Mullan, 2022; Moran & Mullan, 2021). Very recently, Liddelow, Mullan, et al. (2021) argued that past behavior is not an accurate measure of behavioral prepotency or automaticity since a high frequency of past behavior does not always mean the behavior is habitual. Accordingly, a more reasonable approach is that only habits and environmental cues should be used as key components of behavioral prepotency (Liddelow, Ferrier, et al., 2021).

Despite the inconsistency on how behavioral prepotency should be measured, Hall and Fong (2007) postulated that behavioral prepotency not only predicts behavior but also moderates the effect from intention to behavior. That is, higher levels of behavioral automaticity may require more conscious efforts to restrain ourselves from implementing the behavior. Accordingly, the intention-behavior relation could be weakened for individuals with higher level of behavior prepotency. Previous studies provided empirical support for the association between behavioral prepotency and various health-related behaviors, including SSB consumption (Booker & Mullan, 2013; McAlpine & Mullan, 2022; Moran & Mullan, 2021). For example, Moran and Mullan (2021) found that both environmental cues and habits showed direct effects on SSB consumption, while environmental cues significantly moderated the relationship between intention and SSB consumption among an Australian adults sample. In addition, McAlpine and Mullan (2022) found that behavioral prepotency variables (past behavior, habit, and cues) together explained 15.1% variance in undergraduate students' SSB consumption. Taken together, it seems that behavioral prepotency is an important moderator on the effect from intention to behavior of SSB consumption.

Self-regulatory capacity is another crucial variable that has a direct impact on behavior and moderates the effect from intention to behavior (Hall & Fong, 2007). Lower self-regulatory capacity can increase the occurrence of thoughtless behavior and also decrease the chances that people successfully transform their intention into behaviors. For example, intention to SSB consumption might be very low for individuals with high level of self-regulatory capacity under the condition of being able to effectively exert self-control. However, people with low level of self-regulatory capacity cannot exert effective self-control and therefore they can easily transfer their intentions to the unhealthy behavior of consuming SSBs (Hall & Fong, 2007). Previous studies found that self-regulatory capacity had direct effects on health-related behaviors, such as unhealthy snack consumption (Adriaanse et al., 2014), medication adherence (Liddelow, Mullan, et al., 2021), heavy episodic drinking (Black et al., 2017), parental snack, and beverage provision (Charlesworth et al., 2022) as well as SSB consumption (Wenzel et al., 2019). Nonetheless, there is a lack of empirical evidence on the moderation effect of self-regulatory capacity on the intention-SSB consumption.

Aims of the current study

Nowadays, unhealthy SSB consumption is common among Chinese college students with nearly half of Chinese college students consuming at least one bottle of sugar-sweetened

beverage daily (Xu et al., 2017). Building on the social-cognitive theory of TST, we therefore aimed to examine the effects of intention, behavioral prepotency, and self-regulatory capacity on SSB consumption among Chinese college students in the current study. In line with the proposal of TST (Hall & Fong, 2007), we also aimed to examine the moderation effect of behavioral prepotency and self-regulatory capacity on the intention-behavior path. Building on the theoretical proposal of TST (Hall & Fong, 2007) and findings of previous studies (Ames et al., 2016; McAlpine & Mullan, 2022; Moran & Mullan, 2021), four hypotheses were made in the current study: (a) intention is significantly and positively associated with SSB consumption among college students; (b) behavioral prepotency (environmental cues and habits) and self-regulatory capacity are significantly and positively associated with SSB consumption among college students; (c) behavioral prepotency significantly and positively moderates the effect from intention to SSB consumption, in which the effect from intention to SSB consumption is weakened when the behavioral prepotency is low; and (d) self-regulatory capacity significantly and negatively moderates the association between intention and SSB consumption, that is, the effect from intention to SSB consumption is weakened when the self-regulatory capacity is high.

Method

Participants and procedure

Data collection was conducted across two consecutive days at the end of December 2021. Participants were recruited through a third-party market research company Credamo. The Credamo has a nation-wide data base and can provide large-scale data collection services. Specifically, the Credamo platform sent a recruitment advertisement to potential participants who meet our requirement as current college students. Interested participants completed the online survey and returned their responses. It should be noted that anonymous participants in our study are valid and real users who have been certified by Credamo. Informed consent was provided to participants before they were allowed to complete the package of questionnaires online.

To ensure the data collected through Credamo is valid, exclusion criteria was also set. That is, responses were considered invalid when the time used for completing the whole package of questionnaires was less than 180s, which is the minimum time used when individuals simply just select response options without leaving time for thinking. In addition, responses were excluded if participants could not pass a screening item we set on purpose (i.e. participants were specifically asked to choose the number 5 in this item), which indicated that participants did not provide real and valid responses. Although initially, a total of 650 participants provided their responses, the pre-scheduled data collection ended at $n = 500$ as valid responses to be included for data analysis (77% of the total responses). Among the 500 participants who provided valid responses, $n = 352$ are females (70.4%), with the mean age of 21.58 years ($SD = 1.99$). Ethical approval for conducting this study was approved by the Institutional Review Board of the Department of Psychology, Sun Yat-Sen University [Ref: 2022-0627-0252]. The current study was also performed following relevant national and international ethical guidelines and regulations.

Measures

Demographics

Participants self-reported their gender, age, body weight, height, and subjective socioeconomic status (SES). SES was measured using a 10-level ladder on which participants indicated the level that can mostly represent the SES of their families. Higher level in the ladder indicates higher SES, namely, 10 with highest SES and 1 with lowest SES. The value of body mass index (BMI) was computed using participants' self-reported body weight and height.

Intention

Intention was measured using a three-item measure adapted from the intention scale of TPB questionnaire (Ajzen, 2002) adapted to the context of SSB consumption. The sample item was phrased like 'Drinking sugar-sweetened beverages every day is what you intend to do.' Participants were asked to rate on 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). Higher scores indicate a stronger intention. In the current study, the Chinese version measure of intention demonstrated an excellent internal consistency reliability with Cronbach's $\alpha = .934$.

Behavioral prepotency

Following the recommendation of Liddelow, Mullan, et al. (2021) that past behavior should not be treated as an accurate measure of behavioral prepotency, we measured environmental cues and habits as two components of behavioral prepotency. Behavioral prepotency was calculated as a sum index by summing up the scores of environmental cues score and habits (Hall & Fong, 2007). It should be noted that the environmental cues and habits can also be analyzed as two independent variables in the model.

Environmental cues. The Cues to Action Scale (CAS; Booker & Mullan, 2013) was used to measure environmental cues of SSB consumption across five domains that trigger behavior, including: physical, sensory, social, internal, and emotional cues. For each domain, participants were asked to rate on items like 'Are there any physical/sensory/social/internal/emotional cues in the environment which positively influence you to drink sugar-sweetened beverages?' Examples were provided on different domains, for example, physical cues: 'there is a store or supermarket downstairs, which is very convenient for you to buy a sugary drink'. Participants were indicated that if they answered 'No', they don't have to answer the follow-up questions on the frequency and possibility of experiencing those cues. Accordingly, their scores on the corresponding domain would be marked as zero. Participants were indicated that if they provided an answer 'Yes', they had to also provide responses on the frequency and possibility of experiencing those cues: 'How often do you experience these cues?' and 'How likely will you drink sugar-sweetened beverages after experiencing these cues?' Participants indicated their response on two 8-point Likert scales (1 = never/strongly disagree, 8 = a few times a day/strongly agree). To obtain the subscale score of each domain, the scores of frequency and possibility questions scores were then multiplied. The total environmental cues score was the average of all five subscales. Higher score of CAS indicates more types of cues participants experience and greater impacts of environmental cues on participants'

SSB consumption. The Chinese version CAS was translated and back-translated by the research team. In the current study, the CAS demonstrated a good internal consistency reliability with Cronbach's $\alpha = .843$.

Habits. Four items of the Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003), which are developed specifically to measure automaticity, were adapted for use in the context of SSB consumption. The SRHI for SSB consumption contains a stem statement like 'Drinking sugar-sweetened beverages every day is something ...' followed by four items ('It's very natural for me', 'I do without thinking', 'I do it unconsciously' and 'I don't need to remember to do it.') measured on 7-point Likert scale (1 = completely disagree, 7 = completely agree). Higher score of SRHI indicates stronger habit of SSB consumption. In the current study, the Chinese version of SRHI (Zhang et al., 2019) demonstrated an excellent internal consistency reliability with the Cronbach's $\alpha = .902$.

Self-regulatory capacity

The 13-item Brief Self-control Scale (BRS; Tangney et al., 2004) was used to measure college students' self-regulatory capacity in the context of SSB consumption. Sample items of BRS are 'I'm good at resisting temptation' or 'People around me think I have strong self-discipline' and it adopted a 5-point Likert scale (1 = completely disagree, 5 = completely agree). Higher scores indicate greater self-regulatory capacities. In the current study, the internal consistency reliability of the Chinese version BRS is acceptable, Cronbach's $\alpha = .891$.

Sugar-sweetened beverage consumption

In line with a previous study (Zhang et al., 2019), we used two items to measure college students' SSB consumption. For the first item, college students were asked to rate on 'Using past month as a reference, your frequency of drinking sugar-sweetened beverages is ... How many times a week/day on average' using the 7-point Likert scale (1 = less than once a week, 7 = more than three times a day). For the second item, college students were asked to indicate the volume of their SSB consumption 'If you drink sugar-sweetened beverages, how many cups (about 240 ml for one cup) do you drink each time?' using a 5-point Likert scale (1 = less than 180 ml; 5 = more than 600 ml). Scores on the two items were multiplied to obtain the total score of SSB consumption among participants.

Data analysis

Correlational and regression analyses were conducted using IBM SPSS Statistics 25. Descriptive statistics and bivariate correlations were conducted using the unstandardized scores of the study variables. Factor analysis was conducted to examine the issue of common method bias by using Harman's single-factor test recommended by Eichhorn (2014). There is a serious problem of common method bias if only one general factor accounted for the majority of the covariance among the measures (Podsakoff et al., 2003).

Two hierarchical multiple regression analyses were conducted to answer two main aims of the current study: (a) whether the TST variables, intention, behavioral prepotency, and self-regulatory capacity are significantly associated with SSB consumption of college students and (b) whether the two components of behavioral prepotency,

namely environmental cues and habits, are also associated with the behavior of SSB consumption and moderate the intention-SSB consumption path. In the first regression model, demographic covariates including gender, age, BMI, and SES were entered into block one. Intention, behavioral prepotency, and self-regulatory capacity were entered into block two, block three, and block four, sequentially. Finally, in block five, the interaction between intention and behavioral prepotency and the interaction between intention and self-regulatory capacity were entered. In the second regression, demographic covariates were again entered into the model as block one, and then intention was entered into regression model as block two. Environmental cues and habits were entered into the model as block three. Two interactions (intention \times environmental cues and intention \times habits) were entered into block four simultaneously. To obtain standardized estimations of the effect sizes and minimize the potential impacts of collinearity among study variables, all variables were standardized before they were entered into the regression models, except the dichotomous variable gender.

To be more precise on the moderation effects, we further used Johnson-Neyman (J-N) technique (Johnson & Neyman, 1936) to identify the region of significance. That is, after a significant interaction effect was obtained from the regression analyses, the range of self-regulatory capacity scores at which intention is statistically significantly associated with the SSB consumption was calculated by using the 'interactions' package in R 4.1.2.

Results

Descriptive analysis

Means, standard deviations, and correlations between variables are displayed in Table 1. We did not find any correlation between age or BMI and other TST variables. In contrast, gender was found negatively correlated with self-regulatory capacity and SSB consumption ($ps < .01$), while SES was positively correlated with participants' behavioral prepotency, environmental cues, self-regulatory capacity, and SSB consumption ($ps < .05$). Besides, SSB consumption was positively correlated with intention, environmental cue, habits, and behavioral prepotency, and was negatively correlated with self-regulatory capacity ($ps < .05$). Factor analysis was performed using all items, extracting nine factors whose values were greater than one. The first factor accounted for 25.34% (<40%) of the variance, indicating that the common method variance is not a great concern in the current study.

Regression analyses

The findings of the first hierarchic multiple regression analysis are shown in Table 2. In Step 1, gender, age, BMI, and SES totally accounted for a significant variance of 3.8% in SSB consumption ($p < .01$). Among these covariates, gender was found to be significantly associated with SSB consumption ($B = -.31$, 95% CI = $[-.505, -.114]$, $SE = .099$, $\beta = -.141$), while age, BMI, and SES were not ($ps > .05$). In Step 2, intention accounted for an additional significant 22.3% variance ($\beta = .475$, $\Delta F(1, 494) = 148.70$, $p < .001$). In Step 3 and 4, behavioral prepotency and self-regulatory capacity respectively accounted for additional significant 3.3% and 1.4% variances ($\beta_{\text{behavioral prepotency}} = .260$, $\Delta F(1, 493)$

Table 1. Descriptive statistics and bivariate correlations of key study variables among Chinese college students ($n = 500$).

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9
1. Gender	1.70	.46									
2. Age	21.58	1.99	−0.063								
3. BMI	20.77	2.96	−.224**	0.057							
4. SES	4.96	1.33	−0.07	0.019	−0.057						
5. Intention	10.34	5.18	−0.075	0.005	−0.04	0.078					
6. Behavioral prepotency	32.77	12.68	0.006	−0.031	−0.044	.114*	.704**				
7. Environmental cues	16.63	8.29	0.026	−0.02	−0.056	.121**	.472**	.885**			
8. Habits	16.14	6.59	−0.02	−0.034	−0.015	0.069	.762**	.811**	.446**		
9. Self-regulatory capacity	41.15	8.89	−.150**	0.017	−0.079	.178**	−.201**	−.231**	−.165**	−.236**	
10. SSB consumption	5.53	3.77	−.152**	−0.071	0.069	.090*	.483**	.468**	.345**	.466**	−.213**

Note: *M* = mean; *SD* = standard deviations; BMI = body mass index; SES = socio-economic status; SSB = sugar-sweetened beverages consumption; * $p < .05$; ** $p < .01$.

Table 2. Hierarchic multiple regression analysis predicting sugar-sweetened beverage consumption using variables of the temporal self-regulation theory among Chinese college students ($n = 500$).

Predictor	Step 2			Step 3			Step 4			Step 5		
	β [95% CI]	SE	p	β [95% CI]	SE	P	β [95% CI]	SE	p	β [95% CI]	SE	p
1. Intention	.475 [.398, .551]	.039	<0.001	.292 [.187, .398]	.054	<0.001	.279 [.174, .384]	.053	<0.001	.280 [.176, .383]	.053	<0.001
2. Behavioral prepotency				.260 [.154, .365]	.054	<0.001	.236 [.131, .342]	.054	<0.001	.224 [.119, .329]	.053	<0.001
3. Self-regulatory capacity							-.128 [-.207, -.049]	.040	0.002	-.115 [-.194, -.037]	.040	0.004
4. Intention \times behavioral prepotency										.046 [-.034, .126]	.041	0.261
5. Intention \times Self-regulatory capacity										-.128 [-.200, -.056]	.037	0.001
ΔR^2		.223	<0.001		.033	<0.001		.014	0.002		.020	0.001

Note: CI = confidence interval. Step 1 was not displayed in the table as this step includes the controlled demographic variables of age, gender, BMI, and SES.

= 23.34, $p < .001$; $\beta_{\text{self-regulatory capacity}} = -.128$, $\Delta F(1, 492) = 10.12$, $p = .002$). In Step 5, two interaction terms (intention \times behavioral prepotency, intention \times self-regulatory capacity) were added to the regression and accounted for an additional significant 2% variance, $\Delta F(2, 490) = 7.37$, $p = .001$. Furthermore, the interaction between intention and self-regulatory capacity was significant ($\beta = -.128$, $p = .001$) but the interaction between intention and behavioral prepotency was non-significant ($\beta = .046$, $p = .261$). The TST variables and two interactions significantly accounted for a total of 32.9% of the variance in SSB consumption. Findings of the J-N technique showed that intention had a positive effect on SSB consumption when self-regulatory capacity was lower than 60.96, but the effect of intention on SSB consumption was non-significant when self-regulatory capacity was large enough, that is, greater than 60.96 (see Figure 1).

As compared to the first hierarchic multiple regression analysis, the second regression analysis included the environmental cues and habits into the regression model at Step 3 rather than behavioral prepotency, accounting for additional significant 3.6% variance in college students' SSB consumption ($\Delta F(2, 492) = 12.62$, $p < .001$; $\beta_{\text{environmental cues}} = .134$, $p = .002$; $\beta_{\text{habits}} = .206$, $p = .001$). In Step 4, the two interactions (intention \times environmental cues and intention \times habits) accounted for additional 2% variance, $\Delta F(2, 490) = 7.28$, $p = .001$, with only the interaction between intention and habits being a significant

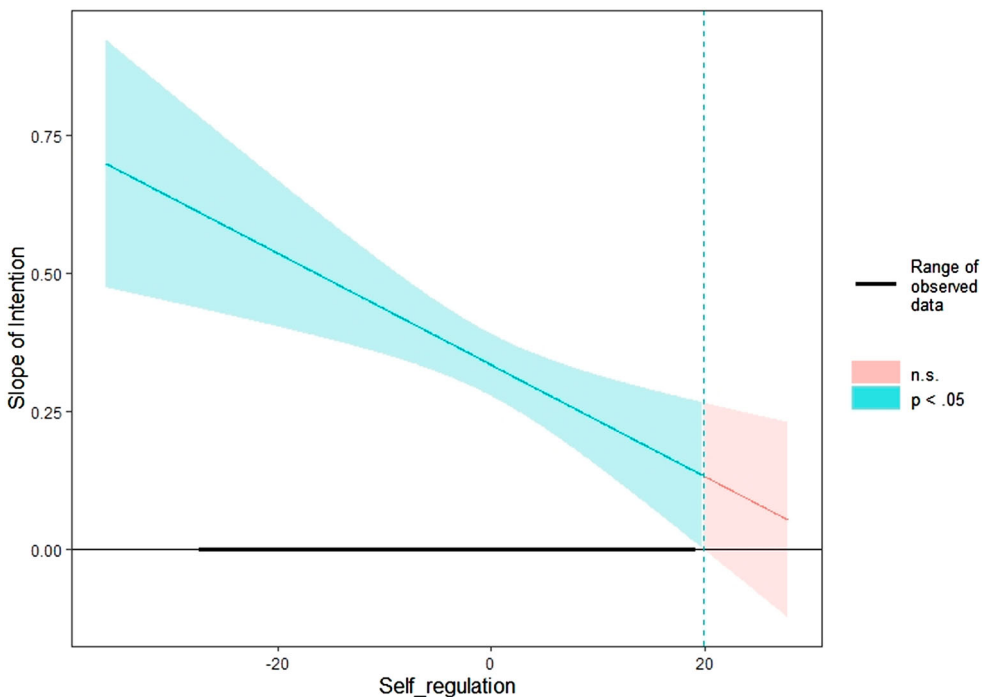


Figure 1. J-N regions of significance and 95% confidence band for the conditional effects of intention on sugar-sweetened beverages consumption as a function of self-regulatory capacity among Chinese college students ($n = 500$). The slope within the light green region is not statistically significantly different from 0. The thick horizontal line shows the range of mean-centred, observed values of self-regulatory capacity ($-27.15, 18.85$). Dashed vertical lines reflect the boundaries of the regions of significance (mean-centred scores: 19.81; uncentred scores: 60.96).

factor related to SSB consumption among college students ($\beta_{\text{intention} \times \text{environmental cues}} = -.044, p = .271$; $\beta_{\text{intention} \times \text{habits}} = .184, p < .001$; see Table 3). Using the J-N technique, intention \times habits showed that intention had a significant and positive effect on SSB consumption when participants' habits score was greater than 12.19, but the effect becomes non-significant when habit score was lower than 12.19 (see Figure 2).

Discussion

The TST combines both the rational (e.g. intention, self-regulatory capacity) and automatic (e.g. behavioral prepotency) social-cognitive processes and thus a more comprehensive framework to explain and understand the social-cognitive factors related to behaviors (Hall & Fong, 2007). Using TST as a theoretical guide, the current study aimed to examine whether the behavioral prepotency variables (including environmental cues and habits) and self-regulatory capacity are significantly associated with college students' SSB consumption and moderate the intention-behavior path. Intention and behavioral prepotency were found positively associated with SSB consumption among college students, while self-regulatory capacity was negatively associated with their SSB consumption. The moderation effects of self-regulatory capacity and habits on the intention-SSB consumption path were significant, although the moderation effect of behavioral prepotency and environmental cues were non-significant. Overall, the findings of the current study demonstrated that the TST can be used to explain and understand the impacts of social-cognitive factors on college students' SSB consumption.

In line with the theoretical proposal of TST (Hall & Fong, 2007) and findings of previous studies (e.g. Charlesworth et al., 2022; Hofmann et al., 2008; Moran & Mullan, 2021), our study found that SSB consumption among college students is the result of joint action of rational processes, represented by intention and self-regulatory capacity, and automatic processes, represented by behavioral prepotency. Both the rational processes (i.e. self-regulatory capacity) and automatic processes (i.e. behavioral prepotency) proposed in TST (Hall & Fong, 2007) have direct impacts on SSB consumption. Consistent with previous studies (McAlpine & Mullan, 2022; Moran & Mullan, 2021), two key components of behavioral prepotency, namely environmental cues and habits, were also

Table 3. Hierarchic multiple regression analysis predicting sugar-sweetened beverage consumption with intention, environment cues, and habits among Chinese college students ($n = 500$).

Predictor	Step 2			Step 3			Step 4		
	β [95% CI]	SE	p	β [95% CI]	SE	P	β [95% CI]	SE	p
1. Intention	.475 [.398, .551]	.039	<0.001	.254 [.135, .373]	.060	<0.001	.200 [.080, .321]	.061	0.001
2. Environmental cues				.134 [.049, .220]	.044	0.002	.110 [.024, .197]	.044	0.013
3. Habits				.206 [.090, .323]	.059	0.001	.278 [.157, .399]	.062	<0.001
4. Intention \times environmental cues							-.044 [-.123, .035]	.040	0.271
5. Intention \times habits							.184 [.089, .279]	.048	<0.001
ΔR^2		.223	<0.001		.036	<0.001		.020	0.001

Note: CI = confidence interval. Environment cues and habits are two components of behavioral prepotency. Step 1 was not displayed in the table as this step includes the controlled demographic variables of age, gender, BMI, and SES.

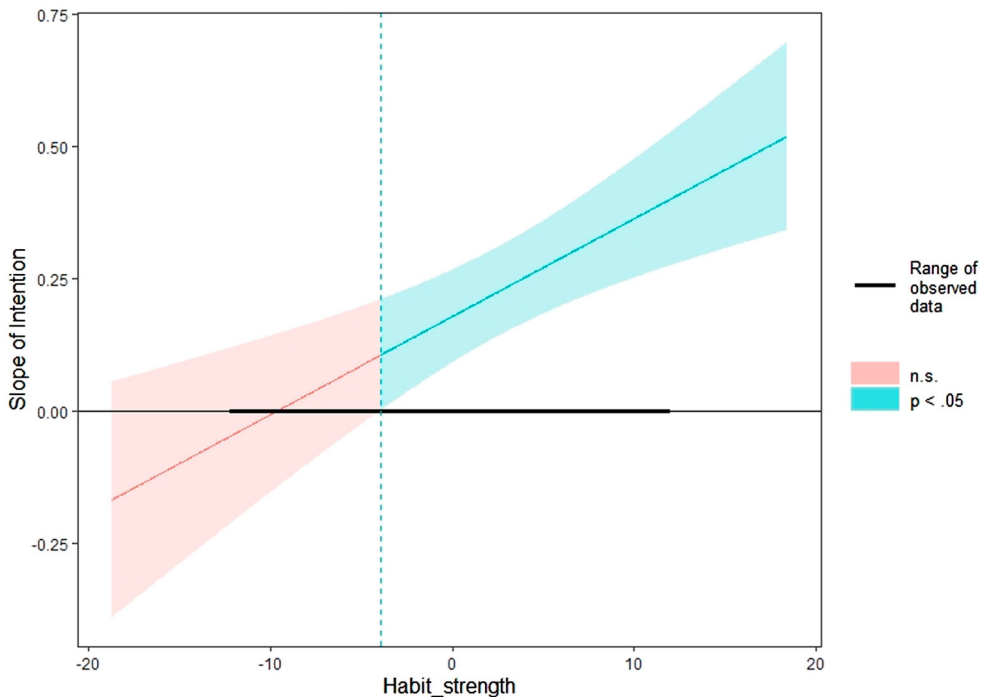


Figure 2. J-N regions of significance and 95% confidence band for the conditional effects of intention on sugar-sweetened beverages consumption as a function of habit strength among Chinese college students ($n = 500$). The slope within the light green region is not statistically significantly different from 0. The thick horizontal line shows the range of mean-centred, observed values of habit strength ($-12.14, 11.86$). Dashed vertical lines reflect the boundaries of the regions of significance (mean-centred scores: -3.95 ; uncentred scores: 12.19).

significantly associated with SSB consumption, indicating the consistency and synchronization between likelihood of performing a given behavior and actual behavior. Moreover, among those TST variables, intention accounted for the largest and most of variance in SSB consumption, serving as the most powerful predicting variable related to SSB consumption among college students. The present result further corroborates to previous studies that used the TST and found a significant effect from intention to different health-related behaviors, such as episodic drinking (Black et al., 2017), snacking (Evans et al., 2017), medication adherence (Liddelow, Mullan, et al., 2021), and also SSB consumption (Moran & Mullan, 2021), indicating a substantial role that intention plays in guiding our behavior. Thus, efforts trying to decrease or increase the intention might be substantially useful in promoting various health-related behaviors.

The findings of the current study provided further evidence that college students' self-regulatory capacity is a key protecting factor limiting their SSB consumption and hinder the translation of intention to SSB consumption. For college students with higher levels of self-regulatory capacity, they may be less inclined to consume sugary drinks because of their high levels of self-control and ability to resist temptations (Ames et al., 2016; Wenzel et al., 2019). College students' intentions to consume SSB might also depend on their degree of self-control, with students having higher levels of self-regulatory

capacity can refrain them from the temptations of drinking SSB. However, it should be noted that previous studies did not find a significant interaction effect or even direct effect of self-regulatory capacity on eating behavior or SSB consumption (Evans et al., 2017; McAlpine & Mullan, 2022; Moran & Mullan, 2021). The inconsistency between the findings of our study and previous studies (e.g. Evans et al., 2017; McAlpine & Mullan, 2022; Moran & Mullan, 2021) may be attributed to the different measures of behavior. Of course, further comparison studies using different measures at the same study can be considered to answer this question.

Although our study and previous studies (Evans et al., 2017; McAlpine & Mullan, 2022; Moran & Mullan, 2021) all used the BRS (Tangney et al., 2004) to measure participants' self-regulatory capacity, the measurement of eating behavior, and/or SSB consumption is different. Previous studies (Evans et al., 2017; McAlpine & Mullan, 2022; Moran & Mullan, 2021) only asked participants to report the number of snacks or sugary drinks they consumed over the previous week, which might not be accurate as the number of drinks consumed last week may not be representative of a person's typical SSB consumption behavior and the recall of specific numbers of drinking sugary drinks may not be precise. In contrast, in our study, college students were asked to report the frequency and quantity of sugary drinks they consumed on average daily or weekly using the past month as a reference. Measuring averaged behavior in a relatively long period may be more sensitive and reliable to capture the stable patterns of individuals' SSB consumption.

In terms of the moderating effect of behavioral prepotency on intention-behavior relation, we found significant interaction effect of habits on the intention-SSB consumption path. It seems that, for college students who have a strong habit of drinking sugary drinks, even a small increase of intention will induce their drinking behavior. In contrast, for college students whose habits of SSB consumption are weak, high levels of intention also could not change their behaviors substantially. Similar findings had been revealed in previous studies on fruit consumption and SSB consumption (de Bruijn, 2010; McAlpine & Mullan, 2022). For example, McAlpine and Mullan (2022) found that as habit increased, the effect of intention on SSB consumption became more pronounced, which was consistent with our present finding. Likewise, de Bruijn (2010) found stronger fruit consumption habits made fruit consumption less intentional, again indicating a significant interaction effect of intention and habit. With that said, future studies should continue to examine the moderating role of behavioral prepotency on the effect from intentions to the behaviors of SSB consumption across other populations.

In the current study, the moderation effect of environmental cues on the intention-SSB consumption was non-significant. It should be noted that evidence from previous studies on whether environmental cues moderate the intention-behavior relationship has been inconsistent. Some studies found that environmental cues moderated the relationship between intention and behavior (Liddelow, Ferrier, et al., 2021; McAlpine & Mullan, 2022), but others did not (Evans et al., 2017; Moran & Mullan, 2021). One possible explanation may be that, by tacitly using the CAS developed by Booker and Mullan (2013), we only measured the environmental cues that trigger participants to drink sugary drinks, while, on the other hand, there are many cues in the environment that prevent us from taking sugary drinks, for example, nutritional warnings on packages of sugary products (Alcantara et al., 2020). To some extent, the unmeasured

environmental cues counteract the influence of environmental triggers. Thus, future studies should also take the detailed and context-specific measurement of environmental cues into consideration.

In order to prevent the potential adverse consequences of SSB consumption in adulthood, effective theory, and evidence-based interventions are urgently needed. Informed by TST (Hall & Fong, 2007) and building on the findings of our study, it is highly recommended that interventions aiming to reduce college students' SSB consumption should target at decreasing SSB consumption intentions, increasing self-regulatory capacity, as well as developing healthy habits of limiting SSB consumption (e.g. Charlesworth et al., 2022; Hofmann et al., 2008; Moran & Mullan, 2021). Normally, interventions for decreasing SSB consumption intentions might include educational components of highlighting adverse consequences of SSB consumption, increasing the salience of the sugar contents of a typical SSB product, and providing information about peers' approval of drinking fewer SSBs and/or efforts to decrease SSB consumption (Vargas-Garcia et al., 2017). Previous studies demonstrated that these types of interventions lead to higher levels of intentions to reduce SSB consumption and significantly less SSB consumption among college students (e.g. Gregorio-Pascual & Mahler, 2020). On the other hand, interventions aimed at improving individuals' self-regulatory capacity and/or developing healthy drinking habits normally use various behavior change techniques (BCTs), such as feedback, goal-setting, self-monitoring, and so on (Shagiwal et al., 2020). Previous studies also showed a significant reduction of SSB consumption for intervention focused on self-regulatory capacity and habit among adolescents (e.g. Ames et al., 2016). Overall, future interventions aimed at reducing college students' SSB consumption should consider both the importance of intention formation and the follow-up key component of developing self-regulatory capacity and habits helping them transform good intentions into actual behaviors of reducing SSB consumption.

Limitations and future directions

Studies are not without limitations. There are a number of limitations we should acknowledge in the current study. First, our study adopted self-reported scales measuring study variables. Self-reported measures are susceptible to bias such as impression management and distorted recall (Sudman & Bradburn, 1974; Van de Mortel, 2008). Future studies should adopt more objective measures to measure study variables. For example, when measuring participants' self-regulatory capacity, using cognitive experiments is an appropriate alternative to consider. Second, the current study is using cross-sectional design and the common method biases cannot be neglected even though we examined the common method variance using Harman's single-factor test. This is because Harman's single-factor test as a statistical control has limited effectiveness in detecting the presence of common method effects and may thus provide a false sense of security to researchers (Aguirre-Urreta & Hu, 2019). Alternatively, a combination of procedural control and statistical control may be useful to manage common method bias (Kock et al., 2021). Future researchers should not only use statistical procedure which is executed after data collection to control common method bias, but also consider a more profound questionnaire design (i.e. the separation of sources for independent and dependent variables) which helps decrease or eliminate common method bias procedurally

before data collection (Kock et al., 2021). Third, the current study was correlational in nature, in which we can not infer the causal relationship between the temporal self-regulation theory variables and SSB consumption. Future research could consider adopting experimental designs (e.g. randomized control trials) to further examine whether changes in behavioral prepotency or self-regulatory capacity could result in changes in behavior. Experimental design can provide a more robust test of temporal self-regulation theory (Shadish et al., 2002). Fourth, the gender distribution in our sample was not balanced, as we have more than two-thirds of females. The findings of our study might be more representative of female college students, in which the generalizability of our results might be influenced. Fifth, there might be some degree of selection bias with only motivated participants being recruited instead of a representative sample of the whole Chinese college students. This is true for most of the research in the field of psychology (and perhaps most of the social sciences disciplines). On the other hand, it is believed that this is not a big issue as long as participants provided their real and valid responses. Last, for the measurement of environmental cues, we only included environmental triggers of SSB consumption without considering the cues that hinder SSB consumption by using the CAS (Booker & Mullan, 2013). It is believed that environmental cues can also prevent people from consuming SSBs. Future research should therefore consider adopting a more comprehensive environmental cues scale comprising both triggers and impediments that might affect individuals' SSB consumption.

Conclusion

Findings of the current study provided empirical evidence supporting the use of TST to understand the SSB consumption among Chinese college students. Intention, behavioral prepotency (i.e. environmental cues and habits) were significantly and positively associated with SSB consumption, while self-regulatory capacity was significantly negatively associated with SSB consumption. Although the moderation effect of environmental cues on the intention-behavior path cannot be supported, the moderation effects of habits and self-regulatory capacity on the intention-SSB consumption relations were revealed in the current study. Future interventions targeting at improving individuals' self-regulatory capacity or developing healthy habits of drinking may be helpful to reduce SSB consumption. We call for research to further examine and extend the findings of the current study using experimental designs to infer causality of college students' SSB consumption.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Authors contribution

CYJ and CQZ developed the study; CYJ conducted the data collection; HLX conducted the data analysis, wrote the first draft of the paper, and edited the paper; GDZ edited the paper; CQZ edited the paper and supervised the whole study.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Institutional review board statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of the Department of Psychology, Sun Yat-Sen University [Ref: 2022-0627-0252].

Informed consent

All participants in this study electronically provided informed consent to participate.

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