The Role of Environmental Cues in Sugar-Sweetened Beverage Consumption Using a Temporal Self-Regulation Theory Framework.

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Abstract

Sugar-sweetened beverage consumption is related to adverse health outcomes such as obesity and Type 2 diabetes. The present research further examined the utility of the temporal self-regulation theory in predicting sugar-sweetened beverage consumption. In addition, the research aimed to identify salient cues that trigger intake. Two-hundred and eighty-seven participants were recruited using convenience sampling in US and Australian populations. Hierarchical multiple regression analyses were used, and the final model accounted for 27.1% of the variance in consumption, providing partial support for the temporal self-regulation theory ($f^2 = 0.37$). Intention accounted for a significant 7.0% of variance ($R^2 = 0.07$, $p < .001$), behavioural prepotency variables (past behaviour, habit, and cues) together combined for an additional 15.1% of variance ($R^2 = 0.15$, $p < .001$), but neither measure of self-regulatory capacity (trait self-control, inhibition) was a significant predictor. No cues emerged as unique predictors, however the findings suggest that consumption may be influenced by a combination of cues across different situations. Behavioural prepotency moderated the intention-behaviour relationship such that as behavioural prepotency increased, the greater the influence intention had on behaviour. Further support for the role of both intention and automatic processes in sugar-sweetened beverage consumption was garnered, but more research is needed to identify when specific cues influence consumption most.

Keywords: Cues; Health; Sugar-sweetened beverages (SSBs); Sugary drinks; Temporal self-regulation theory.

Background

1.1 Sugar-sweetened beverages

Sugar-sweetened beverage consumption refers to the intake of non-alcoholic beverages including soft drinks, cordials, sports drinks, flavoured milks, flavoured mineral waters, and fruit and vegetable drinks (Australian Bureau of Statistics, 2015). Consumption of sugar-sweetened beverages has been associated with many adverse health outcomes such as Type 2 diabetes and other non-communicable diseases (Hu & Malik, 2010; Imamura et al., 2015) and appears to be a significant contributor to obesity prevalence worldwide (Woodward-Lopez et al., 2011). Further evidence for the impact that sugar sweetened beverages have on obesity can be observed by looking at the effect that reducing intake has on obesity rates (Cabrero Escobar et al., 2013; Hu, 2013). Thus, it is important to gain an understanding of the mechanisms that drive sugar-sweetened beverage consumption so that the most effective interventions can be developed, and these negative health outcomes can be reduced.

1.2 Temporal self-regulation theory and sugar-sweetened beverages

Previously, researchers have targeted sugar sweetened beverage intake by providing information about health risks to reduce intention or willingness to (Gregorio-Pascual & Mahler, 2020; Schubert et al., 2021). However, in addition to these conscious and intentional processes research has shown that sugar sweetened beverage consumption may also be influenced by automatic processes (Moran & Mullan, 2021). This means that it is important to consider the effect that automatic factors can have, over and above that of intention. For example, a person may find themselves easily intending to reduce sugar sweetened beverage intake, but clearly, these intentions are not always so easily translated into behaviour. Hall and Fong (2007) proposed temporal self-regulation theory in an attempt to explain some of these forces influencing behaviour after intentions have been made, while still acknowledging the important roles that intentions have in predicting behaviour. Hall and Fong (2007) classify these forces as behavioural prepotency and self-regulatory capacity (see Figure 1).

Behavioural prepotency refers to the automaticity of the behaviour and was originally described as consisting of three sub-facets; biological drives (e.g., thirst, hunger), environmental cues that are associated with the performance of the behaviour, and frequency of past behaviour (Hall & Fong, 2007). More recently however, biological drives have been replaced by habit strength (Hall & Fong, 2013) and although it could be argued that biological drives are particularly important for consumption-based behaviours, environmental cue scales have sought to capture these components instead (Booker & Mullan, 2013) by asking about internal cues (e.g., thirst, hunger). Often, measures of past behaviour alone have been used to assess behavioural prepotency (Booker & Mullan, 2013; Verplanken & Orbell, 2003), since it is commonly one of the best predictors of future behaviours (e.g., Evans et al., 2017). However, habit strength (specifically components that relate to automaticity) can also be used to quantify levels of behavioural prepotency (Hall & Fong, 2013) and although cues are acknowledged to be part of the construct of behavioural prepotency, its role in tandem with other sub-facets has not been explored as extensively in the literature.

Figure 1 near here

Self-regulatory capacity equates to one's ability to exert self-control for the purpose of completing a desired health behaviour (Hall & Fong, 2007). For example, to complete the behaviour of eating healthy, self-control is usually required to resist the temptation to engage in other more readily available or better tasting foods. Integral to the construct of self-regulatory capacity is executive functioning. This is because some of the most basic facets of executive functioning such as inhibition and working memory are thought to contribute to self-regulatory capacity (Hofmann et al., 2012). As a result, studies implementing temporal self-regulation theory have often used one or more measures of executive functioning to quantify self-regulatory capacity (Black et al., 2017; Booker & Mullan, 2013).

Hall and Fong (2007) also postulate that each of the post-intentional variables moderate the relationship between intention and behaviour. Theoretically, when the degree of automaticity of the behaviour is high, cognitive awareness is low, therefore lower levels of intention are needed to initiate performance. Similarly, when behavioural prepotency is low (low levels of automaticity), we are less likely to rely on our automatic processes and are more likely to require stronger levels of intention to complete the desired behaviour. For example, if a person has a strong habitual tendency to drink iced coffee every morning from the same convenience store, they may find it much harder to follow through with their intention to avoid sugar sweetened beverages. However, such effects have been demonstrated inconsistently throughout the literature. Some research has found that only certain components of behavioural prepotency moderate the relationship (e.g., past behaviour; Evans et al., 2017), while others find no effect at all (e.g., Booker & Mullan, 2013).

The interaction effect for self-regulatory capacity and intention is proposed to operate in the reverse direction to behavioural prepotency (Hall & Fong, 2007), such that higher levels of self-regulatory capacity will strengthen the relationship between intention and behaviour. Consider again the example of reducing sugar sweetened beverage consumption. If we believe that consumption is bad for our health, and we have a high capacity to exert our self-regulatory resources, we should find it much easier to translate our intentions to avoid sugar sweetened beverages into behaviour. However, the literature in this area is also varied because some studies have demonstrated moderation effects (e.g., Hall et al., 2008; Liddelow et al., 2021), while others do not (e.g., Allom et al., 2013; Collins & Mullan, 2011; Murray & Mullan, 2019).

Only one study to date has applied temporal self-regulation theory to sugar sweetened beverage consumption. Moran and Mullan (2021) found that temporal self-regulation theory partially predicted consumption in that intention and behavioural prepotency were significant predictors of behaviour, but self-regulatory capacity was not. The same pattern of results was found in unhealthy eating (Evans et al., 2017). The findings initially imply that self-regulatory capacity may not be important in predicting consumption behaviours. However, further inspection of the measures used for self-regulatory capacity may provide an explanation.

1.3 Self-regulatory capacity and the dual-component model of self-control

Moran and Mullan (2021) and Evans et al. (2017) used trait measures of self-control in their studies, whereas others have used state measures, i.e., measures of executive functioning (e.g., Black et al., 2017; Booker & Mullan, 2013). Trait measures are said to capture underlying dispositional aspects of self-control, whereas state measures tend to refer to the ability to exert effortful inhibition at any given moment (de Ridder et al., 2018). Interestingly, these measures do not relate well (Allom et al., 2016), which suggest that perhaps they measure different components of the over-arching construct of self-control. (Hofmann et al., 2009) have suggested that self-control contains both explicit (pursuit of long-term goals) and implicit (promotion of resistance to temptation) processes. It may be that trait measures of self-control assess the more explicit processes, while state or behavioural measures assess implicit processes. Furthermore, it is plausible that both these processes are important to measure to properly capture the construct of self-regulatory capacity in the context of sugar sweetened beverage consumption.

1.4 Environmental cues

Given the importance of environmental cues in behavioural prepotency, more research is needed. Moran and Mullan (2021) measured cues over five different domains (i.e., physical, internal, social, emotional, and sensory), but the scores were combined to create an overall composite variable. This variable when combined with habit strength explained additional variance over intention, which provides more evidence for the role of both these sub-facets within behavioural prepotency. However, it does not give specific insight into how to reduce intake, because we do not know whether specific cue domains reliably predict consumption, or whether the salience of cues differ between individuals. Consequently, interventions may lack direction with respect to how best to target cues to reduce consumption.

Previous research has shown that for adolescents, habit strength of sugar-sweetened beverage consumption is strongly correlated with habit strength of screen use (watching television or using a computer; Kremers et al., 2007). This potentially indicates that physical cues (i.e., watching television) may trigger consumption. Similarly, research exploring snacking has found that exposure to physical cues (watching others eat) and emotional cues (particularly negative affect) increases the likelihood of snacking (Elliston et al., 2017). These studies suggest that physical cues and emotional cues are likely to be important predictors of consumption behaviours. However, more research is needed to determine effects of specific domains of cues in sugar sweetened beverage consumption.

1.5 Aims of the present research

The aim of this research is to explore the role of domain-specific cues in sugar sweetened beverage consumption, and to determine whether assessing both types of self-control (trait and state) allow self-regulatory capacity to significantly predict behaviour. In addition, a secondary aim of the current research was to explore the interaction effects between intention and behavioural prepotency and self-regulatory capacity. Specifically, we hypothesise that (1) *temporal self-regulation theory constructs in combination will significantly predict sugar sweetened beverage consumption; (2) physical cues and emotional cues will uniquely and significantly predict sugar sweetened beverage* *consumption; (3) state and trait measures of self-control in combination will account for significant variance in sugar sweetened beverage consumption; (4a) behavioural prepotency will moderate the relationship between intention and sugar sweetened beverage consumption, such that higher levels of behavioural prepotency will weaken the intention-behaviour relationship; (4b) self-regulatory capacity will moderate the relationship between intention and sugar sweetened beverage consumption, such that higher levels of self-regulatory capacity will strengthen the intention-behaviour relationship.*

2. Method

2.1 Research Design

A prospective correlational design was used, with two time points, one week apart.

2.2 Participants

Two hundred and eighty-seven participants were recruited using convenience sampling from an undergraduate university student pool (17), a paid participant pool (246), and from the general population (24). Data was collected between 2019 and 2020, which meant that parts of data collection fell over the first two weeks of lockdown periods enforced due to COVID-19. In these instances, control questions were included to capture their lockdown status (whether they had been placed in lockdown yet), and to adjust for potential abnormal fluctuations in consumption if they were in lockdown.

Since previous research had limited success demonstrating moderation effects in sugar-sweetened beverages using temporal self-regulation theory constructs (Moran & Mullan, 2021), effect sizes (f^2) ranging from small to moderate (0.02 – 0.15) were used to conduct a priori analyses using G*Power 3.1 (Faul et al., 2009). Sample sizes were averaged which indicated that 235 participants would be required.

Participants belonging to a university participant pool were awarded course credit. Participants recruited through Amazon MTurk were awarded US$3.00 for completion of both parts of the study. The remainder were recruited by advertising through social media platforms e.g., Facebook, Reddit, and Twitter; word of mouth; online participant advertising forums Survey Circle and Psychological Research on the Net.

2.3 Measures

2.3.1 Intention. Based on Ajzen (1991), two 7-point Likert scale items (1 = *strongly disagree*, 7 = *strongly agree*) were administered (e.g., “I intend to avoid drinking sugary drinks over the next week.”), but only one of the items were retained in the final analyses as averaging them produced non-normal data. The two items correlated highly with each other ($r = .88$, $p < .001$), and previous research has also used just one item to assess intention (Charlesworth et al., 2021; McCloskey & Johnson, 2019). Scores ranged from 0 to 6, where higher scores indicated stronger intentions to avoid sugary drinks.

2.3.2 Behavioural Prepotency

2.3.2.1 Past behaviour. Past behaviour was measured with one item from Verplanken and Orbell (2003) Self Report Habit Index, an item that has been used previously to capture past behaviour (e.g., Liddelow et al., 2021). The item asked participants if "Drinking sugary drinks is something I do frequently" measured on a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*). Higher scores indicated higher frequency of past behaviour.

2.3.2.2 Habit strength. Habit strength was measured using a shortened version of the Self Report Habit Index (Verplanken & Orbell, 2003); the Self-Report Behavioural Automaticity Index (SRBAI; Gardner et al., 2012), which only uses the 4 items from the Self-Report Habit Index which relate to automaticity. The current study reports a Cronbach's alpha of .95. The measure contained a central statement "Drinking sugary drinks are something…" followed by four items (e.g., "I do without thinking") measured on a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*). Scores were averaged and ranged from 0 to 6 with higher scores indicating stronger habit strength.

2.3.2.3 Cues. Steps were taken to adapt and further validate the Cues to Action Scale (Booker & Mullan, 2013) to suit the context of the research. A copy was administered to 10 consumers of sugar sweetened beverages with similar demographics to the target population, with instructions to: (a) think about as many different cues as possible that trigger them to consume sugary drinks, and (b) to list which of the five domains (physical, sensory, social, internal, emotional) they think they fall under. The results were collected and Hsieh and Shannon (2005) framework for summative content analysis was used to assess the frequency of the cue examples given. For those examples with less than two occurrences, discussion was used to decide whether they were appropriate examples. For instances where examples fell under two or more domains, further discussion was used to resolve discrepancies and definitively place them under only one of the domains. The activity resulted in a more specific scale with several discrete examples relevant to sugary drink consumption for each domain.

The new Cues to Action Scale- Sugar Sweetened Beverages (CAS-SSB) contains two items for each of the five domains of cues. For each domain, a description, and examples specific to each domain were first given (e.g., "Emotional cues are any emotions which may trigger you to drink sugary drinks. Emotional cues may be things like: Feeling sad/down, feeling happy or as a reward, feeling stressed"). Two items were then administered, the first of which asks participants how often they experience these cues. Responses were given on an 8-point Likert scale (0 = *never*, 7 = *all the time*). The second, asked how often the cue is likely to make them engage in the specific behaviour and was assessed on a 7-point Likert scale (0 = *not at all likely*, 6 = *every time*), for example, "How much is feeling these cues likely to make you drink sugary drinks?". Scores from each item were multiplied to create an overall score for each domain and then ranked according to Table 1.

Table 1 near here

Scores therefore ranged from 0 to 7 with higher scores in each domain indicating greater impact from domain-specific environmental cues on behaviour. Although each item asked questions relating to the same domain, they were assessing different components (frequency versus degree of influence) thus it is inappropriate to report an internal consistency coefficient.

2.3.4 Self-regulatory capacity.

2.3.4.1 Trait self-control. A psychometrically improved and shortened version of the Brief-Self-Control Scale was used (α = .75; Morean et al., 2014). The scale contained seven items (e.g., "I am good at resisting temptation") each scored on a 5-point Likert scale (1 = *not at all*, 5 = *very much*). Four items were reversed coded and total scores were then averaged to range from 0 to 4, with higher scores indicating higher levels of trait self-control. The present sample had a Cronbach's alpha of .78.

2.3.4.2 State self-control. Participants were asked to complete a short, computerised version of the GNG task, which has been used previously by Hall et al. (2008). Participants were asked to press the spacebar as quickly as possible when the "go" stimulus appears (upper-case letters), and to refrain from pressing the spacebar when the "no-go" stimulus appears (lower-case letters). To score, the number of times the spacebar is incorrectly pressed in response to a "no-go" stimulus was used. However, since the task becomes easier the more slowly you respond to "go" stimulus, the score was added to the average latency of response time (in milliseconds) for "go" stimuli, to control for participants who did not press the spacebar as quickly as they could. The average latency was also divided by 200ms in order to moderate the influence on the total score, a number which was based on similar experiments using the GNG task (e.g., Littman & Takács, 2017). Lower scores indicated better state self-control and scores could theoretically have ranged from 0 to 97.5. For the present sample, this range was 1.7 – 11.9.

2.3.5 Behaviour. Sobell and Sobell (1992) timeline follow-back questionnaire was adapted to suit the purpose the study. Participants were asked to report the frequency and quantity of drinks consumed over the previous week. Participants were asked to quantify how many serves they had consumed on each day over the last week. Pictorial guides (separately adjusted to suit US and Australian participants) were provided to help participants assess how many standard serves were consumed on each occasion. Scores ranged from 0 - 51 with higher scores indicating greater consumption of sugar sweetened beverages.

2.3.6 Demographics. Participants were asked about their age, gender, ethnicity, and education level.

2.4 Procedure

The University Human Research Ethics Committee approved this study. After informed consent was obtained, participants completed the measures. A follow up email with a link to the behaviour measure was sent one week later.

2.5 Data Analysis

Hypotheses were pre-specified before data collection, as were the analytic procedures with exception to the post-hoc analysis.

3. Results

3.1 Sample Characteristics

Four-hundred and seventy-eight participants completed part one. Of these, one participant was removed due to having two submissions. A further 21 were removed due to having more than 50% missing data[1]. Of the remaining sample, 169 participants did not complete part two (37.1% attrition rate)[2]. This left 287 participants comprising 52.6% female participants with ages ranging from 17 to 75 to (*M* = 36.6, *SD* = 11.7). Ethnicity groups were represented as follows: 10.1% identified as African American, 5.9% as Asian,

[1] Those with > 50% data did also not complete part two.
[2] Completers were compared to non-completers before removing. Significant differences emerged on items, but these differences reflected typical patterns for poor-quality response (selecting the far-most right option; Van Vaerenbergh & Thomas, 2013) so were deemed acceptable to remove from further analyses.

62.7% as Caucasian, 4.9% as Hispanic, and 16.4% as Other or not identified. The minority of participants completed the measures during COVID-19 (41.1%).

3.4 Hierarchical Multiple Regression Analyses

The correlation matrix (Table 2) shows that none of the demographic variables, nor the GNG score variable correlated with the outcome variable. Of the control variables, lockdown status was also not correlated. To assess relatedness to sugar sweetened beverage consumption, ethnicity groups were analysed using a one-way ANOVA, $F(4, 241) = 1.08$, $p = .366$, which showed that ethnicity was also not significantly tied to the outcome variable. All other predictor variables correlated as expected, although none of the correlations were strong (Dancey & Reidy, 2007). Since the demographic variables and the first control question were not related to consumption, they were not included in the regression. Variables were added to the regression according to the order stipulated by Hall and Fong (2007); intention in block two (after controlling for COVID-related increases/decreases in consumption), behavioural prepotency variables in block three and self-regulatory capacity variables in block four.

Table 2 near here

After controlling for COVID-19 related increases/decreases in SSB consumption, intention significantly accounted for 7.0% of the variance, $\Delta R^2 = .07$, ΔF (1, 284) = 22.63, $p < .001$. An additional 15.1% of variance was explained when behavioural prepotency variables were added, $\Delta R^2 = .15$, ΔF (7, 277) = 9.15, $p < .001$. The addition of self-regulatory capacity variables did not explain additional variance, $\Delta R^2 = .00$, F (2, 275) = 0.47, $p = .630$. The final model significantly accounted for a total of 27.1% of variance in consumption, adjusted $R^2 = .24$, F (11, 275) = 9.30, $p < .001$, $f^2 = 0.37$, a large effect (Cohen, 1988). With the exception of the COVID-19 control variable, only habit accounted for significant unique variance in the final model (Table 3), which also reports standardised and unstandardised coefficients and their confidence intervals, as well as their standard errors.

Table 3 near here

Given that no individual cue domain was uniquely predictive, post-hoc analyses were conducted to determine whether cues as a whole added significant variance over and above habit and past behaviour. The scores for each cue domain were added to create a composite cue variable, and hierarchical multiple regression was conducted in the same order as the previous model, but with the composite cue variable entered separately in its own block after habit and past behaviour. Block 1 (COVID-19 control variable), and block 2 (intention) were identical in this model, but past behaviour and habit combined to explain a significant and additional 11.9% of variance, $\Delta R^2 = .12$, ΔF (2, 282) = 22.05, $p < .001$ in block 3. In block four the composite cue variable provided a further significant 2.8% of variance, $\Delta R^2 = .03$, ΔF (1, 281) = 10.63, $p = .001$, and in the final model accounted for a uniquely significant amount of variance (see Table 4). Self-regulatory capacity variables were not added again given they did not account for variance in the initial model.

Table 4 near here

3.5 Moderation Analyses

Moderation analyses were conducted in SPSS using the PROCESS macro (Hayes, 2017). Individual moderation analyses were conducted for each variable (habit, past behaviour, cues, trait self-control, state self-control), with the COVID-19 control variable included as a covariate for each model. For behavioural prepotency variables, significant interactions with intention were detected for habit and the combined cues variable, but not for past behaviour. For self-regulatory capacity, neither state not trait measures returned significant interaction effects.

For habit, the overall interaction was significant, $b = -0.40$, $t(282) = -2.39$, $p = .02$. Results indicate that when habit strength was low, there was no relationship between intention and behaviour, however when habit was medium, $b = -1.04$, $t(282) = -3.07$, $p < .001$, and when habit strength was high, $b = -1.78$, $t(282) = -3.63$, $p < .001$, intention was significantly related to behaviour such that as habit increased, the effect of intention on behaviour became more pronounced (see Figure 2). The intention-behaviour relationship became non-significant when habit strength dropped below 1.32, indicating that for those with low sugar sweetened beverage habits, intention to avoid did not have an impact on consumption.

Similarly for cues, the overall interaction was significant, $b = -0.10$, $t(282) = -2.38$, $p = .02$. Results indicate that when cues were low, there was no relationship between intention and behaviour, however when cues were medium, $b = -1.02$, $t(282) = -3.09$, $p < .001$, and when cues were high, $b = -1.73$, $t(282) = -3.70$, $p < .001$, intention was significantly related to behaviour such that as cues increased, the effect of intention on behaviour became more pronounced (see Figure 3). The intention-behaviour relationship became non-significant when cues dropped below 10.58, indicating that for those experiencing less frequent and less influential cues, intention to avoid did not have an impact on consumption.

4. Discussion

The constructs of temporal self-regulation theory in combination significantly predicted sugar-sweetened beverage consumption. No domain of cues accounted for significant variance. Furthermore, the addition of the GNG task did not allow for self-regulatory capacity to significantly predict behaviour. Finally, moderation effects were partially supported in that behavioural prepotency moderated the intention-behaviour relationship but in the opposite direction proposed by Hall and Fong (2007), and self-regulatory capacity did not moderate the relationship at all.

Although intention was a significant predictor in the present research, it explained much less variance than previous research (Moran & Mullan, 2021). This may be a result of the way in which the intention items were framed. Moran and Mullan (2021) used a form of intention that aligns with "approach behaviour" (i.e., "I intend to drink sugary drinks"), whereas the current research used a form that aligns with "avoidance behaviour" (e.g., I intend to avoid drinking sugary drinks"). Some research has found that when using avoidance-framed intention for behaviours with long-term adverse outcomes (e.g., pre-drinking; Caudwell et al., 2019), intention provides no significant effect on behaviour. It could be that for behaviours that have long-term negative impacts and relatively immediate rewards (i.e., the sweet taste of a soft drink), behaviour is much more under habitual or non-conscious control (Wood & Neal, 2007).

This is supported further by our results, which indicate that behavioural prepotency plays an important role in predicting sugar-sweetened beverage consumption. Each of the behavioural prepotency variables significantly correlated with each other and in combination explained a significant proportion of variance which adds theoretical support for its role in temporal self-regulation theory. It also demonstrates that purely making intentions to avoid consumption may not always be enough to change behaviour.

Cues were not unique predictors although their role in consumption should not be discounted. One of the possible explanations for the findings is that the saliency of cues differs based on individual differences. That is, one cue domain may be the most important for consumption for some people, whereas other domains might be more important for others. Similarly, different cues might be associated with consumption in different circumstances, such that one type of cue might trigger consumption in one environment, and another type of cue in a completely different one. This is supported by post-hoc analyses which revealed that when added to the regression independently of past behaviour and habit, the combined cues measure provided additional variance. This demonstrates that overall, cues were significant predictors of consumption but that individually, no domain was more important than the others. Furthermore, these findings also consolidate the importance of using cues in conjunction with habit for assessing behavioural prepotency. While the results showed that self-control was related to consumption, it was only a weak association. Furthermore, Go/No-Go scores showed no associations with any variables and provided no utility as a predictor. Moran and Mullan (2021) found that trait self-control was not related to sugar sweetened beverage consumption and given the weak association in the present research, it may be that self-control is not an important predictor of consumption. However, Wenzel et al. (2019) using an intrapersonal design found that trait self-control *was* important, but only when in the presence of others, indicating a potential interplay between self-control and social cues. Previous research in snack consumption also showed that an individual's reactivity to physical cues was related to BMI, but only when self-control was low (Lawrence et al., 2012). Although the authors were assessing physical cues, Wenzel's (2019) findings suggest that self-control might also be important for resisting other types of cues too.

This is supported in the present findings as trait self-control was moderately negatively related to habits and four out of five of the cue domains. This suggests that while self-control may not be directly related to consumption, it might be important in determining whether or not sugar sweetened beverage consumption habits are developed, i.e., those with stronger self-control may be more likely to form healthy beverage habits and avoid unhealthy ones. This concept is somewhat supported by Galla and Duckworth (2015), who found evidence across 6 studies that habits mediate the relationship between self-control and behaviours. However, only positive behaviours were assessed (e.g., healthy snacking) and more research is needed to confirm whether this relationship exists for unhealthy habits, such as sugar sweetened beverage consumption.

The interaction between behavioural prepotency and intention on behaviour was an interesting finding. The direction of the effect was opposite to what was hypothesised. Hall and Fong (2007)posit that behavioural prepotency should weaken the intention-behaviour relationship, but our findings show that the relationship was strengthened. Our findings suggest that when SSB automaticity is low or moderate, intention to avoid consumption does not play a role in predicting consumption. Consumption levels remain lower than those who had high behavioural prepotency (automaticity), regardless of their intentions. But when behavioural prepotency was high, consumption was much lower when intention to avoid was strong too. This implies that for SSB consumption, strong intentions to avoid can override our habits for SSB behaviours. Furthermore, intention was not important for those with low levels of behavioural prepotency. However, this may be because for those in this group with low intentions to avoid already displayed low levels of SSB consumption, so the distinction between this group of participants and those with stronger intentions to avoid may not have been detectable.

The convenience sampling method may limit the generalisability of the study, however, the sample of participants spanned across both Australia and the US, including a reasonable distribution of ages, which provides a comparatively better generalisability to other studies in the field (e.g., Moran & Mullan, 2021). Another limitation of the present research which should be considered is the use of single-item measures for intention and past behaviour. While there are concerns for measures with just one item, correlations between items within these multi-item measures are often very high (Charlesworth et al., 2021), and when single items are pulled from existing scales (like was the case with the present research), they can still meet psychometric criteria to acceptable levels (Fisher et al., 2016).

Furthermore, the implications of the present research are nonetheless important. The finding that no cue domain was a uniquely significant predictor, but that when combined, cues accounted for uniquely significant variance over and above habit has important implications as it suggests that cues which are used for triggering SSB consumption may vary across contexts and individuals. EMA-type studies looking at the types of cues which trigger consumption in real time, would be of benefit to identify predictors of each domain, and ultimately targets for intervention. Another important implication of the present study is that interventions targeting sugar sweetened beverage consumers’ conscious processes (i.e., intention) should continue to be implemented, as the findings suggest that strong intentions to avoid consumption may be enough to overcome the influence of established habits and environmental cues. Given this relationship was oppositional to postulates of temporal self-regulation theory, future research seeking to enhance theoretical understanding should aim to determine for which behaviours this relationship can be demonstrated, and under what conditions.

4.1 Conclusion

Overall, temporal self-regulation theory only moderately predicts SSB consumption, given that self-regulatory capacity variables were not meaningfully predictive. Although the degree of automaticity of drinking sugar-sweetened beverages was an important predictor of consumption, intention to avoid consumption was equally important, such that strong intentions to avoid SSBs may be enough to override high levels of influence from automatic factors. Finally, the results suggest that no single domain of cue may be most important for predicting sugar sweetened beverage consumption, but that the type of cues which trigger consumption may depend on the individual.

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6. Author Contributions

Barbara Mullan supervised this project and provided input during the project development phase, as well as ongoing advice throughout. All other components were conducted by Thomas McAlpine, including data collection, analysis, and preparation of the manuscript.

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Figure 1.

Diagramatic representation of the temporal self-regulation theory. Adapted from "Temporal Self-Regulation Theory: A Model for Individual Health Behavior" by P. A. Hall and G. T. Fong, 2007, *Health Psychology Review, 1*, p. 14. Copyright 2007 by Taylor and Francis.

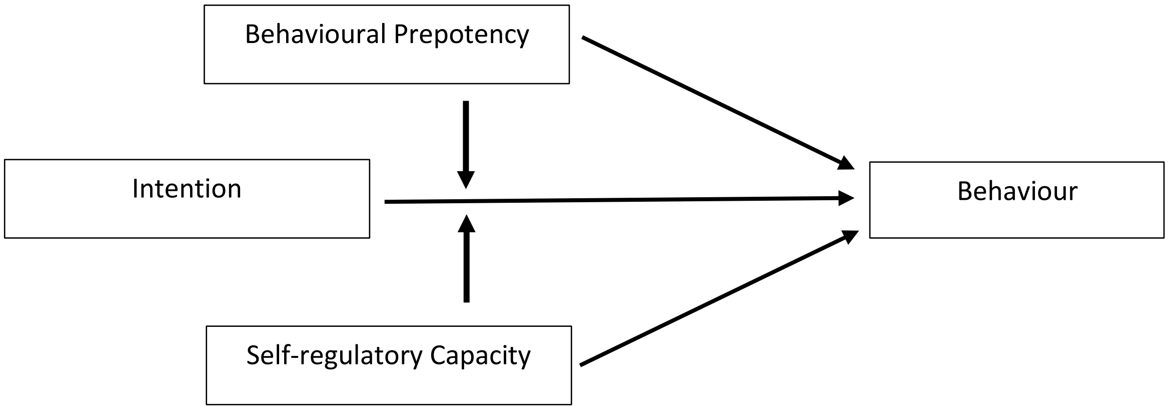

Figure 2.

Intention-consumption relationship by habit strength.

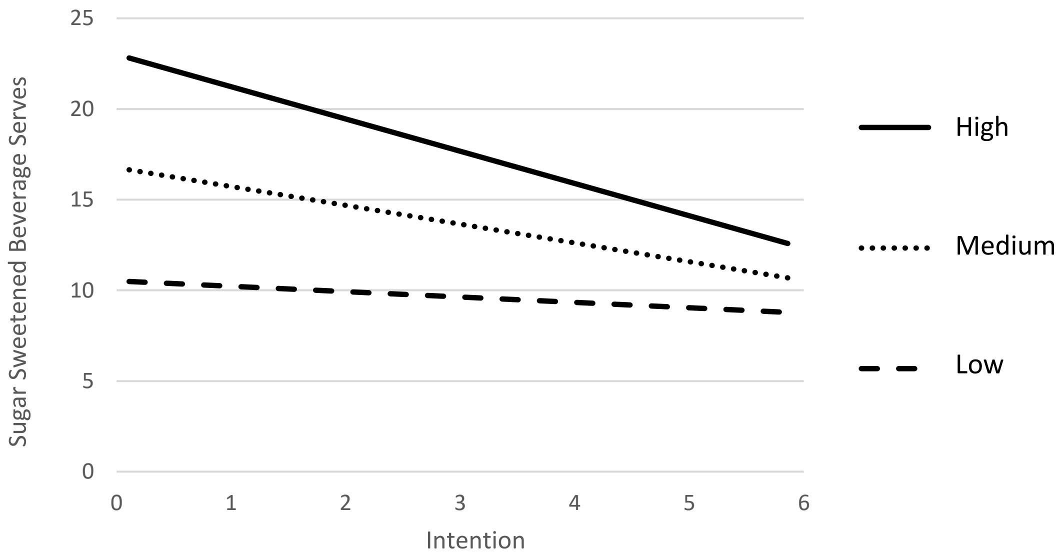

Figure 3.

Intention-consumption relationship by level of cues.

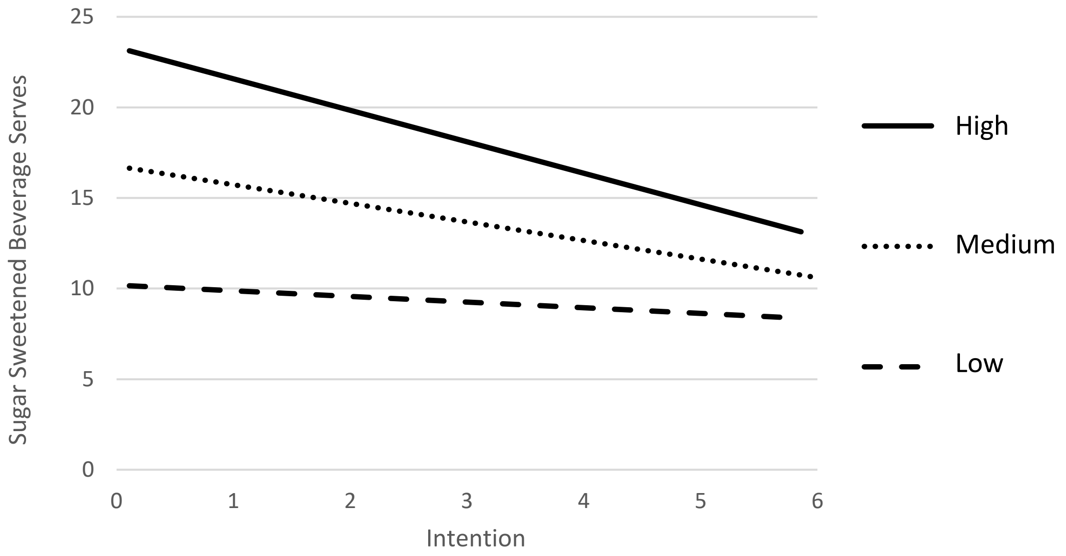

Table 1.

Scoring Protocol for the Cues to Action Scale - Sugar Sweetened Beverages (CAS-SSB).

Product of Cue Items	Cue Score
0	0
1-6	1
7-12	2
13-18	3
19-24	4
25-30	5
31-36	6
37-42	7

Table 2.

Bivariate Correlation Coefficients, Means, and Standard Deviations for all variables (N = 287).

	Measure	1.	2.	3.	4.	5.	6.	7.	8.	*9.*	*10.*	*11.*	*12.*	*13.*	*14.*	*15.*	*16.*	*M*	*SD*
1.	Age	-																36.6	11.7
2.	Gender	.07	-																
3.	Education	.02	.07	-															
4.	COVID1	.10	.02	.03	-														
5.	COVID2	-.10	.07	.01	-.11	-												-0.13	1.61
6.	Intention	-.11	.02	.11	0.04	-.18**	-											3.33	1.93
7.	Past Behaviour	.04	.03	-.04	.12	.21**	-.56**	-										3.27	1.98
8.	Habit	.03	-.04	.02	.19*	.12*	-.35**	.65**	-									2.19	1.84
9.	Physical Cues	.04	.03	-.02	.09	.17**	-.31**	.59**	.49**	-								2.91	1.76
10.	Sensory Cues	.04	.01	.00	.02	.14*	-.31**	.52**	.49**	.62**	-							3.20	1.79
11.	Social Cues	-.14*	-.03	.05	.08	.16**	-.13*	.33**	.30**	.53**	.43**	-						2.37	1.63
12.	Internal Cues	.16**	-.03	-.07	.20*	.16**	-.33**	.55**	.45**	.59**	.51**	.38**	-					3.26	1.94
13.	Emotional Cues	.03	-.02	.03	.05	.15*	-.18**	.40**	.43**	.46**	.49**	.37**	.44**	-				2.08	1.75
14.	Self-Control	.19**	-.05	-.02	-.08	-.05	-.13*	-.25**	-.34*	-.21**	-.17**	-.11	-.17**	-.29**	-			2.53	.71
15.	GNG Score	-.13*	.08	.08	-.03	-.02	.02	.09	.05	.01	-.04	-.06	-.02	.06	-.06	-		3.68	2.77
16.	Behaviour	.04	.07	.00	.00	.22**	-.28**	.41**	.40**	.39**	.35**	.25**	.35**	.34**	-.12*	.02	-	14.03	12.44

Note. COVID1 = COVID-19 lockdown status. COVID2 = COVID-19 related changes in consumption. Biserial correlation coefficients are reported for Gender and COVID1. Spearman's rho coefficients are reported for Education.

* p < .05, two-tailed. ** p < .01, two-tailed.

Table 3.

Standardised (β) and Unstandardised (B) Regression Coefficients, Standard Error (SE) and Squared Semi-Partial Correlations (sr^2) for Variables Predicting Sugar-Sweetened Beverage Consumption Using Hierarchical Multiple Regression Analysis (N = 287)

	Step 1				Step 2				Step 3				Step 4			
Predictor	*B* [95% CI]	*SE B*	β	*sr²*	*B* [95% CI]	*SE B*	β	*sr²*	*B* [95% CI]	*SE B*	β	*sr²*	*B* [95% CI]	*SE B*	β	*sr²*
COVID2	**2.43 [1.217, 3.71]****	**0.64**	**0.22**	**.05**	**1.31 [0.14, 2.50]****	**0.59**	**0.12**	**.03**	**1.30 [0.14, 2.47]***	**0.59**	**0.12**	**.01**	**1.31 [0.14, 2.48]***	**0.59**	**0.12**	**.01**
Intention					**-1.61 [-2.27, -.94]****	**0.34**	**-.27**	**.07**	-0.53 [-1.27, 0.21]	0.38	-0.09	.00	-0.55 [-1.30, 0.20]	0.38	-0.09	.01
Past Behaviour									0.49 [-0.48, 1.47]	0.49	0.09	.00	0.47 [-0.52, 1.46]	0.50	0.08	.00
Habit									**1.11 [0.23, 1.98]***	**0.45**	**0.18**	**.02**	**1.20 [0.30, 2.10]***	**0.46**	**0.19**	**.02**
Physical Cues									0.71 [-0.31, 1.73]	0.52	0.11	.01	0.73 [-0.29, 1.75]	0.52	0.11	.01
Sensory Cues									0.17 [-0.74, 1.08]	0.46	0.03	.00	0.15 [-0.76, 1.06]	0.46	0.02	.00
Social Cues									-0.01 [-0.87, 0.86]	0.44	0.00	.00	0.00 [-0.87, 0.87]	0.44	0.00	.00
Internal Cues									0.40 [-0.41, 1.21]	0.41	0.07	.00	0.39 [-0.42, 1.20]	0.41	0.07	.00
Emotional Cues									0.62 [-0.20, 1.44]	0.42	0.09	.01	0.67 [-0.17, 1.51]	0.43	0.10	.01
Self-Control													0.12 [-0.42, 0.65]	0.27	0.02	.00
GNG Score													0.12 [-0.73, 0.97]	0.43	.02	.00

Note. CI = confidence interval. COVID2 = COVID -19 related consumption changes

* p < .05, two-tailed, ** p < .01, two-tailed

Table 4.

Standardised (β) and Unstandardised (B) Regression Coefficients, Standard Error (SE) and Squared Semi-Partial Correlations (sr^2) for Combined Cues Model (N = 287)

	Step 1				Step 2				Step 3				Step 4			
Predictor	*B* [95% CI]	*SE B*	β	sr^2	*B* [95% CI]	*SE B*	β	sr^2	*B* [95% CI]	*SE B*	β	sr^2	*B* [95% CI]	*SE B*	β	sr^2
COVID2	**2.43 [1.217, 3.71]****	**0.64**	**0.22**	**.05**	**1.31 [0.14, 2.50]****	**0.59**	**0.12**	**.03**	**1.50 [0.34, 2.67]***	**0.59**	**0.14**	**.02**	**1.30 [0.14, 2.45]***	**0.59**	**0.12**	**.01**
Intention					**-1.61 [-2.27, -.94]****	**0.34**	**-.27**	**.07**	-0.49 [-1.24, 0.25]	0.38	-0.08	.00	-0.53 [-1.26, 0.20]	0.37	-0.09	.01
Past Behaviour									**1.13 [0.23, 2.03]***	**0.46**	**0.19**	**.02**	0.55 [-0.41, 1.50]	0.48	0.09	.00
Habit									**1.51 [0.67, 2.36]****	**0.43**	**0.24**	**.03**	**1.13 [0.27, 2.00]***	**0.44**	**0.18**	**.02**
Combined Cues													**0.38 [0.15, 0.61]****	**0.12**	**0.22**	**.03**

Note. CI = confidence interval. COVID2 = COVID -19 related consumption changes

* p < .05, two-tailed, ** p < .01, two-tailed