



Research Paper

Alcohol advertising in disguise: Exposure to zero-alcohol products prompts adolescents to think of alcohol—Reaction time experimental study



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ABSTRACT

Background: Zero-alcohol drinks (<0.5 % alcohol by volume) appear and taste like alcoholic drinks; they may feature brands from alcoholic drinks (“brand extensions”) or “new-to-world” brands. These drinks are not consistently included within many restrictions aimed at reducing adolescents’ exposure to alcohol products and advertising. This online study examined whether adolescents implicitly categorise images of zero-alcohol drinks as alcoholic beverages.

Methods: 331 Australian adolescents aged 15–17 years participated in an online within-subjects reaction time experiment. Participants viewed 20 randomly-ordered images of alcohol, zero-alcohol, and soft drink products and were asked to indicate as quickly as possible whether these images made them think of alcohol, with both response time and agreement recorded. Generalised linear mixed effects models were used to examine differences in response time and agreement by drink type, adjusting for clustering of responses within participants, recent consumption, survey device (mobile/computer), and parental presence.

Results: Most images of alcoholic (94.4 %), brand extension zero-alcohol (90.7 %), and “new-to-world” zero-alcohol (85.6 %) drinks prompted participants to think of alcohol, compared to 5.2 % of soft drinks. In the mixed effects model, compared to alcoholic drinks, participants on average responded 72 ms slower to brand extension zero-alcohol drinks and 215 ms slower to “new-to-world” brand zero-alcohol drinks.

Conclusions: The combination of high levels of agreement and slower reaction times suggest that adolescents categorise zero-alcohol drinks as non-typical alcoholic drinks, rather than soft drinks. Thus, exposure to zero-alcohol drinks had similar effects to exposure to alcoholic drinks. Urgent regulatory action is required to ensure that restrictions on alcohol advertising and availability to minors extend to zero-alcohol drinks.

Introduction

Alcohol consumption in adolescence is particularly harmful due to its neurodevelopmental impacts (Lees et al., 2020), and earlier initiation of alcohol consumption is associated with more harmful patterns of alcohol consumption in adulthood (Gardner et al., 2024; Lee et al., 2024). Alcohol consumption among adolescents in high income countries in

recent decades has declined (Vashishtha et al., 2021). However, it remains the second highest individual risk factor for death and disability among 10–24 year olds globally, behind iron deficiency (Murray et al., 2020). Preventing and reducing alcohol consumption among adolescents are thus common targets of strategies and actions to reduce alcohol harms around the world. For example, in The Netherlands, the National Prevention Agreement targets a reduction in the proportion of people

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aged 12 to 16 years who have ever drunk alcohol from 45 % to <25 % by 2040 (Nationaal Preventie Akkoord, 2019). In Australia, the National Preventive Health Strategy 2021–2030 has a target of <10 % of young people aged 14 to 17 years consuming alcohol by 2030 (Australian Government Department of Health, 2021).

A key influence on adolescent alcohol consumption is exposure to alcohol, including through its presence on retail shelves, advertisements and seeing other people such as parents drink (Jernigan et al., 2017; Yap et al., 2017). Many countries have implemented regulations that aim to reduce adolescents' exposure to alcohol and alcohol advertising. Motivated by concerns about the impact of alcohol advertising on young people, Norway introduced an advertising ban on alcohol in 1975 (Rossow, 2021). In France the Loi Évin was introduced in 1991 to prohibit alcohol advertising through media targeted at young people, as well as controlling advertising content (Gallopel-Morvan et al., 2017). In many Australian jurisdictions, alcohol cannot be sold in supermarkets or other general retail stores that may be frequented by young people; for example, in South Australia, the *Liquor Licensing Act 1997* requires that premises licensed for packaged liquor sales be devoted entirely to the business conducted under the licence and must be physically separate from premises used for other commercial purposes (Government of South Australia, 1997).

Zero-alcohol drinks are drinks that mimic the appearance and taste of alcoholic drinks, while containing no or very small amounts of alcohol. There is no consensus on what constitutes zero- or low-alcohol, with thresholds varying from country to country (Okaru & Lachenmeier, 2022) and across different policy instruments within countries (Bury et al., 2024). However, a common threshold is around <0.5 % alcohol by volume (Okaru & Lachenmeier, 2022). The market for zero-alcohol drinks is growing rapidly globally (Statista, 2024b). The drinks may be useful for adults looking to reduce alcohol consumption (Bowdring et al., 2024; Nicholls, 2023). However, they present a challenge to regulatory efforts to reduce adolescents' exposure to alcohol and alcohol advertising. A large proportion of zero-alcohol drinks share branding and label design features with parent alcohol drinks ("brand extension zero-alcohol drinks"). Other zero-alcohol drinks feature "new-to-world" (NTW) brands – that is, products that feature brands unique to zero-alcohol drinks - but are packaged and labelled similarly to alcoholic drinks. Both types of zero-alcohol drinks thus look visually similar to alcoholic drinks, especially in retail or advertising environments. Yet, these drinks often do not meet regulatory definitions of "alcohol", for example due to their very low-to-no alcohol content and lack of definition within alcohol regulations; indeed, zero-alcohol drinks may fall within the remit of food and soft drink, rather than alcohol, regulations (e.g. *Food Standards Australia New Zealand*, 2022). Thus, these drinks can evade many regulations targeting alcohol exposure, raising concerns that they may be used as surrogate marketing for full-strength alcohol (World Health Organization, 2023). For example, in Ireland, advertising for zero-alcohol drinks has increasingly featured in places such as public transport (Critchlow et al., 2023), despite bans on alcohol advertising in these settings (Government of Ireland, 2018). In Australia, zero-alcohol drinks are available for purchase in supermarkets and convenience stores, typically located alongside soft drinks (a drinks category of which adolescents are the largest consumers (Australian Bureau of Statistics, 2018)).

Given the strong visual resemblance between zero-alcohol and alcoholic drinks, it is plausible that exposure to zero-alcohol drinks functions similarly to exposure to alcoholic drinks. That is, exposure to zero-alcohol drinks may increase people's desire to try, or act as a reminder to consume alcohol. Indeed, adults report mistaking zero-alcohol drinks for their alcoholic counterparts (Harrison et al., 2024). Research has found that zero-alcohol drinks are salient and attractive to adolescents, with over a third of 15–17 year old Australians reporting that they had tried the drinks, and most perceiving them positively as a useful alternative for adults and adolescents when alcohol consumption is socially expected (Booth et al., 2024). Similarly, a substantial minority

of Australian parents reported some openness to providing zero-alcohol drinks to their adolescent children – particularly those parents who thought the drinks may have benefits for their teens such as avoiding alcohol consumption (Bartram et al., 2024c). However, in focus groups and interviews, both adolescents (Booth et al., 2024) and parents (Harrison et al., 2024) expressed concerns that zero-alcohol drinks could also normalise alcohol consumption and act as a gateway to alcohol use.

Both the benefits and concerns about zero-alcohol drinks raised by adolescents and parents relate to the visual and taste resemblance between zero-alcohol and alcoholic drinks. However, evidence directly examining whether exposure to zero-alcohol drinks prompts adolescents to think of alcohol is lacking. In addition, it is not clear whether any effect of exposure to zero-alcohol drinks holds just for brand extension zero-alcohol drinks or whether NTW brand zero-alcohol drinks also prompt adolescents to think of alcohol, given both resemble alcoholic drinks (Bartram et al., 2024b). Investigating whether the effects of exposure differ between brand extension and NTW drinks will help to differentiate between the value of brand-level restrictions on alcohol and alcohol advertising, such as those that have been implemented in Norway (Purves et al., 2022), and approaches that regulate the entire zero-alcohol drink category (c.f., Critchlow et al., 2024). There is precedent from the field of tobacco control for regulating "lookalike" products, with the World Health Organization Framework Convention on Tobacco Control recommending measures that prohibit the "manufacture and sale of sweets, snacks, toys or any other objects in the form of tobacco products which appeal to minors" (World Health Organization, 2003, p. 15).

Theoretical framework

In this study we aimed to explore whether adolescents implicitly categorise zero-alcohol drinks as alcoholic beverages – that is, whether the drinks prompt them to think of alcohol. We drew on category prototypicality theory (Ellis & Nelson, 1999; Rosch et al., 1976), hypothesising that zero-alcohol drinks may be categorised by young people as less-prototypical examples of the broader category of alcohol, and thus exposure to these drinks will activate thoughts of alcohol. According to category prototypicality theory, the ability to classify objects into categories is a fundamental cognitive skill. Members of a category vary in their prototypicality, with prototypical category members providing more descriptive information about a category than non-prototypes. The prototypicality of a category member directly influences how quickly people (including children) are able to identify it as a member of the category, with more time required as prototypicality decreases (Ellis & Nelson, 1999; Rosch et al., 1976). This effect has been utilised in reaction time experiments to distinguish between typical and less typical category members. For example, Ellis and Nelson (1999) explored adults' and children's reaction times and accuracy scores when asked to classify if pictures of prototypical dogs (e.g. Golden Retriever, Beagle), non-prototypical dogs (e.g. Maltese, Miniature Pinscher) and cats (non-category members) were examples of "dogs." They found that both adults and children responded most quickly and accurately when classifying prototypical dogs, less quickly and accurately when classifying non-prototypical dogs (although this difference was more pronounced for children) and showed high accuracy in not classifying cats as dogs.

Drawing on this experimental paradigm, Vichitkunakorn et al. (2022) explored variations in Thai adults' reaction times in response to original and modified alcohol logos, including those placed on bottled water and merchandise (two forms of surrogate marketing that commonly occur in Thailand). They found that participants took slightly longer to recognise the modified logos on non-alcoholic products, but there was no difference in the extent to which the logos prompted a desire to drink alcohol, concluding that the modified logos thus effectively reminded consumers of the alcoholic drinks.

In the current study, we took a similar approach to these two studies,

extending this paradigm to explore differences in adolescents' responses and response times with respect to images of alcoholic drinks, zero-alcohol drinks (including both brand extension and NTW brand drinks), and soft drinks. If zero-alcohol drinks are viewed as less-prototypical members of the alcohol category, we would expect to see slower response times and fewer respondents agreeing that the drinks make them think of alcohol compared to alcoholic drinks. However, we would expect to see more agreement compared to soft drinks. Thus, our research questions were:

RQ1: Are there differences in adolescents' reaction time in response to images of alcohol, brand extension zero-alcohol, and NTW brand zero-alcohol drinks?

RQ2: Are there differences in the proportion of adolescents who agree that images of alcohol, brand extension zero-alcohol, and NTW brand zero-alcohol drinks make them think of alcohol?

Methods

Study design

This study used an online, within-subjects reaction time experimental design. A protocol of this study and analysis procedures were registered in the Open Science Framework (Bartram et al., 2024a).

Participants

331 adolescents aged 15 to 17 years who lived in Australia were recruited to complete a 10 min online experimental survey in April 2024. A sample size of 300 was estimated to provide at least 80 % power to detect differences of 15 milliseconds in reaction time between drink types, with significance set at 0.05, and assuming an intraclass correlation of 0.15 and normally distributed data (Hedges & Rhoads, 2010); this sample size was increased by 10 % to account for the non-normality of reaction time data (Van Zandt & Ratcliff, 1995).

Participants were recruited via a large national online panel provider called "Pureprofile" (<http://www.pureprofile.com/au>). Pureprofile comprises a panel of approximately 80,000 Australian adults aged 18 years and over, who have registered to take part in social and market research surveys and provided detailed profile information, including whether they have children and if they would be willing for their children to be invited to complete surveys. Panel members who had previously indicated that they were the parent or guardian of a child aged 15 to 17 years and might be willing for their child to undertake a survey were sent an invitation for their child to take part in the study via the panel's electronic platform. No invitations were sent directly to minors. The invitation included information about the study and a consent form. Parents were asked to indicate their consent to their child taking part by selecting a response option "I consent to my child participating." Parents who consented were asked to provide their device to their child so the child could complete the survey. The child was also provided with study information and a consent form and asked to indicate their consent to participate by selecting a button to start the survey. Participants were also asked to confirm that their parent had provided consent to their participation. As participants were deemed to be young people of developing maturity, both parent and child consent was required (National Health & Medical Research Council et al., 2023). Participants were reimbursed AUD2 for survey completion. This study had ethical approval from Flinders University's Human Research Ethics Committee (Project ID 6681).

Quotas were applied so that the demographic profile of respondents was similar to the Australian population for gender, state/territory, and metropolitan/regional location. Nonetheless, as the sample was recruited from an online panel via parent panel members who were willing for their child to participate in a survey, it is not representative of all adolescents.

Stimuli

This study used a randomly ordered series of 20 images of packaged drinks, including five examples of each of four drink types: alcohol, brand extension zero-alcohol, NTW brand zero-alcohol, soft drink (see [Supplementary File for images](#)). Although some reaction time experiments use a larger number of trials (e.g. Carpenter et al., 2019 included blocks of up to 40 trials), response consistency has been found to decline in other types of online experiments as the number of trials exceeds 20 (e.g. Bech et al., 2011; Sauer et al., 2011). Further, the optimal survey length when working with adolescents is <10 min (Omran et al., 2019). Therefore, we used 20 images as this provided sufficient power for the within-subjects design while minimising response fatigue and overall survey length.

Zero-alcohol drinks were selected for inclusion based on availability for sale in Australia's two largest supermarkets (locations in which young people were likely to be exposed to zero-alcohol drinks, and which together have 65 % total market share (Statista, 2024a)) and variety of drink type (namely two beers, a wine, spirit, and pre-mix drink were selected; two beers were included because industry reports indicate that beers dominate the zero-alcohol drink market, comprising 80 % of zero-alcohol drink sales in Australia (Food & Beverage Media, 2022)). The same variety of alcoholic drinks were included, with brands nominated as top selling or people's choice in recent Australian industry reports selected for inclusion (Drill, 2023; Parker, 2023; Young, 2023). Soft drinks reflected the most commonly available soft drinks in Australia (C. Miller et al., 2022). Selected drinks were purchased from Australian retail settings and photographed at a uniform distance against a white background to provide images for the experiment. The relative size of each drink was maintained in the experiment, with the lower edge of the image appearing at the same height for each stimulus to ensure that the distance between the image and response options was constant.

By providing brief exposure to images of packaged drinks, we aimed to mimic the brief exposure to packaged drinks that may occur when an adolescent passes the drink on a supermarket shelf or briefly glimpses an advertisement. However, we acknowledge that images were presented without such contextual cues, limiting the ecological validity of the design.

Procedure

After providing informed consent, participants first completed demographic measures and then were introduced to the reaction time experiment. Participants were advised that they would be shown a series of images and that they should respond as quickly as possible. First, participants were shown five practice images of either dogs or cats, and asked to respond as quickly as possible to the question "Is this a dog?" (response options: "Yes"/"No"). After the five practice images, participants were then advised that they would be shown a series of images of different drink products, and asked to respond as quickly as possible to the question "Does this make you think of alcohol?" (response options: "Yes"/"No"). Participants were then shown the 20 stimuli in randomised order. Response options appeared at the same location on the screen for each stimulus. Response and response time from page load (in milliseconds) were recorded for each stimulus. Finally, participants completed measures of product consumption, alcohol initiation, zero-alcohol initiation, and parental presence as described below. The device type used to complete the survey (mobile (including tablet) or non-mobile (including desktop and laptop computers) was detected and recorded automatically by the survey platform and was used as a covariate in response time analyses to adjust for potential differences in response time across devices. The within-subjects design, with each participant responding to each image, served to control for variation in internet speed between participants.

Additional measures

Demographics

Participants reported age, gender, and postcode. Postcode was mapped to the Index of Relative Socio-economic Disadvantage to provide an area-based indicator of socio-economic status (Australian Bureau of Statistics, 2023) and to the Australian Statistical Geography Standard to provide an indicator of metropolitan or non-metropolitan location (Australian Bureau of Statistics, 2021).

Product consumption

At the image level, recent consumption of the 20 stimuli was measured by asking participants whether they have had at least a few sips of this product in the past three months (response options: “Yes”/“No”/“Not sure”, dichotomised to “Yes”/“No or not sure” for analysis).

Alcohol and zero-alcohol initiation

As a measure of alcohol initiation, participants were asked to indicate if they had ever had even part of an alcoholic drink, with response options “No”, “Yes, just a few sips”, “Yes, I have had fewer than 10 alcoholic drinks in my life”, and “Yes, I have had 10 or more alcoholic drinks in my life”, with responses dichotomised to “Never a full drink” (“No”/“Yes, just a few sips”) or “At least one full drink” (“Yes, I have had fewer than 10 alcoholic drinks in my life”/“Yes, I have had 10 or more alcoholic drinks in my life”) for analyses (adapted from Guerin and White (2020)). As a measure of zero-alcohol initiation (whether participants had ever consumed zero-alcohol drinks), participants were provided with a definition and shown an image of examples of zero-alcohol drinks (compiled from the stimuli used in the study), then asked to indicate if they had ever had even part of a zero-alcohol drink, with the same response options as for alcohol initiation.

Parental presence

Participants were asked to indicate whether their parent was present in the room with them while they completed the survey (response options: “Yes”/“No”), as parental presence may influence how young people respond to questions about sensitive behaviours such as alcohol consumption (Horm et al., 1996).

Analysis

Data were analysed using IBM SPSS Statistics 28 (IBM Corp, 2021) for descriptive statistics and RStudio 2024.04.2 for generalized linear mixed-effects models. Trials with response times greater than 10,000 ms (i.e. 10 s) were excluded on the rationale that this was likely to reflect distraction on the part of the participant. A cut-off of 10,000 ms was used as it is a common limit applied in reaction time studies (e.g. Carpenter et al., 2019; Vichitkunakorn et al., 2022). A total of 36 observations from 28 participants were excluded (0.54 % of all observations), with a maximum of three out of 20 observations excluded per participant; no participants were excluded from the study. Descriptive statistics (means, standard deviations, proportions) were first calculated for sample characteristics and outcome variables, and the distribution of response times was examined. To examine differences in response time by drink type, a mixed-effects gamma regression model was used, with drink type, recent product consumption, and survey device included as fixed effects and participant ID included as a random effect to reflect the clustered nature of the data. A gamma distribution is appropriate given the exponentially distributed nature of response time data (Van Zandt & Ratcliff, 1995). To examine differences in the proportion of participants agreeing that a drink makes them think of alcohol by drink type, a mixed-effects logistic regression model was used, with drink type and parental presence included as fixed effects and participant ID included as a random effect to reflect the clustered nature of the data. The model was restricted to include only the drink types alcohol, brand extension zero-alcohol, and NTW zero-alcohol; including soft drinks in the model

led to infeasibly large odds ratios given the extreme distribution of cases (i.e. very few respondents agreed that soft drinks made them think of alcohol while most agreed that the other drink types made them think of alcohol, see Table 1). To assess fit, models were compared to the null (intercept only) model on AIC, BIC, and a likelihood ratio test.

Deviations from protocol

Analyses deviated from those pre-registered on the Open Science Framework (Bartram et al., 2024a) as follows. The protocol did not specify excluding observations greater than 10,000 ms, however this was found to be necessary to support model convergence. Soft drinks were excluded from the mixed-effects logistic regression as noted above. The protocol specified the inclusion of additional covariates, namely alcohol initiation, zero-alcohol initiation, and gender; however, both models failed to converge with all covariates included. For the gamma model, covariates with the smallest estimated differences in response time between categories in bivariate models (see Supplementary Table 1) were eliminated from the full model one by one until convergence was achieved for the gamma model; this was achieved when covariates with an estimated effect of 25 ms or less were excluded. Although an effect of 25 ms was statistically significant, we considered it too small a difference to have meaningful implications for theory or practice. For the logistic model, only those covariates with odds ratios with 95 % confidence intervals excluding 1 in bivariate models (indicating an association between the covariate and response) were included in the final logistic model (see Supplementary Table 2).

Results

Sample characteristics

Table 2 shows sample characteristics: 52.3 % of participants were male, 39.6 % were aged 17, and 72.8 % lived in a metropolitan location, with participants from the most disadvantaged quintile of locations slightly underrepresented (14.2 %). When completing the survey, 61.9 % of participants used a mobile device and 71.6 % had a parent present in the same room. In terms of prior consumption, 29.0 % of participants reported that they had drunk at least a full drink of alcohol previously, while only 5.7 % reported that they had drunk at least a full drink of a zero-alcohol drink.

Response time to prompt ‘Does this make you think of alcohol?’

As shown in Table 1, participants responded to the prompt “Does this make you think of alcohol?” with a mean response time of 1649 ms (SD=935 ms) when shown images of alcoholic drinks, with slower mean response times observed for brand extension zero-alcohol drinks (M = 1765 ms; SD=1078 ms) and NTW brand zero-alcohol drinks (M = 1935 ms; SD=1216 ms). Mean response times for soft drinks were slightly faster than those for alcohol (M = 1618 ms; SD=783 ms).

Table 3 shows the results of a mixed effects gamma regression. Adjusting for clustering of responses within participants and controlling for the type of device used to complete the survey and whether participants had recently consumed the product shown, participants on

Table 1

Mean response time and percent agreement with prompt ‘Does this make you think of alcohol?’ by drink type (n = 6584 observations).

	n	Response time (milliseconds)		Agreement
		M	SD	%
Alcohol	1647	1649	935	94.4
Brand extension zero-alcohol	1652	1765	1078	90.7
NTW brand zero-alcohol	1639	1935	1216	85.6
Soft drink	1646	1618	783	5.2

Table 2
Sample characteristics (n = 331).

	n	%
Gender		
Male/man/boy	173	52.3
Female/woman/girl	151	45.6
Non-binary	6	1.8
Prefer not to answer	1	0.3
Age		
15	91	27.5
16	109	32.9
17	131	39.6
Location		
Metropolitan	241	72.8
Non-metropolitan	90	27.2
Quintile of Relative Socio-economic Disadvantage^a		
Quintile 1 – Most disadvantaged	47	14.2
Quintile 2	63	19.1
Quintile 3	81	24.5
Quintile 4	67	20.3
Quintile 5 – Least disadvantaged	72	21.8
Device used to complete survey		
Mobile	205	61.9
Desktop	126	38.1
Parent present while completing survey	237	71.6
Consumed at least 1 full drink of alcohol	96	29.0
Never consumed alcohol	126	38.1
Consumed just a few sips of alcohol	109	32.9
Consumed fewer than 10 alcoholic drinks in life	36	10.9
Consumed 10 or more alcoholic drinks in life	60	18.1
Consumed at least 1 full drink of zero-alcohol	19	5.7
Never consumed zero-alcohol	252	76.1
Consumed just a few sips of zero-alcohol	60	18.1
Consumed fewer than 10 zero-alcohol drinks in life	15	4.5
Consumed 10 or more zero-alcohol drinks in life	4	1.2

^a N=330 due to missing value on postcode.

Table 3
Mixed effects gamma regression modelling response time in milliseconds to prompt “Does this make you think of alcohol?” (N = 6584 observations among 331 participants).

Fixed Effects	Estimate (ms)	95 % CI		p
		LL (ms)	UL (ms)	
Intercept	1682.49	1674.00	1690.98	<0.001
Drink type (ref: Alcohol)				
Brand extension zero-alcohol	71.95	62.39	81.51	<0.001
NTW brand zero-alcohol	214.51	207.69	221.33	<0.001
Soft drink	47.27	38.04	56.50	<0.001
Recently drunk product	-61.07	-69.85	-52.29	<0.001
Survey device (ref: Mobile)				
Non-mobile	147.23	136.14	158.32	<0.001
Random Effects				
		Variance	SD	
Participant (Intercept)		154,700	393.35	
Model Fit Statistics				
	AIC	BIC	Deviance	
Null (intercept only) model	103,073	103,093	103,067	
Full model	102,926	102,981	102,910	
Likelihood ratio test: $\chi^2(df=5) = 156.48, p < 0.001$				

Note: AIC=Akaike’s Information Criterion; BIC=Bayesian Information Criterion; Deviance=-2 log likelihood; smaller values indicate better fit.

average responded 72 ms slower to images of brand extension drinks, 215 ms slower to images of NTW brand drinks, and 47 ms slower to images of soft drinks compared to images of alcoholic drinks. Participants on average responded 61 ms faster to images of products they had consumed recently, and 147 ms slower if they completed the survey on a

non-mobile device compared to a mobile device.

Agreement with prompt “Does this make you think of alcohol?”

As shown in Table 1, the vast majority of images of alcoholic drinks (94.4 %), brand extension zero-alcohol drinks (90.7 %), and NTW brand zero-alcohol drinks (85.6 %) prompted participants to think of alcohol, while only a small proportion of images of soft drinks (5.2 %) prompted participants to think of alcohol.

Table 4 shows the results of a mixed effects logistic regression examining how agreement varies by drink type, for alcohol and zero-alcohol drink types only. Adjusting for clustering of responses within participants and controlling for parental presence, the odds of an image prompting participants to think of alcohol were significantly lower for brand extension zero-alcohol drinks (AOR 0.51, 95 % CI 0.38, 0.69) and NTW brand drinks (AOR 0.26, 95 % CI 0.20, 0.35) compared to alcoholic drinks. The odds of an image prompting participants to think of alcohol were 1.89 times higher (95 % CI 1.48, 2.41) for brand extension compared to NTW brand zero-alcohol drinks. Participants were also more likely to report that an image made them think of alcohol if a parent was present while they completed the survey (AOR 1.66, 95 % CI 1.02, 2.68).

Discussion

With respect to RQ1, we found adolescent reaction times were slower when responding to images of zero-alcohol drinks compared to images of alcoholic drinks. Reaction times were slower for NTW zero-alcohol drinks than brand extension zero-alcohol drinks. Category prototypicality theory (Ellis & Nelson, 1999; Rosch et al., 1976) suggests that this indicates zero-alcohol drinks were viewed as less prototypical than alcoholic drinks, with brand extension drinks viewed as more prototypical than NTW drinks. With respect to RQ2, we found that nearly all responses indicated zero-alcohol drinks prompted participants to think of alcohol, compared to very few responses to images of prototypical soft drinks. Collectively, these findings suggest that adolescents categorise zero-alcohol drinks within the broader category of “alcoholic drinks,” in contrast to “soft drinks.” These findings support concerns raised by policymakers (World Health Organization, 2023), researchers (Miller et al., 2022b), parents (Harrison et al., 2024), and adolescents (Booth et al., 2024) that the strong visual resemblance between zero-alcohol

Table 4
Mixed effects logistic regression modelling agreement with prompt “Does this make you think of alcohol?” (N = 4938 responses among 331 participants).

Fixed Effects	OR	95 % CI		p
		LL	UL	
Product category (ref: Alcohol)				
Brand extension zero-alcohol	0.51	0.38	0.69	<0.001
NTW brand zero-alcohol	0.26	0.20	0.35	<0.001
Parent present while completing survey	1.66	1.02	2.68	.039
Random Effects				
		Variance	SD	
Participant (Intercept)		2.54	1.59	
Model Fit Statistics				
	AIC	BIC	Deviance	
Null (intercept only) model	2759	2772	2755	
Full model	2667	2699	2657	
Likelihood ratio test: $\chi^2(df=3) = 97.96, p < 0.001$				

Note: Responses to images of soft drink products excluded from model. AIC=Akaike’s Information Criterion; BIC=Bayesian Information Criterion; Deviance=-2 log likelihood; smaller values indicate better fit.

and alcoholic drinks means that exposure to zero-alcohol drinks through their presence in retail environments and advertisements may function similarly to exposure to alcohol products and advertising – a key influence on adolescent alcohol consumption (Jernigan et al., 2017; Yap et al., 2017).

These findings are consistent with research showing that other alcohol-branded products, such as bottled water (Kaewpramkusol et al., 2019; Vichitkunakorn et al., 2022), clothing, and merchandise (Jones et al., 2014) prompt young people to think of alcohol. It extends previous work by showing that, with zero-alcohol drinks, this effect can occur not just for products that share an alcohol brand, but also those employing NTW brands. The findings thus contribute to calls for research into how exposure to zero-alcohol products and advertising may function as surrogate marketing for full-strength alcohol products (Critchlow et al., 2023; World Health Organization, 2023).

Implications for policy

These findings have important implications for policymakers, as they indicate a need to regulate the advertising of zero-alcohol drinks in a similar manner to alcoholic drinks to limit children's exposure to these drinks and their advertising. Regulating the drink category as a whole, rather than just drinks featuring alcohol brand extensions (as implemented in Norway (Purves et al., 2022)), is advisable, since both brand extension and NTW drinks were categorised by adolescents as alcohol. Although existing industry self-regulatory guides do suggest that marketers only promote zero-alcohol drinks to adults, self-regulatory approaches have been found to be ineffective in reducing youth exposure to alcohol advertising (Jongenelis et al., 2021). In addition, these self-regulatory guides explicitly allow for zero-alcohol advertising to include themes that are not recommended for alcohol advertising, such as hydration and health benefits, particularly for NTW brands (Alcohol Beverages Advertising Code, 2023; Diageo, 2023). Mandatory, independent regulations encompassing zero-alcohol drinks are thus recommended, potentially drawing on models for regulating “lookalike” tobacco products (World Health Organization, 2003, p. 15).

Future research directions

Although this study was specific to adolescents, it is plausible that the effect also extends to adults, with research showing that parents may treat zero-alcohol drinks in a similar manner to alcoholic drinks when considering whether to provide them to their children (Bartram et al., 2024c; Harrison et al., 2024). Future research should seek to demonstrate the robustness of the findings by replicating the experiment with different cohorts of adolescents, as well as exploring whether the effects found in this study hold across different demographic groups such as adult drinkers, abstainers, and people with alcohol dependence. In addition, there would be value in exploring which features of drinks other than alcohol content and brand are most influential in prompting people to categorise a drink as an “alcoholic drink” (e.g. product descriptor, container shape). Such research might be useful in guiding regulatory definitions of “alcohol-like” products such as zero-alcohol drinks, helping to reduce inconsistencies in definitions between policy instruments (Bury et al., 2024) and jurisdictions (Okaru & Lachenmeier, 2022).

Strengths and limitations

A strength of this study was its use of an experimental design, pre-registered analysis, and theoretical framework to investigate whether exposure to zero-alcohol drinks prompts adolescents to think of alcohol. However, the online platform may have limited the ecological validity of the study, and future studies could seek to more closely mimic the “real world” conditions in which people encounter zero-alcohol drinks. Response times may have been affected by differences in device type and

internet speed across participants. However, the effect of this on findings was limited by the study design's focus on within-person effects, with within-system variability in web-based reaction time studies found to be small (Reimers & Stewart, 2015). As acknowledged earlier, the sample was not representative of all adolescents, although the within-person design also ameliorates this concern.

Conclusion

Findings from this study suggest that, as least for adolescents, zero-alcohol drinks are best understood as members of the category of “alcoholic drinks,” not “soft drinks.” Exposure to zero-alcohol drinks within retail settings and through advertisements is thus likely to prompt adolescents to think of alcohol in a similar manner to when they are exposed to alcoholic drinks, suggesting that regulatory approaches that seek to limit adolescents' exposure to alcohol should also extend to zero-alcohol drinks.

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Data availability

Data are available upon reasonable request to the corresponding author.

CRedit authorship contribution statement

Ashlea Bartram: Writing – original draft, Methodology, Formal analysis, Conceptualization. **Murthy Mittinty:** Writing – review & editing, Methodology, Formal analysis. **Md Abdul Ahad:** Writing – original draft. **Svetlana Bogomolova:** Writing – review & editing, Methodology, Conceptualization. **Joanne Dono:** Writing – review & editing, Methodology, Conceptualization. **Aimee L. Brownbill:** Writing – review & editing, Methodology, Conceptualization. **Nathan J. Harrison:** Writing – review & editing, Methodology, Conceptualization. **Jacqui Garcia:** Writing – review & editing, Methodology, Conceptualization. **Ivana Glavinic:** Writing – review & editing, Methodology. **Mia May:** Writing – review & editing, Methodology. **Jacqueline Bowden:** Writing – review & editing, Methodology, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Ashlea Bartram reports financial support was provided by Channel Seven Children's Research Foundation Inc. Ashlea Bartram reports financial support was provided by Australian Government Department of Health and Aged Care. Ashlea Bartram reports a relationship with Australian Government Department of Health and Aged Care that includes: funding grants. Md Abdul Ahad reports a relationship with Australian Government Department of Health and Aged Care that includes: funding grants. Jacqueline Bowden reports a relationship with Australian Government Department of Health and Aged Care that includes: funding grants. If there are other authors, they 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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Supplementary materials

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