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Research Paper

Characteristics and effects of cannabis advertisements with appeal to youth in California

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ABSTRACT

Background: California boasts the largest regulated cannabis market in the world, but it is increasingly exposing youth to cannabis marketing, and the state's definition of content appealing to youth is vague. We aimed to identify the specific features of California cannabis ads that increase interest in cannabis use among adolescents to inform reasonably restrictive marketing policy.
Methods: Participants consisted of 409 youth (age 16–20 years) susceptible to using cannabis in the future and living in California. Using an online experiment, participants were randomly assigned to view cannabis ads with and without features previously shown to be appealing to adolescents, followed by questions about attitudes toward the ad and their interest in using the advertised cannabis product or service. Multivariable regressions tested associations of content features with these outcomes.
Results: Several features were significantly associated with increasing youth interest in cannabis use and attitudes toward the ad following ad exposure, including illustration, clear product descriptions, food or flavor references, depictions of positive sensations, adventure, psychoactive effects, and references to heavy consumption.
Conclusion: California cannabis ads contain features that appeal to youth and that are not restricted in California or other U.S. states with legal cannabis retail.

Introduction

Cannabis initiation by underage youth (age <21) is common and tends to peak around age 16 (Miech et al., 2023). Cannabis use during this unique developmental period poses an increased risk of adverse outcomes, including cannabis use disorder, psychosis, and reduced cognitive function (Abush et al., 2018; D'Souza et al., 2022; Lichenstein et al., 2022; Schaefer et al., 2021). It has been well established that exposure to ads, defined in this study as content designed and/or intended to promote product use through advertisements in traditional (e.g., TV, radio, print) and digital media and/or organic content on social media, is associated with alcohol and tobacco product initiation and continued use among youth and young adults (Anderson et al., 2009; Donaldson et al., 2022; Jernigan et al., 2017). The growing cannabis literature reveals a similar pattern: exposure to cannabis ads is associated with cannabis use among adolescents (Dai, 2017; Firth et al., 2022; Trangenstein et al., 2019; Whitehill et al., 2020) and young adults (Cabrera-Nguyen et al., 2016; Kim et al., 2022; Krauss et al., 2017; Rup et al., 2020).

Despite nearly all of the U.S. states with a legal recreational cannabis market implementing some ad placement restrictions to limit exposure to underage youth, (National Institute on Alcohol Abuse and Alcoholism, 2023) youth are nevertheless increasingly seeing cannabis-related ads (Dai, 2017; D'Amico et al., 2018; Fiala, 2020; Trangenstein et al., 2019; Whitehill et al., 2020). Though most social media platforms prohibit paid cannabis ads, they allow brands to post unpaid cannabis ads (e.g., organic posts on brand pages) that are easily accessible to underage youth (Berg et al., 2023). Given that 95% of adolescents aged 13–17 and 93% of young adults aged 18–29 use social media (Gottfried, 2024; Sidoti & Faverio, 2024), it is unsurprising that exposure to cannabis ads on social media is more common than in traditional media (Krauss et al., 2017; Rup et al., 2020). Unlike traditional or digital media, social media allows users to engage with ads by liking, sharing, and/or commenting on posts. Trangenstein et al. found

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adolescents who engaged with cannabis ads on social media used cannabis more heavily (Trangenstein et al., 2019). Further, the social media platforms have not made these brand posts easily accessible to researchers (Yu, 2024), creating challenges in calculating overall youth exposure to cannabis-related content.

Beyond exposure to ads, when the content of the ad (e.g., features or messaging) is appealing to youth, it has a stronger association with use-related outcomes. Youth who find the content appealing are more likely to report positive attitudes toward the content and increased susceptibility to use the product in the future (Arnett & Terhanian, 1998; Chen et al., 2005; Fleming et al., 2004; Goldberg Scott et al., 2023; Nixon et al., 2022). Positive attitudes and susceptibility to use are predictors of future use (Alvaro et al., 2013; Barrington-Trimis et al., 2020; Carey et al., 2018; Pierce et al., 1996) and thus are crucial measures when actual behavioral outcomes data is sensitive and difficult to collect, as with future youth cannabis use. Further, these measures can identify youth who could be prevented from initiation if interventions were implemented, such as regulating cannabis promotional content that influences these precursors to future use.

Several health behavior theories address the causal mechanism of ads' influence on attitudes and behaviors, but in many cases, underage youth are uniquely vulnerable to this influence. Social Learning Theory holds that we learn by observing others and modeling those behaviors seen as normative (Bandura, 1985). Youth experience greater social anxiety than other age groups (Kessler et al., 2005) and tend to be preoccupied with what is socially accepted (Steinberg, 2023). Further, their lack of experience with age-restricted products makes them more susceptible to believing that the way ads portray consumption is normative. Modeling behaviors is even more likely when the person observed is attractive, successful, and/or similar-looking to ourselves (Austin & Hust, 2005; Grube, 1995). Ads can exploit this vulnerability, often depicting celebrities and/or youthful actors, which increases adolescents' intent to purchase the advertised product (Chen et al., 2005; Waiters et al., 2001). Ad modeling also taps into the adolescent process of identity formation (Erikson, 1968), suggesting youth can use consumption to express a brand's identity as their own (Deutsch & Theodorou, 2010; Middaugh, 2019).

The Elaboration Likelihood Model suggests that ads effectively persuade viewers through either 1) central processing, wherein the ad's persuasive message, such as product information, is carefully evaluated by the viewer before acceptance, or 2) peripheral processing, wherein superficial cues like emotions or the attractiveness of the model persuade the viewer to accept the message (Petty & Cacioppo, 1986). Youth are more likely to use peripheral processing, focusing on positive feelings elicited rather than the marketing intent or product attributes (Petty & Cacioppo, 1986). This may be because youth tend to experience more negative affect than other age groups and thus are more receptive to ads that show product use leading to happiness (Pechmann et al., 2005). Youth often report using alcohol or other substances as a way to cope with distress (Gould et al., 2012; Whalen et al., 2001). Another possible explanation is that youth are more likely to respond emotionally rather than cognitively when under emotional or social arousal (van Duijvenvoorde et al., 2016), and ads with dominant emotional or social themes could elicit that kind of reaction.

Conversely, product information, such as taste, quality, composition, and value, tend to trigger central processing (Petty & Cacioppo, 1986) and are less liked by youth when present in alcohol ads (Aitken et al., 1988; Henehan et al., 2020). However, studies of e-cigarette marketing found youth, especially non-users, liked product information (Farrelly et al., 2015; Padon, Lochbuehler, et al., 2018). This may be because e-cigarettes were novel but growing in popularity at the time, and knowing how to use an e-cigarette would have provided social capital. Product information for new cannabis products may be similarly appealing to inexperienced youth.

Lang's Limited Capacity Model adds that humans have limited cognitive resources for message processing. Ads can steal attention away from other tasks using certain stylistic features (e.g., fast edits, intense images), but ads that overload these resources may be ignored or less effective (Lang, 1990, 2000). However, the adolescent brain has a greater need for stimulation than adults (Zuckerman, 1979), predisposing youth to involuntarily orient and attend to ads that use production elements such as illustration, colors, action, and intense images (Gorn et al., 1997; Lang, 2000; Lang et al., 2004; Pieters et al., 2010; Rossiter, 1982). Youth also tend to engage in sensation-seeking and risky activities more often than adults (Gardner & Steinberg, 2005; Giedd, 2008; Martin et al., 2002). Thus, media depictions of adventure or activities that require high alertness, sexual or romantic situations, and rule-bending activities, such as consuming intoxicating substances, result in greater message processing, higher ad recall, and more positive attitudes toward the product among youth (Donohew et al., 1998; Jones & Donovan, 2001; Pechmann et al., 2005; Waiters et al., 2001).

Finally, certain features that youth associate with youth-oriented entertainment, including magic, fantasy, or humor, can increase ad appeal to youth (Chen et al., 2005; Lewis & Hill, 1998). Animals and anthropomorphized creatures or products, which may be given eyes or a voice and shaped into a more humanlike form, are also seen as youth-oriented, and ads featuring these characters are rated highly by youth on likeability (Nash et al., 2009).

To provide specific guidance for cannabis advertising content regulation, research must identify the content features most likely to appeal to underage youth. At least 20 U.S. states have passed regulations that ostensibly aim to restrict cannabis advertising appealing to youth (Allard et al., 2023; Swinburne & Liu, 2022). Many of these laws only offer broad statements, such as prohibiting cannabis from being "marketed or advertised to minors" (Marketing and Advertising Restrictions, Mich. Admin. Code R. 420.507, 2022). Even the regulations with more detail fail to provide clear or enforceable definitions of what constitutes youth-appealing advertising, leaving significant gaps in their effectiveness (Swinburne & Liu, 2022). The California Department of Cannabis Control indicates that ads cannot include:

> (1) any depictions or images of minors or anyone under 21 years of age, and (2) any images that are attractive to children, including, but not limited to: (A) Cartoons; (B) Any likeness to images, characters, or phrases that are popularly used to advertise to children. (§ 15040 - Advertising Placement and Prohibitions, 2021)

Vermont uses similar language, but a few more examples:

> Cannabis Establishments are prohibited from using objects, such as toys, inflatables, movie characters, cartoon characters, child-friendly depictions of food or other consumables, or include any other display, depiction, or image designed in any manner likely to be appealing to minors or anyone under 21 years of age. (Vermont Regulation of Cannabis Establishments § 2.2.11 Advertising, 2023)

Besides the omission of many of the features that have previously been shown to appeal to youth in the literature (Padon et al., 2017; Padon et al., 2018), the lack of specificity on what characters, cartoons, or toys most appeal to adolescents, what images are attractive to children, and what phrases or images are popularly used to advertise to minors presents opportunities for non-compliance and challenges to enforcement. Marketing restrictions informed by research on features appealing to underage youth may reduce the likelihood of initiation of cannabis use before youth can legally purchase. In this study, youth aged 16–20 participated in an online experiment to test the effects of exposure to cannabis ads with specific features on their attitudes and interest in use.

Methods

Selection of experimental stimuli

We collected California cannabis ads from traditional media (i.e., TV,

magazines, newspapers, radio, Internet (display, mobile (web), video, search), and out-of-home (outdoor/billboards)) and social media (Facebook and Instagram) for potential inclusion in the experimental study. A random 10% sample (n = 287) was selected for coding (see **Supplementary Figure 1** for flowchart of selection process). The Content Appealing to Youth (CAY) index modified for cannabis was used to analyze the content of the cannabis ads (Padon et al., 2017; Padon et al., 2018). (See **Supplementary Table 1** for the modified Cannabis-CAY index with feature definitions and scoring.)

To enable an examination of the unique contribution of individual features on youth appeal, we identified a subset of ads that used fewer overall features by summing the features present in each ad and sorting them by feature count. To ensure the experimental sample represented every CAY category (production elements, characters, youth-oriented themes, product appeals, rewarding appeals, and health appeals), we created a dichotomous variable for each ad indicating the absence of any features from each category (0) vs presence of any features from each category (1). Ads were then drawn sequentially from within each category, starting with those with fewer total features for inclusion in the experiment. This resulted in a subsample of 29 ads.

Experimental design

An online experiment was administered using a sequential monadic design and simple random sampling with replacement. Each participant evaluated 5 ads randomly assigned from the subsample of 29, one at a time (Qualtrics, n.d.). Evaluations of each ad were measured immediately after exposure to each ad. Benefits of this method include the efficiency of allowing the same group of participants to evaluate multiple conditions and the minimization of comparison bias by presenting a single ad at a time.

Participants

Youth (age 16–20 years) susceptible to cannabis use and living in California were recruited from Qualtrics' online panel. Qualtrics recruits participants via online advertisements and uses existing panels from partner vendors. Qualtrics' samples tend to be within 5–10% of the corresponding demographic characteristic within the U.S. population (Miliaikeala et al., 2020).

Qualtrics sent invitations to panel members aged 18–20 and to panel members who were parents/guardians of adolescents to request permission to invite their adolescents to participate. Parents and youth were informed that the purpose of the study was to learn about what young people think about cannabis and that a range of questions related to cannabis marketing and cannabis use would be asked. Parents were told that we needed participation from both teens who have used cannabis and those who have not to prevent parents from assuming their teen has used cannabis if they participated. Informed consent or assent (if age under 18) was obtained from all participants. Participants were instructed to complete the study in a private place. All data were received de-identified. The Institutional Review Board of the Public Health Institute approved the project (I21–012).

Measures

Susceptibility to cannabis use

The screening questionnaire measured susceptibility to use cannabis in the future with three items – 1) "Do you think in the future you might try using cannabis?" 2) "If one of your closest friends were to offer you cannabis, would you try it?" and 3) "Do you think in the next 12 months, you might try using cannabis?" from a modified susceptibility-to-smoke index (Persoskie & O'Brien, 2022). Response options ranged from definitely yes (1) to definitely not (4). Those who responded "definitely not" to all three items were excluded from participation as they are considered to have a firm resolve to remain never users (Persoskie & O'Brien, 2022) and are likely not vulnerable to cannabis marketing appeals regardless of the advertising content. All other respondents were considered susceptible to cannabis use and eligible to participate. The three items were averaged to create a single index (Barrington-Trimis et al., 2020; Persoskie & O'Brien, 2022).

Attitudes toward the ads

Attitudes were measured across 8 items: 1) "How much did you like this ad?" (1=dislike a lot – 5=like a lot) (Quantilope, 2024); 2) "This was an effective ad" (1=strongly disagree – 5=strongly agree) (Padon, Lochbuehler, et al., 2018); "The ad I just saw…3) grabbed my attention, 4) is informative, 5) is convincing, 6) makes using cannabis seem unpleasant to me, 7) makes me concerned about the health effects of using cannabis, and 8) makes cannabis use feel safe to me." (Alvaro et al., 2013; Davis et al., 2013) Items (3) – (7) have been used together as the Perceived Message Effects (PME) scale (Cappella, 2018; Duke et al., 2016; Sutton et al., 2019). PME, as a scale, has mainly been tested on anti-tobacco and anti-cannabis health communication campaigns and may be more relevant to ads promoting the avoidance or cessation of behavior. Thus, we tested the reliability of all 8 items combined. Items (6) and (7) were reverse-coded so that higher scores indicate more positive ad evaluation.

Desire to use

Respondents were asked if the ad made them want to "buy the product/use the service," referring to cannabis delivery or storefront dispensaries, and their responses ranged from strongly disagree (1) to strongly agree (5).

Cannabis advertising exposure

Participants were asked where and how frequently they had seen or heard advertising for cannabis, cannabis products, brands, or retail stores/deliverers in the past 30 days across 7 media types: "On billboards or outdoor signs; In print magazines or newspapers; On the radio; On television (broadcast or cable); On social media sites (i.e., Instagram, Tiktok, Facebook, YouTube, Snapchat, Clubhouse, Twitter, Twitch, etc.); On streaming video sites like Hulu, Peacock, Paramount+, Crackle, Fawesome.tv, etc.; On the Internet on websites or blogs." Frequency of exposure within these categories was summed across platforms and dichotomized at the mean. This binary variable reflected lower than average past cannabis advertising exposure (0) versus higher (1), which could represent either high frequency of exposure to cannabis ads on a single medium or less frequent exposure but across media.

Demographic covariates

Self-reported age, race/ethnicity, gender, and sexual orientation were collected.

Statistical analysis

All analyses were conducted in Stata 18. The dependent measures' descriptive data included univariate summary statistics, Cronbach's alpha for scale reliability, item-test, and item-rest correlations. Following reliability testing of the items measuring attitude toward the ads, we dropped 3 items, and the remaining 5 were averaged into a single measure of attitudes toward the ad. (See **Supplementary Figure 2** for reliability testing details).

Unadjusted means and standard deviations of the ad evaluation outcomes were calculated for each content feature. We conducted separate multivariable regression models (ordered logistic regression for desire to use cannabis products or services and linear regression for the continuous attitudes measure) to assess the statistical significance of associations between each outcome and feature. Stata's vce cluster option accounted for non-independent ratings among participants across ads. Models adjusted for race/ethnicity (reference group: non-Hispanic White), gender (reference group: female), sexual orientation

(reference group: lesbian, gay or bisexual (LGB)), susceptibility to future cannabis use (reference group: less susceptibility), and past cannabis ad exposure (reference group: low exposure, centered at the mean). Including susceptibility and past ad exposure yielded a better fitting model than solely controlling for demographics based on Akaike information criteria and Bayesian information criteria. When multiple features were in the same ad, we conducted sensitivity analyses that included the overlapping features in the same model to test the robustness of the associations.

Results

Sample description

Study sample demographics are presented in Table 1. The average age was 17.7 (SD=1.4), and predominantly female. The distribution of race/ethnicity of the sample was similar to the population of 13–17-year-olds in California (KidsData, 2021), though the proportion of NH Asians was 6.6 percentage points lower than in the state. The percentage reporting lesbian, gay or bisexual orientation was higher than has been reported for high schoolers in California (Austin et al., 2023), but the study sample includes 19 and 20 year olds, and rates have been shown to increase with age and over time (Johnson, 2024). Almost 30% (n=118) answered "definitely yes" to all three intentions to use cannabis items. Eighty-seven percent had seen or heard cannabis ads in the past 30 days. Nearly 40% (n=159) had higher than average past cannabis ad exposure, due to a right skew.

The overall average desire to use the advertised cannabis product or service was 2.97. Agreement on the attitudes items ranged from 3.13 to 3.29, with a 3.19 overall mean attitude measure (Table 2). (See **Supplementary Table 2** for the frequency of CAY content features and ratings by feature in the ad sample).

Table 3 shows unadjusted, average ad evaluation ratings following exposure to ads with each CAY feature. The highest ratings for desire to use and positive attitudes toward the ad were given to ads with animals or creatures (desire to use: M=3.27, ad attitudes: M=3.43, respectively), illustration (M=3.22, M=3.39), and positive sensation features (M=3.20, M=3.37). The lowest-rated features were faces (M=2.68, M=3.08), avoiding negative mood (M=2.71, M=3.07), humor

Table 1
Sample characteristics among youth (age 16–20) participants (n = 409).

		M (SD)
Age		17.7 (1.4)
Intentions to use cannabis in the future[a]		2.03 (0.87)
High past cannabis ad exposure[b] (n (%))		159 (38.9)
		n (%)
Gender Identification	Female	299 (73.1)
	Male	82 (20.1)
	Non-Binary/Prefer not to say[c]	28 (6.9)
Race/Ethnicity	Non-Hispanic White	120 (29.3)
	Non-Hispanic Black	36 (8.8)
	Non-Hispanic Asian	18 (4.4)
	Non-Hispanic Other[d]	32 (7.8)
	Hispanic/Latinx	203 (49.6)
Sexual Orientation	Straight	245 (59.9)
	Lesbian or gay	39 (9.5)
	Bisexual	93 (22.7)
	Other/Prefer not to say	32 (7.8)

[a] Intentions to use cannabis in the future was calculated by averaging across the three items.

[b] High past cannabis ad exposure was defined as having a score above the mean frequency of cannabis ad exposure (M=4.6; SD=4.7; Min=0, Max=29).

[c] This category included "third gender," "genderfluid," and "other" gender identifications.

[d] Due to small sample sizes, respondents who identified as Native American, American Indian, Hawaiian Islander, Pacific Islander, Other, or more than one race were grouped in a single category.

Table 2
Dependent measures scale metrics from participants' (n = 409) ad ratings (n = 2035).

Measures	M (SD)	α[a]	Scale
Desire to use	2.97 (1.31)		1 (Strongly disagree) – 5 (Strongly agree)
Attitudes toward the ad	3.19 (1.00)	0.88	
Ad made cannabis use seem safe to me	3.20 (1.18)		
Ad grabbed attention	3.29 (1.29)		
Ad was informative	3.16 (1.21)		
Ad was effective	3.13 (1.24)		
Ad liking	3.16 (1.16)		1 (Dislike a lot) – 5 (Like a lot)

Notes: All dependent measures were scaled such that a higher value for the scale or item indicates more positive responses (e.g., more favorable attitudes). Desire to use was measured from a single item with response options from 1 (strongly disagree) to 5 (strongly agree). Attitude toward the ad measure averaged across the five items.

[a] Cronbach's alpha measure of reliability.

Table 3
Unadjusted mean ratings for desire to use cannabis products or services and ad attitudes following exposure to ads with each content feature.

Ad Feature	Desire to use M (SD)	Ad Attitudes M (SD)
Production elements		
Illustration	3.22 (1.29)	3.39 (0.96)
Colors[a]	3.02 (1.28)	3.24 (0.97)
Portrait mode	2.98 (1.32)	3.17 (1.02)
Texture	2.94 (1.31)	3.18 (0.99)
Shine	3.02 (1.31)	3.26 (0.99)
Action	3.02 (1.33)	3.26 (0.98)
Characters		
Faces	2.68 (0.13)	3.08 (0.94)
Animal/creature	3.27 (1.25)	3.43 (0.90)
Youth theme		
Magic/Fantasy	3.14 (1.33)	3.34 (0.98)
Humor	2.81 (1.30)	3.11 (1.05)
Product appeals		
Product described[b]	3.11 (1.29)	3.33 (0.93)
Product shown	3.05 (1.31)	3.26 (0.98)
Food/flavor	3.06 (1.35)	3.25 (1.04)
Price	3.09 (1.29)	3.31 (0.93)
Product properties	3.11 (1.32)	3.26 (1.01)
Product composition	3.00 (1.32)	3.18 (1.00)
Competitive appeal	3.00 (1.32)	3.16 (1.03)
Rewarding appeals		
Positive sensation	3.20 (1.32)	3.37 (0.99)
Positive mood	2.99 (1.29)	3.26 (0.97)
Avoiding mood	2.71 (1.30)	3.07 (0.98)
Psychoactive appeal	3.16 (1.35)	3.33 (1.02)
Addiction	3.04 (1.31)	3.25 (0.98)
Adventure	3.12 (1.27)	3.34 (0.96)
Socializing	2.87 (1.31)	3.23 (0.99)
Individuality	2.89 (1.25)	3.21 (0.91)
Health appeals	2.98 (1.02)	3.03 (1.03)

Note: Desire to use was measured from a single item with response options from 1 (strongly disagree) to 5 (strongly agree). The ad attitudes measure was created by averaging 5 items. Features are omitted if they either did not appear or appeared only once in the sample of ads (i.e., surprise, intense images, youthful model, fictional spokesperson, celebrity, avoiding negative sensation, achievement, physical performance, social positioning, sexual or romantic connotations, and injury).

[a] Categorized as % ads with three or more colors.

[b] Categorized as % when the product is immediately apparent.

(M=2.81, M=3.11) and health appeals (M=2.98, M=3.03).

Multivariable regression analyses adjusting for clustering of ratings and covariates age, gender, race, sexual orientation, susceptibility to future use, and previous exposure to cannabis ads (Table 4) confirmed many of the Cannabis-CAY index features are appealing to youth when present in cannabis ads. Across the production elements features, ads featuring illustration had significantly higher odds of youth reporting a desire to use the advertised product (OR=2.0, 95%CI [1.59–2.58]) and positive attitudes toward the ad (b=0.41, p<.001) compared to ads without illustration. The odds of reporting a desire to use the product and likelihood of positive ad attitudes were significantly higher for ads featuring action (OR=1.53, 95%CI [1.16–2.02]; b=0.30, p<.001), more colors (OR=1.44, 95%CI [1.10–1.89]; b=0.21, p<.01), and shine (OR=1.36, 95%CI [1.15–1.60]; b=0.22, p<.001) than for ads without these features. Of the production elements, only portrait mode and texture were not associated with the outcomes.

Among the character features, animals or other creatures significantly increased the odds of desire to use (OR=1.73, 95%CI [1.22–2.47]) and positive ad attitudes (b=0.30, p<.001) compared to ads without animals or creatures. However, ads with faces significantly decreased the odds of desire to use (OR=0.57, 95%CI [0.48–0.70]) and ad attitudes (b=-0.15, p<.05). This relationship was maintained in models that adjusted for other features in the ads with faces and when iteratively removing ads with faces one at a time and rerunning the model.

We also explored youth-oriented themes, the third CAY category. Neither magic/fantasy nor humor were significantly related to desire to use the product or positive attitudes.

Nearly all the product appeals were significantly and positively related to desire to use and ad attitudes. The odds of wanting to use the product were 91% higher for ads with references to foods or flavors (95%CI [1.48–2.47]), and positive ad attitudes increased by 0.35 points (p < .001) compared to ads without food or flavor references. Clearly describing the product and showing the product increased the odds of desire to use it by 58% (95%CI [1.30–1.94]) and 42% (95%CI [1.21–1.67]), respectively, and each increased positive attitudes (b=0.28, p<.001; b=0.19, p<.001) compared to ads that did not clearly describe or show the product. Pricing information was also significantly related to desire to use (OR=1.27, 95%CI [1.05–1.54]) and ad attitudes (b=0.16, p<.05). Information on the product properties and product composition each increased the odds of wanting to use the product (OR=1.51, 95%CI [1.29–1.77]; OR=1.26, 95%CI [1.07–1.50]) and properties increased positive ad attitudes by 0.15 (p < .001), but composition was not significantly related to attitudes. Of the product appeals, only competitive appeals were not significantly related to either of the outcomes.

Findings were mixed among the CAY features interpreted as rewarding appeals. The odds of reporting a desire to use the product and likelihood of positive ad attitudes were significantly higher for ads featuring positive sensations (OR=1.88, 95%CI [1.44–2.46]; b=0.33, p<.001), psychoactive appeal (OR=1.47, 95%CI [1.20–1.81]; b=0.17, p<.01), addiction (OR=1.26, 95%CI [1.04–1.52]; b=0.13, p<.01) and adventure (OR=1.32, 95%CI [1.06–1.63]; b=0.19, p<.001). However, depicting cannabis as a means of avoiding bad moods decreased the odds of wanting to use (OR=0.52, 95%CI [0.35–0.77] and was negatively associated with ad attitudes (b=-0.19, p<.05). Socializing, individualism, and depicting cannabis to promote good moods were not significantly related to the outcomes.

Finally, health appeal, a new potential CAY category, was tested. References to cannabis use improving health decreased the odds of desire to use (OR=0.83, 95%CI [0.70–0.99]) and was negatively associated with attitudes toward the ad (b=-0.18, p<.001) compared to ads without health appeal features.

Table 4
Multivariable logistic regressions of ad evaluation outcomes desire to use cannabis products or services and linear regressions of ad attitudes following exposure to ads with each feature, adjusting for covariates and accounting for clustering of participant ratings.

	Desire to use			Ad Attitudes		
Ad Features	**OR (SE)**	**LLCI**	**ULCI**	***b* (SE)**	**LLCI**	**ULCI**
Production elements						
Illustration	**2.03 (0.25)**	1.59	2.58	**0.41 (0.06)**	0.30	0.53
Colors	**1.44 (0.20)**	1.10	1.89	**0.21 (0.06)**	0.08	0.33
Action	**1.53 (0.22)**	1.16	2.02	**0.30 (0.07)**	0.18	0.43
Shine	**1.36 (0.11)**	1.15	1.60	**0.22 (0.04)**	0.15	0.30
Portrait mode	1.12 (0.08)	0.96	1.29	0.02 (0.04)	−0.05	0.09
Texture	0.88 (0.07)	0.75	1.03	−0.05 (0.04)	−0.13	0.04
Characters						
Animal/ Creature	**1.73 (0.31)**	1.22	2.47	**0.39 (0.08)**	0.15	0.45
Faces	**0.57 (0.06)**	0.48	0.70	**−0.15 (0.05)**	−0.25	−0.06
Youth theme						
Magic/Fantasy	1.27 (0.22)	0.90	1.78	0.14 (0.08)	−0.02	0.30
Humor	0.73 (0.12)	0.53	1.02	−0.07 (0.09)	−0.25	0.11
Product appeals						
Product described	**1.58 (0.16)**	1.30	1.94	**0.28 (0.05)**	0.18	0.38
Product shown	**1.42 (0.12)**	1.21	1.67	**0.19 (0.04)**	0.11	0.27
Food/flavor	**1.91 (0.25)**	1.48	2.47	**0.35 (0.06)**	0.23	0.47
Price	**1.27 (0.13)**	1.05	1.54	**0.16 (0.05)**	0.06	0.26
Product properties	**1.51 (0.12)**	1.29	1.77	**0.15 (0.04)**	0.07	0.23
Product composition	**1.26 (0.11)**	1.07	1.50	0.00 (0.04)	−0.08	0.08
Competitive appeal	1.06 (0.09)	0.89	1.26	−0.06 (0.04)	−0.14	0.03
Rewarding appeals						
Positive sensation	**1.88 (0.26)**	1.44	2.46	**0.33 (0.06)**	0.20	0.46
Psychoactive appeal	**1.47 (0.15)**	1.20	1.81	**0.17 (0.05)**	0.07	0.27
Addiction	**1.26 (0.12)**	1.04	1.52	**0.13 (0.05)**	0.03	0.22
Adventure	**1.32 (0.14)**	1.06	1.63	**0.19 (0.05)**	0.09	0.29
Socializing	0.81 (0.10)	0.64	1.02	0.02 (0.06)	−0.10	0.14
Positive mood	0.89 (0.10)	0.71	1.12	0.10 (0.06)	−0.00	0.21
Avoiding mood	**0.52 (0.10)**	0.35	0.77	**−0.19 (0.09)**	−0.38	−0.01
Individualism	0.94 (0.11)	0.74	1.18	0.07 (0.06)	−0.05	0.18
Health appeals	**0.83 (0.07)**	0.70	0.99	**−0.18 (0.05)**	−0.28	−0.09

Notes: p-values < 0.05 indicated in bold. LLCI=Lower level confidence interval; ULCI=Upper level confidence interval. Ordered logistic regression was used to model desire to use, a categorical variable, and linear regression was used to model the ad attitudes measure as continuous. Stata's vce cluster option accounted for non-independent ratings among participants across ads. Ad features were normalized. Models adjusted for covariates age, race/ethnicity (reference group: non-Hispanic white), sex (reference group: female), sexual orientation (reference group: bisexual/gay), mean susceptibility to future cannabis use, and past cannabis ad exposure (reference group: low exposure, centered at the mean).

Discussion

Our results identify ad features that are significantly associated with underage youth's desire to use cannabis products or services and positive attitudes toward cannabis ads, both of which are predictors of future use (Fleming et al., 2004; Pierce et al., 2018; Ray et al., 1973; Unger et al., 2003). This represents an opportunity to align the findings with U. S. cannabis marketing regulations to prevent and reduce cannabis use among youth.

Regarding effective state-level strategies, several states have implemented prohibitions on the use of cartoons or cartoon characters in advertising (Allard et al., 2023), a measure that our findings suggest is partially supported. However, the definition needs to be expanded to reflect respondents' preference for illustrated ads more broadly, as well as to specify that animals or creatures should not be allowed. Our findings also support regulations that prohibit depicting actual product use in ads, which may reduce normative perceptions consistent with social cognitive theory (Bandura, 1985). However, the youth in our study also liked clear descriptions of the cannabis products and ads that showed the product even when not in use. Thus, it may be prudent to omit images of the actual products.

In contrast to these effective strategies, our findings also highlight certain measures implemented by states that appear to have limited impact on reducing ad appeal to youth. States that prohibit "images… popularly used to advertise to children" may interpret magic and fantasy to be banned, as they are considered youth-oriented. However, these features were not associated with youth attitudes or increased interest in using cannabis.

Beyond the measures currently implemented, our findings identify critical areas where states have yet to take action. Appeals like food and flavors that youth recognize, promises of positive sensations from cannabis use, and feeling "high" (psychoactive appeal) likely trigger peripheral processing of the content and create positive expectancies of cannabis use, a significant predictor of future use (Fleming et al., 2004; Hapsari et al., 2017; Petty & Cacioppo, 1986). Policymakers may want to limit food/flavor references to text-only and avoid depictions or descriptions of the intoxicating effects of cannabis.

Some results contradict previous assumptions and require additional investigation. For instance, showing human faces in ads typically makes the ads more likely to get noticed (ADWERX, 2024; Kauffmann et al., 2021). However, in this study, faces were associated with decreased odds of positive attitudes and interest in using cannabis. One possibility is that while youth are likely to emulate younger-looking models due to their similarity to the viewer (Bandura, 1985; Chen et al., 2005), the models in this sample looked older. The presence of faces may also have triggered a negative feeling of self-consciousness as youth were asked about illegal behavior (Baltazar et al., 2014). Two-thirds of the ads with faces in this sample had unsmiling, serious expressions (see Fig. 1 for an example), which could compound the feeling of social judgment. Future qualitative and neuromarketing research could help explain under what conditions faces and social scenes contribute to perceptions of positive lifestyle appeals versus prohibitive behavioral norms.

Limitations

The respondent sample included only Californian youth, who were disproportionately female and LGB, which may bias the findings. Rates of cannabis use among female adolescents have recently surpassed males' (Miech et al., 2024), and lesbian, gay, and bisexual teens have high cannabis use rates (Caba et al., 2024). Asian ethnicity was underrepresented, and that group has lower rates of cannabis use. These characteristics limit generalizability. Future research should explore

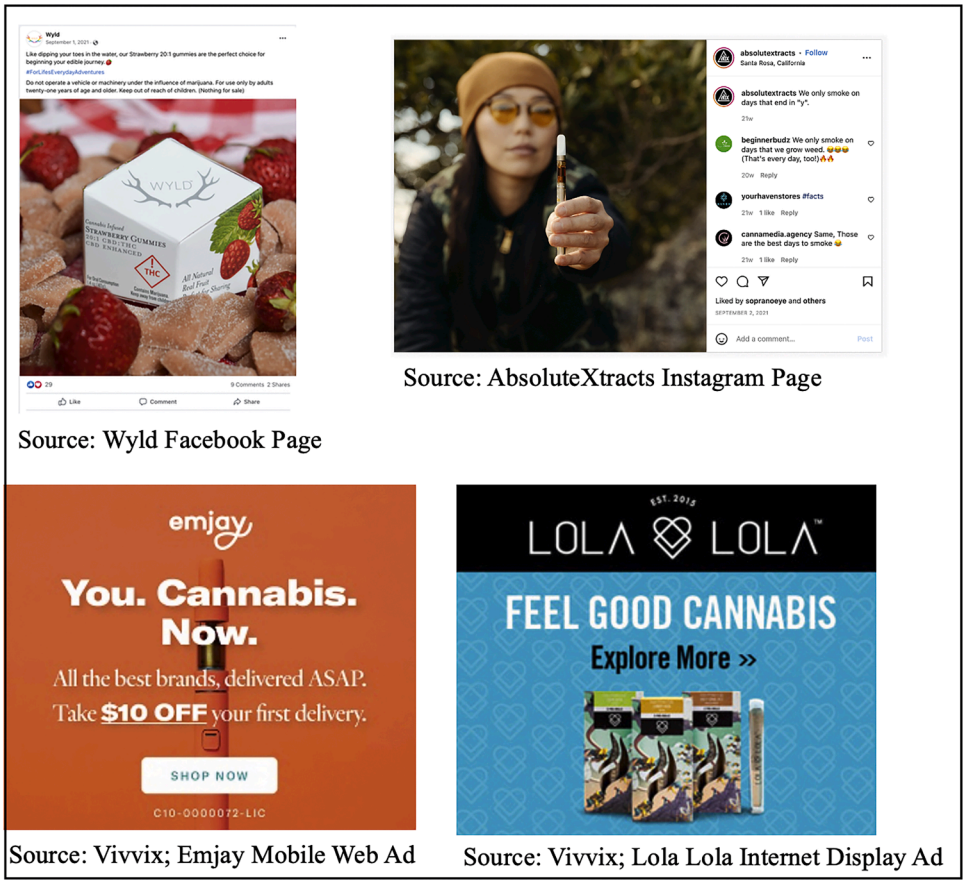

Fig. 1. Examples of advertisements.

whether these effects vary across subgroups that may be more at risk of cannabis use, which could provide valuable insights into subgroup-specific responses to ads that could be used to prevent initiation of use.

To examine the unique contribution of each feature on appeal among youth, ads that contained fewer content features were selected for this study. Still, most of the ads contained multiple features, which presents limitations to concluding whether specific features are more effective than others. However, this sample has ecological validity in that ads tend to contain multiple youth-appealing features (Hoetger et al., 2020; Padon et al., 2017; Padon, Rimal, DeJong, et al., 2018), and previous research has shown that increasing ads' design complexity through multiple features increases the attention paid to the ad (Pieters et al., 2010). Earlier CAY studies found a positive association between the count of CAY features in an ad and youth brand preference (Padon et al., 2018c). Future research should test the replicability of this study's feature-level analysis while examining how those effects might change with differing combinations and counts of features within an ad among youth.

Features' effects on youth may be stronger if presented in more dynamic formats. We did not include radio or video ads, which can include sound effects, sound saturation, music, quick camera cuts, and enhanced ability to tell a story, thus warranting future research.

Teens perceive different cannabis products to have different risks, thus, effects may differ depending on the cannabis product being advertised. For example, concentrated cannabis products and cannabis vapes that are higher in potency than cannabis flower may be advertised using psychoactive appeals and references to heavy or frequent use more than other cannabis products. Because these products are used more often by adolescents with existing riskier behaviors, such as co-use with other substances (Meier et al., 2019), these effects may also be moderated by previous cannabis use. Our study focuses on the effects of CAY features controlling for covariates to inform policy interventions that apply broadly across diverse populations. However, future research should explore whether these effects vary by intentions to use cannabis in the future.

Despite these limitations, this study demonstrates a need to reconsider current advertising restrictions for cannabis. We recommend that states add or broaden regulations on prohibited or restricted content and add specific examples of "images, characters, or phrases" that research suggests youth find appealing. States may also consider implementing a marketing pre-approval process, as in Vermont (Alcoholic Beverages, Cannabis, and Tobacco; § 864. Advertising, 2021), to increase the likelihood of compliance and aid enforcement.

Conclusions

This evidence suggests that current regulations may not be preventing cannabis ads that increase youth interest in using cannabis. These findings provide a foundation to guide marketing policy to reduce ads' influence on youth and prevent or reduce cannabis use among youth.

Ethics approval

The authors declare that they have obtained ethics approval from an appropriately constituted ethics committee/institutional review board where the research entailed animal or human participation.

Public Health Institute Institutional Review Board; Approval number I21–012.

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CRediT authorship contribution statement

Alisa A. Padon: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Dara G. Ghahremani:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Bethany Simard:** Writing – review & editing, Supervision, Software, Methodology, Investigation, Funding acquisition, Formal analysis. **Aurash J. Soroosh:** Writing – review & editing, Investigation. **Lynn D. Silver:** Writing – review & editing, Investigation, Conceptualization.

Declaration of competing interest

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

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2025.104718.

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