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Yet Again Conversations Matter: The Importance of Interpersonal Discussions, Educational Campaigns, and Advertising on Cannabis-Related Risk Perceptions, Attitudes, and Intentions in At-Risk Young Adults

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ABSTRACT

The present study seeks to evaluate the relationships between cannabis-related communication and outcomes of interest such as cannabis-related risk perceptions, attitudes, and behaviors among young adults. Young adults who were at risk for cannabis use were surveyed online in 2020. Results showed that exposure to online educational messages was associated with higher intentions of engaging in peer intervention, while exposure to online advertising was related to higher intention to use cannabis. Anti-cannabis interpersonal discussion was associated with increased risk perceptions, less favorable cannabis attitudes, and a higher likelihood of peer intervention. More pro-cannabis interpersonal discussion was associated with decreased risk perceptions, more favorable cannabis attitudes, higher use intention, and decreased likelihood of peer intervention. In addition, pro-cannabis interpersonal discussion mediated the relationship between exposure to advertising and cannabis risk perceptions, intentions to use cannabis, attitudes about cannabis, and the likelihood of peer intervention. In contrast, anti-cannabis interpersonal discussion mediated the relationship between exposure to educational messages online and cannabis risk perceptions and the likelihood of peer intervention. These findings underscore the need to regulate online cannabis marketing and the importance of investing in online education campaigns to increase public understanding of the risks associated with cannabis consumption in young adulthood.

As the legalization of recreational cannabis use expands across the United States, there is a growing need to educate the public, especially adolescents and young adults, about the health risks of this product. The Centers for Disease Control and Prevention outline some of these risks including but not limited to addiction (Hall & Degenhardt, 2009; Lopez-Quintero et al., 2011), impact on brain development and functioning (Batalha et al., 2013; Filbey et al., 2014), pulmonary (Aldington et al., 2007; Hall & Degenhardt, 2009; Tashkin, 2013; Taylor, Poulton, Moffitt, Ramankutty, & Sears, 2000) and heart concerns (Franz & Frishman, 2016; Hall & Degenhardt, 2009; Rumalla, Reddy, & Mittal, 2016a, 2016b; Sidney, 2002; Wolff et al., 2013), and effects on mental health (Bovasso, 2001; Hall & Degenhardt, 2009; McKay & Tennant, 2000; Rey, Sawyer, Raphael, Patton, &

Lynskey, 2002; Rey & Tennant, 2002; Volkow et al., 2016). Despite this, recent data suggest that young adults' perceptions of potential harm of cannabis have declined precipitously (Johnston et al., 2018). Also, cannabis use among young adults (18–25-year-olds) presents an upward trend. In comparison to 2002, when 29.8% of the young adults reported cannabis use in the past year, in 2019 this estimate was 35.4% (Substance Abuse and Mental Health Services Administration, 2020). Considering the negative implications of cannabis use and the growing popularity of cannabis products among young adults, there is an urgent need to better understand how exposure to cannabis-related messaging (e.g., online marketing, interpersonal discussions, and educational campaigns) affects risk perceptions, attitudes, and behavioral intentions of young adults regarding cannabis use. Such insights can inform public health regulations and communication campaigns that can educate young adults about the potentially harmful effects of cannabis and prevent early initiation.

One factor that can affect cannabis use by young adults is social influence, in particular, interpersonal discussions between young adults as social diffusion can facilitate or inhibit substance use behaviors among different groups (Wakefield, Loken, & Hornik, 2010). Interpersonal discussions may constitute an effective social

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influence because these interactions provide an opportunity for youth to access other people's attitudes and verify their own knowledge about the world (Southwell & Yzer, 2009). In addition, expressing one's opinion to a group may alter the whole network's opinion climate toward a topic even when an expressed opinion is initially inconsistent with the group norm (David et al., 2006). More generally, interpersonal communication allows for the provision of more information to one's group as well as the establishment or change of existing social norms. Recent research on cannabis information processing suggests that receiving information about marijuana from interpersonal sources can differentially affect attitudes toward cannabis depending on whether individuals have high or low elaboration motivation, ability, and trust in the source (Lewis, Rossmann, de Bruijn, & Martinez, 2022). In addition, past research (Jeong & Bae, 2018), especially on tobacco use interventions, has shown that interpersonal discussions can change not only beliefs and attitudes but also smoking-related behaviors (Hafstad, Aarø, & Langmark, 1996; Hwang, 2012; Jeong, Tan, Brennan, Gibson, & Hornik, 2015; Morgan et al., 2018; Tan, Bigman, Mello, & Sanders-Jackson, 2015; Tan, Bigman, & Sanders-Jackson, 2015; Thrasher et al., 2016). For instance, exposure to conversations about educational campaigns positively influenced individuals' anti-smoking beliefs in a large-scale study (Hwang, 2012). In relation to e-cigarettes, anti-vaping interpersonal discussions were associated with higher perceived harm of e-cigarettes, while pro-vaping interpersonal discussions were associated with lower perceived harm of e-cigarette consumption (Tan, Bigman, Mello, & Sanders-Jackson, 2015). In addition, having anti-smoking conversations as well as health warning labels was related to increased attempts to quit smoking (Hafstad et al., 1996; Jeong et al., 2015; Morgan et al., 2018; Tan, Bigman, & Sanders-Jackson, 2015).

Educational campaigns and advertising can also affect individuals' health beliefs and behaviors. For instance, exposure to educational campaigns about smoking had a positive effect on participants' anti-smoking beliefs (Hwang, 2012). In the e-cigarette domain, advertising was associated with increased health concerns, while favorable advertising was related to decreased health concerns post-consumption (Tan, Bigman, Mello, & Sanders-Jackson, 2015). A recent study regarding cannabis marketing on Facebook, Instagram, and Twitter showed that increased exposure to cannabis-related advertising was associated with cannabis use in the previous year among 15–19-year-olds (Whitehill, Trangenstein, Jenkins, Jernigan, & Moreno, 2020). These results warrant further examination of how online and social media campaigns and advertising affect young adults' perceptions of cannabis and cannabis behaviors. Given that recreational cannabis is legal in only 18 states and in the District of Columbia, the regulations related to cannabis advertising remain state-specific, and most social media platforms have their own policies about what kind of advertising content can be posted (Pickel, 2018; Whitehill et al., 2020). Yet, even though most platforms prohibit direct advertising of cannabis (Pickel, 2018), cannabis companies and dispensaries can still have social media pages for their brands that are widely accessible to young adults who are frequent users of these social media platforms (Whitehill et al., 2020). Considering that nearly all teens use some social media platforms and 45%

of them are constantly present on them (Anderson & Jiang, 2018), young adults have plenty of opportunities to be exposed to cannabis marketing on social media and on the internet more generally (Dai, 2017).

Extending the previous findings, this study sought to examine how interpersonal discussions, as well as exposure to social media posts such as anti-cannabis educational messages and pro-cannabis marketing, affect individuals' perceptions of cannabis-related health risks, intentions to use, pro-cannabis attitudes, and likelihood of peer intervention (i.e., educating cannabis-using friends about the health harms of cannabis use and offering to help). We are specifically interested in examining the likelihood of peer intervention because enhanced intentions to converse with cannabis users and to inform them about the health consequences of cannabis consumption would attest to the potential of leveraging peer influence in preventing cannabis initiation and progression (David et al., 2006; van den Putte, Yzer, Southwell, de Bruijn, & Willemse, 2011). Educational campaigns and interpersonal discussions may facilitate positive peer influence, and in turn, successful peer interventions. Bigman, Mello, Sanders-Jackson, and Tan (2019) found that messages that increase personal perceptions of the risks associated with vaping led individuals to speak up more frequently against vaping in public spaces. Similar results were observed by Kam and Lee (2013) where those who were more exposed to anti-drug messages were more likely to talk to their friends about the negative consequences of drug use. These results suggest that mass communication messages may increase the likelihood of peer intervention. We hypothesize that increased exposure to educational messages and anti-cannabis interpersonal discussions about cannabis will be associated with increased risk perceptions, lower intentions to use cannabis, lower pro-cannabis attitudes, and higher likelihood of peer intervention, whereas exposure to both pro-cannabis interpersonal discussions and social media advertising about cannabis will yield the opposite results.

Next, considering that in the case of tobacco use, interpersonal discussions have been shown to mediate the relationship between the anti-smoking campaign exposure and smoking-related beliefs and quitting behaviors (Hwang, 2012; Jeong et al., 2015; van den Putte et al., 2011) and that friend-to-friend communication against drugs (including cannabis) mediated the relationships between anti-drug mass media campaign message exposure and viewing anti-drug websites (Kam & Lee, 2013), we seek to assess these relationships in the domain of cannabis use, empirically testing the mediating effects of cannabis-related interpersonal discussion. We hypothesize that (a) pro- and (b) anti-cannabis interpersonal discussions will, respectively, mediate the relationships between educational message exposure (IV) and outcomes (DV) including risk perceptions, intentions to use cannabis, pro-cannabis attitudes, and likelihood of peer intervention, in opposite directions.

Lastly, if interpersonal discussion mediates the relationship between educational campaign exposure and outcomes of interest, will these effects be present with pro-cannabis advertising? Past research in alcohol advertising suggests that interpersonal communication can mediate the relationship between exposure to alcohol advertising and drinking (Jang & Frederick, 2012). In

addition, alcohol advertising that contains humor can spark interpersonal conversations that will, in turn, lead to more positive evaluations of the ad, the brand, and more general alcohol evaluations (Hendriks & Strick, 2020). Extending these findings into research about cannabis advertising, we will assess whether and how pro- and anti-cannabis interpersonal discussions mediate the effects of advertising on outcomes of interest.

Method

Study Sample and Data Collection

An online survey was fielded with the national, but non-probabilistic, Qualtrics panel between September 28 and October 12, 2020, to assess cannabis warning labels' effectiveness among 18–26-year-olds at risk for cannabis use. We specifically focused on participants at elevated risk of cannabis use and screened out those reporting *definitely no* to all of the following items: 1) use of marijuana in the next 6 months, 2) willingness to try marijuana if one of their best friends offered it, and 3) being curious about using marijuana. This sample was matched with national distributions of gender, race, and ethnicity. The final analytical sample included 523 participants. Detailed descriptive statistics of sample characteristics are presented in Table 1.

This paper reports data collected from a larger project, whose protocol was approved by the Institutional Review Board at the corresponding authors' institution. The larger project also collects experimental data on how re-design cannabis warning labels could improve information recall, emotional reactions, and perceived message effectiveness, and these results do not overlap with the current study and will be reported separately (Kim et al., 2022). Importantly, all the independent variables reported in the current paper were measured prior to randomized exposure to cannabis warning labels and were hence statistically independent of experimental conditions. All the dependent variables reported here were measured after experimental conditions. We controlled for experimental condition assignment in all follow-up analyses. Because exposure to cannabis warning labels is statistically independent of cannabis-related communication variables (all measured prior to treatment) reported here due to randomization, such exposure would not bias the estimation of the *relationships* between, though not necessarily the mean levels of, these predictors and outcomes. Data and material can be accessed at <https://osf.io/uv27s/>.

The present study employs multiple regression and structural equation modeling to gather correlational evidence on how cannabis-related communication may predict risk perceptions, attitudinal, and behavioral outcomes and whether interpersonal discussion may mediate the effects of exposure to social media educational and advertising messages.

Measures

Outcome Variables

Risk Perceptions

Risk perceptions were measured by averaging participants' responses across 26 items that asked about perceived health risks related to cannabis consumption ($M = 3.01$, $SD = 0.82$).

Participants were asked whether each given health condition is an outcome of cannabis consumption (e.g., pregnancy-related problems and non-fatal overdose). The responses ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). Thus, the higher mean value of this variable indicates increased perceptions about health risks associated with cannabis.

Pro-Cannabis Attitudes

A semantic differential scale was used to measure attitudes toward cannabis use, starting with a prompt: "My using marijuana in the next 3 months would be...." On a 7-point Likert scale, response options ranged from *bad* to *good*, *unenjoyable* to *enjoyable*, *unpleasant* to *pleasant*, *foolish* to *wise*, and *harmful* to *beneficial*. Responses were mean-centered and averaged into a single score of pro-cannabis attitudes ($\alpha = .94$, $M = 0.55$, $SD = 1.83$).

Intentions To Use Cannabis

Two questions were asked: "If you have a chance this weekend, would you use any marijuana?" and "Do you think you will use any marijuana in the next three months?" (Barrington-Trimis et al., 2020; Fallin, Roditis, & Glantz, 2015). The answers were on a 4-point scale ranging from *definitely no* to *definitely yes*. Responses to the two questions were averaged to form a single score ($\alpha = .86$, $M = 2.74$, $SD = 0.94$).

Likelihood Of Peer Intervention

Participants were presented with the prompt: "In the following week, if you were to find out that one of your friends tries to use marijuana, how likely is it that you would do each of the following?" Three actions were presented on a scale from 1 (*very unlikely*) to 4 (*very likely*): "Try to talk to your friend about the harms of marijuana," "Try to get your friend to seek help," and "Tell your friend you are worried about them" (adopted from Kam & Yang, 2014). Responses were averaged together to create a scale measuring the likelihood of peer intervention ($\alpha = .85$, $M = 2.15$, $SD = 0.89$).

Cannabis Exposure Predictors

Interpersonal Discussions

Engagement in pro- and anti-cannabis interpersonal discussions was assessed separately with the following items: "In the past 3 months, how often have your close friends or family members talked positively/negatively about marijuana products with you?" The response options included *never*, *once or twice*, *three or four times*, and *five times or more*.

Online Exposures

Online educational exposure was measured using three items. Participants had to indicate how many times they noticed educational campaigns or public health messages about marijuana in the past 3 months in each of the sources: e-mails or text messages, internet websites, and on social media sites such as Facebook, Twitter, YouTube, Instagram, or Snapchat. The answer options were *never*, *once or twice*, *three or four times*, and *five times or more*. The answers to the three items were averaged to create a variable measuring exposure to online educational messages ($\alpha = .71$, $M = 2.12$, $SD = 0.84$). In a similar way, we measured the

Table 1. Participant demographics

Characteristic	n (%)
Age	
18–20	260 (49.7)
21–26	263 (50.3)
Gender	
Male	235 (44.9)
Female	277 (53)
Other	11 (2.1)
Race	
White	331 (63.3)
Asian or Pacific Islander	101 (19.3)
American Indian or Alaska Native	8 (1.5)
Black or African American	36 (6.9)
Other	21 (4)
More than one race	26 (5)
Ethnicity	
Not of Hispanic, Latino/a, or Spanish origin	416 (79.5)
Mexican, Mexican American, Chicano/a	57 (10.9)
Puerto Rican	20 (3.8)
Cuban	7 (1.3)
Another Hispanic, Latino, or Spanish origin	23 (4.4)
Income	
Less than \$20,000	128 (24.5)
\$20,000 – \$29,999	69 (13.2)
\$30,000 – \$39,999	36 (6.9)
\$40,000 – \$49,999	63 (12)
\$50,000 – \$74,999	100 (19.1)
\$75,000 – \$99,999	57 (10.9)
\$100,000 – \$124,999	29 (5.5)
\$125,000 – \$149,999	14 (2.7)
\$150,000 – \$249,999	12 (2.3)
\$250,000 or more	15 (2.9)
Education	
Less than high school	25 (4.8)
High school graduate	190 (36.3)
Some college	193 (36.9)
College graduate	90 (17.2)
Graduate or professional school	25 (4.8)
Sexual orientation	
Completely heterosexual (attracted to persons of the opposite sex)	320 (61.2)
Mostly heterosexual	53 (10.1)
Bisexual (equally attracted to men and women)	80 (15.3)
Mostly homosexual	18 (3.4)
Completely homosexual (gay/lesbian, attracted to persons of the same sex)	27 (5.2)
Not sure	10 (1.9)
Prefer not to disclose	15 (2.9)
Party affiliation	
Republican	96 (18.4)
Democrat	238 (45.5)
Independent	158 (30.2)
Other	31 (5.9)

exposure to online advertising. Participants were asked if in the past 3 months they have noticed marijuana products, brands, or businesses being advertised in the same three sources (e-mails or text messages, websites, social media sites). The responses were also averaged together ($\alpha = .67$, $M = 2.37$, $SD = 0.82$). Measures for both educational and advertising online exposures were adopted from Hammond et al. (2021).

Covariates

Covariates included age, gender, race, ethnicity, income, education, political party affiliation, political ideology, parent-adolescent drug talk styles (five scenarios ranging from have had several conversations with parents about alcohol and drugs to never have had such conversations with parents; Shin, Pettigrew, Miller-Day, Hecht, & Krieger, 2019), sexual orientation (Charlton et al., 2013), control for experimental conditions, and perceived social support. Perceived social support (Zimet, Dahlem, Zimet, & Farley, 1988) was measured with 12 statements designed to make participants think about people in their lives who support them. Respondents were asked to indicate how well each statement describes them on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The 12 items were then averaged ($\alpha = .91$, $M = 3.56$, $SD = 0.79$).

Data Analysis

Multiple regressions with the ordinary least squares (OLS) estimator were used to examine the associations between exposure predictors and risk perceptions, attitudes, intentions to use, and likelihood of peer intervention. All regression models include demographic variables as well as other covariates mentioned above. Next, structural equation modeling (SEM) was utilized to assess the mediating roles of pro- and anti-cannabis interpersonal discussions on the effects of online exposure to cannabis messaging on behavioral outcomes. The SEM model allows covariances between mediators and among outcome variables. It also controlled for

measured covariates predicting all endogenous variables. Experimental conditions used in the main study were statistically independent of predictors in this analysis. The model specification is depicted in Figure 1.

Results

Sample Characteristics

The mean age of the sample was 21.5 years, 53% were female, 63.3% were White, and 22% completed college education or higher. Sample characteristics are summarized in Table 1.

Multiple Regression Analyses Predicting cannabis-related Cognitive, Attitudinal, and Behavioral Outcomes

The results are summarized in Table 2. Exposure to online educational messages was associated with higher likelihood of peer intervention ($b = 0.12$, 95% CI [0.01, 0.23], $p = .036$). At the same time, it was not related to risk perceptions, intentions to use, and pro-cannabis attitudes. Next, exposure to online advertising messages was associated with a higher intention to use cannabis ($b = 0.14$, 95% CI [0.02, 0.26], $p = .018$) and was not associated with risk perceptions, pro-cannabis attitudes, and peer intervention. As hypothesized, greater exposure to anti-cannabis interpersonal discussion was related to increased risk perceptions ($b = 0.17$, 95% CI [0.10, 0.24], $p < .001$), lower pro-cannabis attitudes ($b = -0.16$, 95% CI [-0.32, -0.00], $p = .048$), and higher likelihood of peer intervention ($b = 0.28$, 95% CI [0.21, 0.36], $p < .001$). It was also marginally associated with decreased intention for cannabis use ($b = -0.07$, 95% CI [-0.14, 0.01], $p = .090$).

Exposure to more pro-cannabis interpersonal discussions yielded the opposite results. In particular, it was associated with decreased risk perceptions ($b = -0.10$, 95% CI [-0.17, -0.03], $p = .006$), higher pro-cannabis attitudes ($b = 0.34$, 95% CI [0.18, 0.49], $p < .001$), higher intentions to use ($b = 0.35$, 95% CI [0.28, 0.43], $p < .001$), and decreased likelihood of peer interventions ($b = -0.16$, 95% CI [-0.23, -0.09], $p < .001$).

The Mediating Roles of Interpersonal Discussions

Next, we examine the indirect effects of pro- and anti-cannabis interpersonal discussions mediating the relationships between exposure to online educational and advertising messages and outcomes. Overall, the model was a perfect fit to the data since the model was just-identified and saturated: chi-squared test $\chi^2 (0) = 0$, comparative fit index (CFI) = 1, root mean square error of

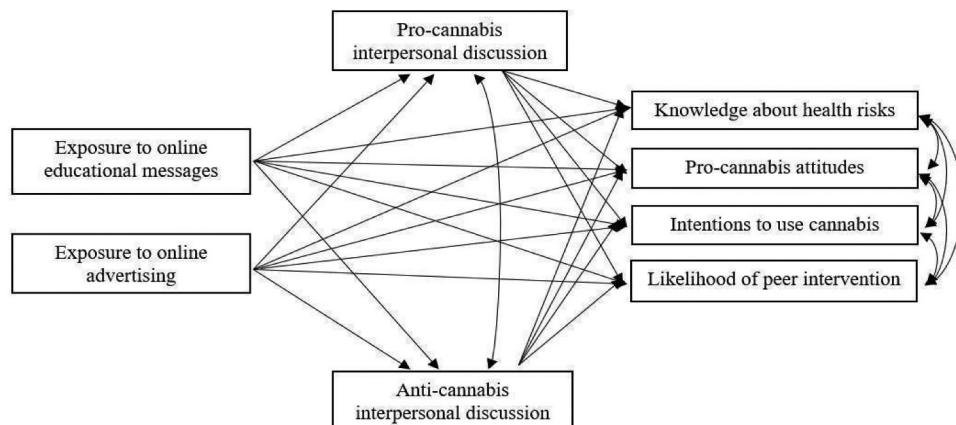


Figure 1. Structural equation model.

Table 2. Predictors for increased risk perceptions, pro-cannabis attitudes, intentions to use, and likelihood of peer intervention among U.S. young adults (18–26 yrs old)

	Risk perceptions	Pro-cannabis attitudes	Intentions to use cannabis	Likelihood of peer intervention
Exposure to social media educational messages	0.086 (−0.02, 0.20)	0.180 (−0.07, 0.43)	−0.053 (−0.17, 0.06)	0.121* (0.01, 0.23)
Exposure to social media advertising	−0.01 (−0.12, 0.10)	0.16 (−0.08, 0.41)	0.14* (0.02, 0.26)	−0.03 (−0.15, 0.08)
Positive interpersonal discussion	−0.10** (−0.17, −0.03)	0.34*** (0.18, 0.49)	0.35*** (0.28, 0.43)	−0.16*** (−0.23, −0.09)
Negative interpersonal discussion	0.17*** (0.10, 0.24)	−0.16* (−0.32, −0.00)	−0.07 (−0.14, 0.01)	0.28*** (0.21, 0.36)
Perceived social support	0.16*** (0.07, 0.25)	0.06 (−0.14, 0.26)	0.15** (0.06, 0.25)	0.08 (−0.01, 0.18)
Age (21 and above vs 18–20)	−0.24*** (−0.38, −0.10)	0.25 (−0.07, 0.56)	0.14 (−0.01, 0.29)	0.05 (−0.10, 0.19)
White vs nonwhite	−0.08 (−0.22, 0.06)	0.04 (−0.28, 0.37)	0.13 (−0.02, 0.28)	−0.24** (−0.39, −0.10)
Income (20,000–49,000 vs less than 20,000)	0.13 (−0.05, 0.32)	−0.47* (−0.88, −0.05)	−0.13 (−0.31, 0.06)	0.17 (−0.03, 0.36)
Income (50,000+ vs less than 20,000)	−0.02 (−0.20, 0.16)	−0.58** (−0.99, −0.18)	−0.10 (−0.29, 0.09)	0.17 (−0.02, 0.36)
Party (Republican vs Democrat)	0.08 (−0.14, 0.29)	0.60* (0.11, 1.08)	0.06 (−0.17, 0.29)	0.09 (−0.13, 0.32)
Ideology (higher = more conservative)	−0.02 (−0.07, 0.03)	−0.14* (−0.25, −0.03)	−0.01 (−0.06, 0.04)	0.03 (−0.03, 0.07)
Constant	2.63*** (1.98, 3.28)	−0.01 (−1.48, 1.46)	1.06** (0.37, 1.75)	1.88*** (1.20, 2.55)
Observations	523	515	523	523
R ²	0.13	0.13	0.25	0.22
Adjusted R ²	0.09	0.10	0.25	0.18
Residual Std. Error	0.78 (df = 500)	1.74 (df = 492)	0.82 (df = 500)	0.80 (df = 500)
F Statistic	3.47*** (df = 22; 500)	3.47*** (df = 22; 492)	7.75*** (df = 22; 500)	6.24*** (df = 22; 500)

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Non-significant covariates included: parent-adolescent drug talk styles, experimental condition, sexual orientation, education, gender, and ethnicity.

approximation (RMSEA) = 0, Tucker-Lewis index (TLI) = 1, standardized root mean squared residual (SRMR) = 0. The results are summarized in Table 3. The strongest indirect effects emerged with respect to exposure to ads: it was positively associated with pro-cannabis interpersonal discussions, which in turn was associated with fewer risk perceptions related to cannabis use (*indirect* ES = −0.03, 95% CI [−0.07, −0.01], $p = .026$), higher intentions to use cannabis (*indirect* ES = 0.12, 95% CI [0.07, 0.18], $p < .001$), more positive attitudes about cannabis use (*indirect* ES = 0.12, 95% CI [0.05, 0.20], $p = .003$), and lower likelihood of peer intervention (*indirect* ES = −0.06, 95% CI [−0.10, −0.03], $p = .001$). On the other hand, exposure to educational messages was positively associated with anti-cannabis interpersonal discussions, which were in turn associated with more risk perceptions related to cannabis use (*indirect* ES = 0.03, 95% CI [0.01, 0.07], $p = .021$) and a higher likelihood of peer intervention (*indirect* ES = 0.06, 95% CI [0.02, 0.10],

$p = .010$). These results are robust after controlling for an extensive list of covariates (see the Measures section for details). All other tested indirect effects were non-significant. Notably, exposure to the anti-cannabis interpersonal discussion in those who were exposed to cannabis ads did not significantly improve behavioral outcomes.

Discussion

The present study shows first, self-reported exposure to online advertising was associated with a higher intention to use cannabis, suggesting the need to regulate online cannabis marketing for the younger population. Second, exposure to educational messages was associated with increased likelihood of peer intervention but did not significantly predict other behavioral outcomes. More investment is needed to improve current educational campaigns as legalization continues, and these findings

Table 3. Indirect effects of pro- and anti-cannabis interpersonal discussions mediating the effects of exposure to advertising and educational messages on risk perceptions, intentions for cannabis use, attitudes, and likelihood of peer intervention among U.S. young adults (18–26 yrs old)

Mediation models	Indirect effect	95% CI
Exposure to advertising → pro-cannabis interpersonal discussion → Risk perceptions	-0.03	(-0.07, -0.01)
Intentions to use	0.12	(0.07, 0.18)
Attitudes	0.12	(0.05, 0.20)
Peer intervention	-0.06	(-0.10, -0.03)
Exposure to advertising → anti-cannabis interpersonal discussion → Risk perceptions	0.02	(-0.00, 0.05)
Intentions to use	-0.01	(-0.03, 0.00)
Attitudes	-0.02	(-0.06, 0.01)
Peer intervention	0.04	(-0.00, 0.08)
Exposure to educational messages → pro-cannabis interpersonal discussion → Risk perceptions	-0.01	(-0.02, 0.01)
Intentions to use	0.02	(-0.03, 0.07)
Attitudes	0.02	(-0.03, 0.07)
Peer intervention	-0.01	(-0.03, 0.01)
Exposure to educational messages → anti-cannabis interpersonal discussion → Risk perceptions	0.03	(0.01, 0.07)
Intentions to use	-0.01	(-0.03, 0.00)
Attitudes	-0.03	(-0.08, 0.00)
Peer intervention	0.06	(0.02, 0.10)

Note: All models included measured covariates and experiment conditions as predictors.

underscore the feasibility of leveraging peer intervention through educational campaigns to target young adults.

Third, not only did cannabis-related interpersonal discussions emerge as significant predictors of cannabis-related outcomes (total effects), they were also found to statistically

mediate the effects of self-reported exposure to social media educational and marketing messages (indirect effects) on outcomes of interest. Cannabis-related interpersonal discussions were associated with not only risk perceptions and attitudes but also cannabis use intentions and importantly, young adults' likelihood to engage in peer intervention. These findings dovetailed the pattern observed in tobacco research where interpersonal discussion was found to affect smokers' attitudes and behaviors (Hafstad et al., 1996; Hwang, 2012; Jeong et al., 2015; Morgan et al., 2018; Tan, Bigman, Mello, & Sanders-Jackson, 2015; Tan, Bigman, & Sanders-Jackson, 2015; Thrasher et al., 2016). Additionally, consistent with prior research (Hendriks & Strick, 2020; Hwang, 2012; Jang & Frederick, 2012; Jeong et al., 2015; Kam & Lee, 2013; van den Putte et al., 2011), these results support the hypothesis that interpersonal discussions can serve as a mediator between informational sources and health behaviors, which is a significant addition to the literature on cannabis use as it has traditionally been a more clandestine and stigmatizing topic than tobacco use (Barratt, 2011; Reid, 2020).

Importantly, in the past, the National Youth Anti-Drug Media Campaign inadvertently produced pro-drug normative influences and backfired (David et al., 2006; Hornik, Jacobsohn, Orwin, Piesse, & Kalton, 2008). As the interest begins to rise among the public health community to design and implement a new wave of educational media campaigns in response to cannabis legalization and marketing, our results serve as a timely reminder for the importance of considering the roles of campaign-induced interpersonal discussions and social influences. Educational campaigns should consider stimulating preventive conversations and simultaneously reducing pro-cannabis discussions as another valuable goal to pursue beyond direct intrapersonal outcomes. Given the documented effectiveness of leveraging peer influences to prevent substance use (Kelly, Dow, Yeterian, & Kahler, 2010; Kelly, Stout, & Slaymaker, 2013; Sussman, 2010; Valente, Hoffman, Ritt-Olson, Lichtman, & Johnson, 2003; Valente et al., 2007), our results suggest that fostering preventive cannabis-related conversations has the potential to activate the social influence route for cannabis education and prevention. Recent research has shown that the effects of information scanning and seeking from interpersonal sources on cannabis-related attitudes are particularly noticeable among individuals high in preexisting motivation and ability for information processing and trust in sources (Lewis et al., 2022). Future research is encouraged to examine whether the documented mediating pathways through interpersonal discussions in the current study are further moderated by variables related to individuals' elaboration likelihood, trust, and other individual-level predispositions through longitudinal moderated mediation analyses.

In addition, several other results have important implications for future campaign development and regulations. First, it is important to highlight the positive relationship between exposure to online educational messages and the likelihood of peer intervention. This finding suggests that it is necessary to invest funds in educational campaigns even when direct impacts on

individuals themselves are not readily discernible. Peer intervention may provide additional help when implementing interventions to stop substance abuse among young adults who value peer opinions. Next, there is a need for regulating online cannabis marketing. The findings strongly support the idea that exposure to advertising and marketing materials online is associated with increased intention to partake in cannabis use. This finding aligns with previous literature suggesting that social media exposure to cannabis ads leads to use (Whitehill et al., 2020). Since cannabis consumption can cause negative health consequences for young adults (Aldington et al., 2007; Batalla et al., 2013; Bovasso, 2001; Filbey et al., 2014; Franz & Frishman, 2016; Hall & Degenhardt, 2009; Lopez-Quintero et al., 2011; McKay & Tennant, 2000; Rey et al., 2002; Rey & Tennant, 2002; Rumalla et al., 2016a, 2016b; Sidney, 2002; Tashkin, 2013; Taylor et al., 2000; Volkow et al., 2016; Wolff et al., 2013) and young adults frequently encounter cannabis advertising on the internet (Dai, 2017; Whitehill et al., 2020), it is important to monitor how cannabis products are advertised online and to consider strengthening regulation of online marketing.

Another set of interesting and apparently contradictory findings is related to perceived social support. We found that perceived social support was positively associated with both risk perception and intention to use cannabis. One potential explanation could be that individuals who have significant others, friends, or family to support them through times of trouble are more likely to use cannabis because they have the supporting buffer in case their use leads to negative consequences. Although this reason sounds plausible, our data could not verify the speculation. Another explanation could be that substance users are supported behaviorally by their friendship networks, which are likely to consist of other substance users (Best & Lubman, 2017). However, if this is the underlying mechanism, one would expect to see a positive relationship between perceived social support and *reduced* risk perceptions—our results showed the opposite pattern. Although we do not have additional data to support our speculation, we report this finding for future research to clarify the nature of social support networks in which young adults are embedded to better identify points for intervention.

Overall, our findings highlight the importance of interpersonal discussions in cannabis research, yet there are several notable limitations. First, the current study is observational, and causality cannot be established. Future studies should focus on investigating the mechanisms through which interpersonal discussion influences behaviors and attitudes in the cannabis domain via longitudinal or experimental designs. With that said, our study provides important insights to warrant future research in this domain given the changing legal context around cannabis products and the growing urgency to better improve educational efforts targeting at-risk populations. Next, while we strive to match our sample to national distributions on gender, race, and ethnicity, our sampling strategy was not probabilistic and certain demographics were under-represented in the final sample (sexual minorities, those

with higher educational levels). Our use of an online Qualtrics sample is comparable to previously published studies (Trangenstein, Whitehill, Jenkins, Jernigan, & Moreno, 2019; Whitehill et al., 2020) using the same sampling strategy, which found comparable demographic composition and prevalence estimates of past cannabis use between the Qualtrics sample and representative national samples. That said, future research is encouraged to recruit a representative national sample, ideally with a longitudinal design, to replicate our key findings. Third, our measures are self-reported and future research is encouraged to adopt behavioral measures that could reduce plausible measurement noises, especially those that could directly measure cannabis use behaviors. Finally, we did not measure participants' prior cannabis use given the illegality of underage use still in many states and the risk-benefit tradeoff. That said, we screened participants' susceptibility for cannabis use and only those high in risk for use were retained as eligible. Our data thus speak to the highly susceptible group of young adults, if not existing cannabis users already.

In conclusion, against a backdrop where legalization and product availability are rapidly expanding, while perceptions of use are rapidly declining, this study shows the expected influence of exposure to online marketing on the intention to use cannabis and provides new empirical evidence on the effects of social media cannabis messaging and interpersonal discussions. The findings can help guide public educational and regulatory efforts to increase understanding of the risks associated with cannabis consumption in late adolescence, stimulate peer intervention, and regulate online advertising. Finally, this study highlights the importance of interpersonal communication about cannabis and its potential to change attitudes and behaviors related to legalized cannabis products.

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