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The Social Life of Health-Promotion Messages: Alcohol Craving in Complex Information Environments


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Abstract

Objective: Within complex information environments, persuasive messages are often viewed in close proximity to other relevant and possibly contradictory content. While persuasion research focuses on optimizing individual message types (e.g. anti- or pro-alcohol messages), scarce knowledge about competition between message types hinders the prediction of message effects in real-world settings. We directly compared effects of competing message types to understand relative effects and underlying mechanisms. **Methods:** Across three studies, English-speaking convenience samples from online panels and our University's student pool (N=468) viewed a large sample of alcohol-related messages (N=190) of different types (pro-, anti-, and non-alcoholic messages from professional and peer sources). Using within-subject designs, we measured the relative impact of message types on alcohol craving and mechanisms driving these effects. **Results:** Pro-alcohol messages were more impactful than anti-alcohol messages, especially among frequent binge drinkers. Although emotional responses and familiarity with the alcohol-related content were relevant mechanisms for both pro- and anti-alcohol message effects, both mechanisms were more strongly coupled to craving in response to pro- (vs. anti-alcohol) messages. **Conclusions:** Accounting for a large variety of messages, our results suggest that restricting pro-alcohol content may be more effective in reducing consumption than producing anti-alcohol content within populations represented by our English-speaking convenience samples. The findings further raise specific concerns about the effectiveness of anti-alcohol messages that target familiarity and emotional processes, especially when viewed in direct competition with pro-alcohol information. Further research on the competition between related message types is crucial to support understanding and prediction of message effectiveness.

SIGNIFICANCE: We examined how health promotion (professional anti-alcohol) messages perform relative to other relevant confirmatory (peer-produced anti-alcohol messages) and contradictory (professional/peer-produced pro-alcohol) information by comparing alcohol craving across message types. Understanding competition between message types will help improve predictions of message effects in modern, diverse information environments.

Keywords: alcohol craving, anti-alcohol messages, persuasion, alcohol marketing, emotions, familiarity

The Social Life of Health-Promotion Messages: Alcohol Craving in Complex Information Environments

Persuasive messages live largely unexplored, metaphorical "social lives". Within rich information environments, each message interacts and competes with its "peers" (i.e. other messages relevant to the same attitude or behavior which may or may not be congruent with the focal message; e.g. see Stautz and Marteau, 2016; Young et al., 2018). These interactions likely create interference between message effects which complicates the prediction of message effectiveness. To illustrate, like most daily choices, alcohol consumption has pros and cons. It is a social catalyst, associated with fun and friendship (Duckworth et al., 2021), but also a significant cause of death, injury, and disease (OECD, 2016). Consequently, diverse stakeholders, from alcohol brands, to public health authorities, to party-loving peers and concerned family, seek to influence alcohol consumption. Their voices create rich information environments and frequent exposures to alcohol-related messages varying in valence (pro/anti-alcohol) and source (peers or professionals). Extensive prior work has examined individual message types (e.g. exclusively pro-, Jernigan et al., 2017, or anti-alcohol messages, Young et al., 2018). Yet, we know little about relative effectiveness and potential interference between effects of messages varying in source and valence. In three exploratory studies, we directly compared effects of pro- and anti-alcohol messages from professional and peer sources on alcohol craving and ask whether these messages exert influence through similar or different psychological mechanisms.

Persuasion in Complex Information Environments

How do we make decisions in complex, ambiguous information environments such as that surrounding alcohol? The human brain is capable of seamlessly and speedily weighting myriad factors relevant to a given decision (Busemeyer et al., 2019). This is reflected in behavior change and decision-making theories like the Reasoned Action Approach (Fishbein and Ajzen, 2010) and Identity-Value Model (Berkman et al., 2017), which describe an integration process where diverse information relevant to a given choice (e.g. social norms and attitudes) is used to inform a decision (Falk and Scholz, 2018). In other words, when deciding whether to consume alcohol, individuals likely consider multiple alcohol information types, such as both pro- and anti-alcohol information from peers and professionals. Modern, fast-changing information environments like

social media which are populated by numerous message creators further increase the likelihood that diverse information about alcohol is encountered in close spatial and temporal proximity, enhancing the chance of direct competition and unpredictable interference.

One small aspect of the integration process of competing messages has been studied fruitfully in communication science research on the interactions between mass media messages and message-related interpersonal communication. The Two-Step Flow model (Katz, 1957; Katz and Lazarsfeld, 1955) posits that mass media influences target groups indirectly through the gate-keeping efforts of *opinion leaders* who further distribute and interpret messages within their social network. Empirical evidence shows that message-related interpersonal communication impacts both who is exposed to mass media content and how message receivers are affected (Jeong and Bae, 2017). This can result in either enhanced (Jeong and Bae, 2017) or diminished (David et al., 2006) message effects. For instance, research on alcohol consumption shows that the effects of anti-alcohol messaging are partially mediated by the valence (pro- or anti-alcohol) of subsequent interpersonal conversations (e.g. Hendriks et al., 2012), and unhealthy effects of pro-alcohol interpersonal conversations are moderated by an individual's sensitivity to anti-alcohol persuasive messaging (Scholz et al., 2019). More recent theorizing has expanded on this work by identifying various types of interfaces between persuasive messages and the social interactions of message receivers (Pettigrew et al., 2018; Shin et al., 2021).

This work highlights the importance of research into the "social life" of persuasive messages, but has not yet distinguished the specific message types that might be encountered within the greater, socially-curated information environment. The broader persuasion literature remains fragmented with separate fields focusing on individual message types. For instance, research on social influences on alcohol consumption (e.g. Borsari and Carey, 2001) rarely intersects with work on professional messaging on the same topic (e.g. Jeong and Bae, 2017; Jernigan et al., 2017), and work on pro-alcohol messages rarely considers anti-alcohol equivalents. Variation in operationalizations and theoretical approaches has produced incomparable data across directly competing message types. We ask:

Research Question (RQ)1: What are the relative effects of alcohol-related messages varying in valence and source on alcohol craving?

Competition Across Valence and Source Dimensions

To answer RQ1, we immersed study participants in rich information environments containing alcohol-related messages varying in valence and source and compared their effects on alcohol craving. Alcohol craving is a key predictor of consumption (Ramirez and Miranda, 2014), sensitive to message exposure manipulations (Noel and Lakhan, 2020; Stautz and Marteau, 2016), and can ethically and validly be measured in repeated trials, enabling us to measure responses to multiple types of alcohol information within individuals.

By definition, pro- and anti-alcohol messages highlight positive or negative aspects of alcohol and/or alcohol consumption, respectively. First, we sought to establish whether these efforts are linked to subsequent alcohol craving in expected ways:

H1: Alcohol craving will be higher in response to pro- versus non-alcoholic messages and non-alcoholic versus anti-alcohol messages.

Message effects as hypothesized in H1 are more consequential for public health interests to the extent that they specifically modulate alcohol craving rather than general appetite for beverages. Prior work is uninformative regarding the specificity of alcohol message effects.

H2: The effect of pro- vs. anti-alcohol messaging on craving is larger when craving is assessed for alcoholic rather than non-alcoholic beverages.

To reduce (risky) alcohol consumption, is it more effective to produce more anti-alcohol messaging or further regulate pro-alcohol messaging? Only direct comparisons between message types are informative for this important question. To our knowledge, only two existing studies produced relevant data, with contradictory results and limited generalizability. Stautz and Marteau (2016) randomly assigned participants to view either ten anti-, pro-, or non-alcoholic video advertisements. Anti-alcohol (vs. non-alcoholic) messages significantly reduced alcohol craving, while pro-alcohol stimuli did not have significant effects. In contrast, using the same design, Stautz and colleagues (2017) found consistently (but insignificantly) larger effects of pro- than anti-alcohol messages, relative to non-alcoholic stimuli. It remains unclear how these inconsistent results translate to new stimulus types or to complex information environments which contain more than one message type per person. We compared relative effects of a large sample of static pro-, anti-, and non-alcoholic messages in a within-subject design.

With regards to message source, both professional and peer-produced alcohol information are known to impact alcohol consumption and its determinants (e.g. Bruijn et al., 2016; Moreno and Whitehill, 2014). Are professionally designed campaigns more successful in influencing alcohol craving than relatable peer-produced messages or vice versa? Do source effects differ across pro- and anti-alcohol messages? We extend the limited prior work comparing pro- and anti-alcohol content by including both professionally and peer-produced stimuli.

Drivers of Alcohol Craving

Designing reliable, generalizable message effects requires an understanding of the underlying psychological mechanisms. More specifically, in the context of complex information environments, quantifying the relative importance of a mechanism for competing message types may help to predict the likelihood and nature of interference between their effects. For instance, if both pro- and anti-alcohol messaging affect alcohol consumption by portraying self-relevant, familiar circumstances, which of these appeals exerts greater influence?

RQ2: Is alcohol craving in response to alcohol-related messages varying in valence and source driven by similar or different psychological processes?

We examined RQ2 on the example of two particularly central processes in the context of the alcohol information environment: emotions and familiarity.

Emotions

Emotional states are known triggers of health behaviors, including alcohol consumption (Sher & Grekin, 2007), and often-used targets of persuasive messages across behavioral domains (Hornik et al., 2016; Myrick, 2015; Nabi, 2017; Poels and Dewitte, 2019). More specifically, both pro- and anti-alcohol messaging often aim to evoke emotions. Professional anti-alcohol messaging emphasizes negative outcomes of (excessive) consumption such as catastrophic accidents (fear) caused by drunk drivers (guilt) or inappropriate social situations (shame; Becheur et al., 2007; Duhachek et al., 2012). In contrast, professional pro-alcohol messaging highlights positive aspects of alcohol consumption. For instance, partying and relaxation (happiness) are major themes in US TV advertising for alcohol (Morgenstern et al., 2015). To meaningfully compare emotional mechanisms of message effects between message types, we focus on emotional responses that are relevant across types and could, thus, lead to

message effect interference. Following a prior example (Stautz et al., 2017), we assessed the general classes of positive and negative emotions rather than specific emotions. Stautz and colleagues' (2017) findings suggest:

H3: Pro-alcohol messages are associated with more positive and less negative emotional responses than anti-alcohol messages.

Emotional responses to pro- (Chen et al., 2005) and anti-alcohol (Becheur et al., 2007) messaging are known to be related to message effectiveness, but their relative effect sizes are unexplored. We compare how and how strongly positive and negative emotions are related to craving and how these effects are moderated by message type. We expect that:

H4: Positive emotional responses to alcohol-related messages will be positively (H4a) and negative emotional responses will be negatively (H4b) associated with alcohol craving.

Further, we expect that emotions that are typically targeted by a message type are more expected and experienced more consistently and more strongly by message receivers. Consequently, emotions that are more frequently targeted by a message type may play a larger role in impacting alcohol craving in response to this message type.

H5: When comparing pro- to anti-alcohol messages, positive emotional responses will be more strongly (H5a) and negative emotional responses will be less strongly (H5b) associated with alcohol craving.

Most of the existing work on emotional responses to alcohol messages has focused on professional messages. Yet, early content analyses suggest that emotional mechanisms may function differently for peer-produced messaging. Peer-produced messages generally have less clear persuasive intentions (Hendriks et al., 2017) and, consequently, employ emotional appeals less consistently and less strategically. While peer-produced pro-alcohol messages generally seem to mimic professional pro-alcohol content in that they often express positive emotions related to alcohol, peer-produced anti-alcohol messages may be more emotionally ambiguous. For instance, a social media post may depict negative outcomes of drinking similar to those displayed in professional anti-alcohol campaigns (e.g. a bike accident), but portray it in a humorous light as the unfortunate, yet funny outcome of an epic night. Pure anti-alcohol sentiment is disincentivised by the strong pro-alcohol norms among young adults (Beullens and

Schepers, 2013). How are these emotions linked to craving? We explored source effects on the relationship between emotional responses to alcohol-related messages and alcohol craving and compared them between pro- and anti-alcohol messages.

Familiarity

A second relevant psychological mechanism in the context of alcohol-related messaging is familiarity. We define familiarity as perceptions that a message shows characters who are 'like me' and/or a familiar situation. The literature discusses these types of familiarity under audience-character similarity (Kim et al., 2016) and message self-relevance.

A content analysis of alcohol-related posts on social media suggests that pro-alcohol content is much more prevalent than anti-alcohol messages (Hendriks et al., 2018). More generally, strong pro-alcohol social norms among young adults likely create similar patterns of overexposure to pro- rather than anti-alcohol content through other mediated and interpersonal communication. Exacerbating this imbalance, general self-serving biases (Mezulis et al., 2004) likely bias recipients of anti-alcohol information to underestimate their own similarities with characters who are experiencing negative outcomes from drinking alcohol.

H6: Pro-alcohol messages will be perceived as more familiar than anti-alcohol messages.

Generally, familiarity is thought to increase message effectiveness by enhancing attention and involvement. In fact, creating familiar scenarios and characters are popular tailoring strategies that support message effectiveness across domains (Lustria et al., 2013). Similarly, message self-relevance increases persuasion (Falk and Scholz, 2018).

H7: Enhancing message effectiveness, higher familiarity with pro-alcohol messages will be associated with increased and higher familiarity with anti-alcohol messages will be associated with decreased alcohol craving.

Prior work focused on familiarity of professional messaging, creating a knowledge gap about peer-produced messages, which likely have stronger objective similarities with the life of message recipients. Here we explore whether familiarity is a stronger driver of craving in response to peer or professional messages and whether these effects differ by message valence.

Method

We conducted three online experiments to directly compare the impact of different alcohol-related message types on alcohol craving and to explore mechanisms of these effects. Study 1a established craving responses to a large sample of professional and peer-produced pro- and anti-alcohol messages representing a broad spectrum of alcohol-related information available in the information environment. Study 1b introduced comparison conditions of professional- and peer-produced messages about non-alcoholic beverages. Study 2 conceptually replicated Studies 1a/b using a subset of the same alcoholic stimuli and a different task design. All participants provided informed consent and study procedures were approved by the ethical review board at the University of Amsterdam (2020-PC-12672).

Transparency and Openness

The studies reported here were not pre-registered. Measures, data, and analysis code are available on GitHub [REDACTED]. To protect copyright interests of original content creators, the stimulus set is only available upon request. The reproducibility package does include a table with descriptions of all stimuli and the stimulus source. Only Study 2 participants answered questions not described in this manuscript related to orthogonal research questions about meat consumption. These additional measures are included in the reproducibility package.

Participants

English-speaking participants were recruited on the panel platform Prolific (Study 1a: $N = 325$, $N_{female} = 105$, $N_{male} = 216$, $N_{non-binary} = 3$, $N_{prefer-not-to-say} = 1$; Study 1b: $N = 92$, $N_{female} = 58$, $N_{male} = 34$, $N_{non-binary} = 0$, $N_{prefer-not-to-say} = 0$) and our university's student pool (Study 2: $N = 51$, $N_{female} = 37$, $N_{male} = 13$, $N_{non-binary} = 0$, $N_{prefer-not-to-say} = 0$). All three samples were similar in age (M (SD), Range: Study 1a: 23.71 (4.11), 18-35; Study 1b: 24.73 (4.06), 19-36; Study 2: 20.04 (1.99), 18-25). The modal Study 1a and 1b participant reported to consume alcohol twice per week in the last year, both samples ranging from participants who never drank and participants who drank every day, and to binge drink 1-2 times in the last year (Study 1a) and 2-3 days per month in the last year (Study 1b), again with both samples ranging from never to every

day. Instead of drinking and binge-drinking frequency, Study 2 participants reported an average score on the Alcohol Use Disorder Identification Test (AUDIT; Saunders et al., 1993) of 8.18 (SD = 4.95), Range = 1-25), indicating a medium risk level in their alcohol consumption.

Messages

160 alcohol-related (40/Valence: pro/anti-alcohol x Source: professional/peer-produced condition) and 30 non-alcoholic messages (15/source condition) were generated. This large message set enhances the robustness and generalizability of our results, avoiding case-category confounds (Kim and Cappella, 2019b) by representing a variety of messages per type. We thus achieve a relatively high representativeness of the alcohol information environment.

Images were purposefully sampled from public Instagram posts and prior research in order to manipulate valence (pro-/anti-/non-alcoholic) and source (professional/peer). Pro- and anti-alcohol images displayed alcohol or alcohol consumption in a positive or negative light, respectively. Non-alcoholic messages portrayed (the consumption of) non-alcoholic beverages in a positive light. Source was manipulated by sampling images from Instagram pages of businesses (e.g. alcohol brands) and international, English-language anti-(binge) drinking campaigns studied in prior research (Scholz et al., 2019; professional sources) or from public Instagram accounts of 'normal' users (peer sources). Hashtags were manipulated to reinforce image condition (e.g. using brand names, campaign slogans, or hashtags commonly used on Instagram for content of the respective type) and to control the amount of text across conditions.

Stimuli were placed into visual templates (Supplementary Figure 1). In Studies 1a/b, and half of Study 2 trials per participant, the template mimicked an Instagram post. For the remaining Study 2 trials, we placed messages in a template mimicking a Google search result with hashtags representing search terms. The purpose of this manipulation was to test the specificity of results to the context of social media. Because we did not find significant effects of this exploratory online platform factor, we are reporting results collapsing across media conditions.

Procedures

Participants were invited to a 15 (Study 1a/b) or 60 minute (Study 2) online experiment which they completed in a location of their choosing on any device.

All studies employed within-subject designs. Per trial Study 1a ($N_{trials/person} = 12$) and 1b

($N_{trials/person} = 12$) participants viewed a message before rating their current alcohol craving, one manipulation check item per experimental factor (see Supplementary Materials), emotional responses, and familiarity. Messages shown to each Study 1a participant were randomly chosen from the full set of alcohol-related messages, implementing a 2 Valence (pro vs. anti-alcohol) x 2 Source (professional vs. peer-produced) full-factorial design. Messages shown to each Study 1b participant were randomly chosen out of the full samples of alcoholic (4/person) and non-alcoholic (8/person) messages and implemented a 3 Valence (pro vs. anti vs. non-alcoholic) x 2 Source (professional vs. peer-produced) full-factorial design.

Serving as conceptual replication and pilot study for follow-up work, Study 2 employed an automatically paced task optimized for the functional neuroimaging environment. Per trial ($N_{trials/person} = 88$), participants viewed a message for six seconds, followed by a brief fixation period and, subsequently, a standardized alcohol (72 trials/person) or non-alcohol (16 trials/person) cue displaying a beverage which was shown for four seconds. Standardized (non-)alcohol cues were sampled from the Amsterdam Beverage Picture Set (Pronk et al., 2015). After the first two seconds of cue exposure, participants were asked to rate their craving for the beverage displayed by the cue. Trials were separated by a fixation period. An example trial is shown in Supplementary Figure 2. Messages shown to each Study 2 participant were randomly chosen from a sub-set ($N_{messages} = 88$ per valence * source condition) of alcohol-related messages used in Study 1a/b, implementing a 2 Valence (pro vs. anti-alcohol) x 2 Source (professional vs. peer-produced) x 2 Cue type (alcoholic vs. non-alcoholic) design.

Each person viewed a random subset of messages per type to limit participant burden. Still, this experimental design guaranteed a sufficient number of independent ratings per message to generate valid message evaluations (Kim and Cappella, 2019a). Per message, Study 1a generated an average of 24.52 ratings (SD = 0.95), Study 1b generated, on average 4.84 (SD = 2.33) for alcoholic messages (all of which were already evaluated in Study 1a) and 24.53 (SD = 4.14) for non-alcoholic messages. All messages used in Study 2 were rated by all 51 participants.

Self-Report Measures

Craving was assessed in all studies using Likert-type scales. In Studies 1a/b, craving was measured immediately after stimulus exposure: "Looking at this post makes me want to drink

alcohol today." (1= Not at all, 7 = Very much). In Study 2, craving was assessed after exposure to (non-)alcoholic beverage: "Imagine holding this drink. Rate: [Looking at this post] makes me want to drink this" (1 = Not at all, 5 = Very much).

Emotional responses were assessed in Studies 1a/b with two items: "To what extent does this post make you feel the following?" [positive/negative] (Likert-type scale: 1 = Not at all, 7 = Very much).

Familiarity was assessed with two items in Studies 1a/1b: "To what extent do you agree or disagree with the following statements? This post..." [shows people that are like me/shows a situation I'm familiar with] (Likert-type scale: 1 = Totally disagree, 7 = Totally agree).

Supplementary Table 1 reports descriptive statistics for key self-report measures, disaggregated by message condition and study.

Drinking and binge drinking frequency were assessed using two items based on the NIAAA's "Task Force on Recommended Alcohol Questions" (adjusted for European drink sizes; NIAAA, 2003) in Study 1a/b, and using the AUDIT (Saunders et al., 1993) in Study 2.

Data Analysis

To test effects of familiarity, we created a familiarity index by computing the average of the self-relevance and familiarity ratings per trial (Cronbach's alpha for item scores averaged on the stimulus-level = 0.97, 95%CI[0.96,0.98]). Because Study 2 utilized a different craving scale than Study 1a/b, craving was z-scored in analyses including data from both Study 1 and 2.

The within-subjects data were analysed using multi-level regression models as implemented in R's *lmerTest* package (Kuznetsova et al., 2019) to account for the nested structure of the data within participants, messages, and, where applicable, studies. Marginal means and post-hoc pairwise comparisons were computed using R's *emmeans* package (Lenth, 2022). Model equations are provided in the notes of tables reporting the relevant results or, if no table is provided, in the results section.

Results

Manipulation checks in Study 1a/b confirmed that the stimuli were perceived as intended according to the valence and source manipulations (see Supplementary Materials).

Valence and Source Effects

H1 hypothesized a step-wise increase of alcohol craving from anti- to non-alcoholic to pro-alcohol messages. Study 1b (the only study including non-alcoholic messages) indeed shows a significant influence of valence on craving (Table 1 and Figure 1A) so that pro-alcohol messages ($M_{\text{marginal}} = 1.22$, 95% CI[1.06,1.39]) significantly enhanced standardized alcohol craving relative to non-alcoholic messages ($M_{\text{marginal}} = -0.23$, 95% CI[-0.37,-0.08]; $estimate = -1.45$, $SE = 0.1$, $p < .001$). The effect of anti- ($M_{\text{marginal}} = -0.29$, 95% CI[-0.45,-0.12]) compared to non-alcoholic messages was substantially smaller and not significantly different from zero ($estimate = -0.06$, $SE = 0.09$, $p = 0.807$). All subsequent analyses are focused on comparisons between pro- and anti-alcohol messages.

Table 1 shows that the strong valence effect (pro- > anti-alcohol) on alcohol craving replicates across all three studies. Confirming H2, a significant interaction between valence and cue type (as presented in Study 2; see Table 1, Figure 1B) further shows that this effect is specific to alcohol rather than general beverage craving. In fact, pro-alcohol messaging decreased craving for non-alcoholic drinks relative to anti-alcohol messages.

Main effects derived using *emmeans* reveal no main effects of source across all three studies (Study 1a: $estimate = 0.01$, $SE = 0.04$, $p = 0.847$, Study 1b: $estimate = -0.14$, $SE = 0.08$, $p = 0.082$, Study 2: $estimate = 0$, $SE = 0.04$, $p = 0.988$) and Table 1 shows no evidence of interactions between source and valence.

Drinking habits and message receptivity

A possible explanation for the ineffectiveness of anti-alcohol (vs. non-alcoholic) messages is that anti-alcohol messages generally target high risk (binge) drinkers and may not resonate with low risk drinkers. Yet, an additional multi-level regression model fit to Study 1b data (Figure 1C, Supplementary Table 5) shows that those who reported higher binge drinking frequency, on average, reported higher alcohol craving and a higher sensitivity to pro-alcohol (vs. non-alcoholic), but not to anti-alcohol messages.

Emotions

Next we examined the relationship between emotional responses to messages (assessed in Studies 1a/b) and alcohol craving. To test H3, we fit two multi-level regression models regressing negative and positive emotions, respectively, on valence condition, accounting for random intercepts across participants, stimuli and studies. As expected, pro-alcohol messages were associated with more positive ($B = 2.27, 95\%CI[2.07, 2.48], p < .001$) and less negative emotional responses than anti-alcohol messages ($B = -2.4, 95\%CI[-2.63, -2.16], p < .001$). Figure 2A reveals no substantial differences between professional and peer-produced stimuli.

Table 2 (left) shows relationships between emotional responses to message exposure and alcohol craving by message conditions using combined data from Studies 1a/b. In line with H4a and 4b, positive emotional responses to alcohol-related messages generally led to higher alcohol craving and negative emotional responses led to lower alcohol craving. Further confirming H5a positive emotions were more strongly positively associated with craving for pro- vs. anti-alcohol messages. Yet, targeted emotions did not universally act as stronger mechanisms towards craving across all messages. In contrast to H5b, the negative effect of negative emotional responses on craving was also stronger for pro- compared to anti-alcohol messages (Figure 2B). Emotional response did not interact with source condition.

Familiarity

Next we examined the relationships between perceived message familiarity (assessed in Studies 1a/b) and alcohol craving. To test H6, we fit a multi-level regression model regressing familiarity on valence condition, accounting for random intercepts across participants, stimuli and studies. As expected, pro-alcohol messages were perceived as more familiar than anti-alcohol messages ($B = 1.66, 95\%CI[1.5, 1.82], p < .001$), with pro-alcohol messages being almost as familiar as non-alcoholic information (Figure 2C).

Table 2 (right) shows relationships between message familiarity and alcohol craving by message conditions in Studies 1a/b. On average, participants reported higher alcohol craving in response to more familiar alcohol messages. In partial support of H7, familiarity enhanced the intended effects of pro-, but not anti-alcohol messages. Specifically, familiarity was more strongly positively associated with alcohol craving in pro- compared to anti-alcohol messages. However,

the effect of familiarity on alcohol craving remained positive in response to anti-alcohol messages (Figure 2D). Again, we do not see source by familiarity interactions.

Discussion

Within modern, socially curated information environments, we are likely to encounter multiple messages relevant to the same decision in close spatial and temporal proximity. These messages might vary across dimensions such as source and valence. A strong research focus on individual message types has left knowledge gaps regarding relative effects, interactions and potential interference between the effects of competing message types. Unknown interference adds noise to predictions of persuasive message effects and ultimately limits the impact communication efforts may have on target audiences. Using the example of alcohol-related messages across three studies, we directly compared the effects of competing messages to ask: What are the relative effects of alcohol-related messages varying in valence and source on alcohol craving? Further, is alcohol craving in response to alcohol-related messages varying in valence and source driven by similar or different psychological mechanisms?

We found pronounced effects of message valence on alcohol craving so that pro-alcohol information led to substantially higher alcohol craving than non-alcoholic and anti-alcohol messages. Anti-alcohol messages were significantly less impactful than pro-alcohol messages and did not lower alcohol craving compared to non-alcoholic messages. These findings contribute to the previous, sparse and inconsistent results regarding whether pro- (Stautz et al., 2017) or anti-alcohol (Stautz and Marteau, 2016) messages are more impactful.

We propose three potential causes of this imbalance. First, existing anti-alcohol messaging may, on average, be truly less impactful than pro-alcohol messaging. Although not explicitly tested in prior work, this idea is consistent with reviews identifying small or even statistically insignificant effects of anti-alcohol campaigns on drinking (Young et al., 2018) and somewhat more consistent and direct effects of alcohol marketing on alcohol consumption (Jernigan et al., 2017). We extend this work by contributing a rare direct comparison of message types with results that hold high representatives of the typical alcohol information environment compared to other studies of its type given the large, diverse message samples used here. It is, however, important to note that prior work has found significant differences in the effectiveness of

different anti-alcohol messaging strategies (e.g. Lee, 2018). A fruitful future direction is thus to systematically test relative effects of pro- and anti-alcohol messaging across messaging strategies (e.g. comparing pro- and anti-alcohol messaging focused on social vs. health impacts of alcohol).

Second, our results may be due to a context-driven floor effect. We observed low levels of alcohol craving in response to non-alcoholic messages ($M = 1.59$, $SD = 1.24$ on a scale from 1-7). Thus, there may have been little opportunity for anti-alcohol messages to further lower craving. Given that Study 1a/b presented here were conducted with online samples, the message exposure context underlying our findings is not unlike what may be expected from typical internet use. It is an open empirical question whether anti-alcohol messaging would be more effective within just-in-time interventions in moments when alcohol craving is high.

Third, most anti-alcohol campaigns focus on negative outcomes of extreme, risky alcohol consumption rather than advocating for complete abstinence. We thus tested whether alcohol-related messages resonated more strongly with frequent binge drinkers. On the contrary, more frequent binge drinkers were more sensitive to pro-, but not to anti-alcohol messaging. This is partially in line with one prior study which found that heavier drinking in college students was associated with increased perceived effectiveness of pro-alcohol advertising and decreased perceived effectiveness of anti-alcohol messaging (Austin et al., 1999). Overall, our data lend greater support to strategies that restrict pro-alcohol rather than promote anti-alcohol content.

Next, we examined drivers of alcohol craving in response to messages varying in valence and source. Extending prior findings (Stautz et al., 2017) to a broader set of messages, the pro-alcohol stimuli included here evoked, on average, more positive and less negative emotional responses than the set of anti-alcohol messages. Our results further confirm prior findings showing relationships between message-induced emotions and alcohol craving (Becheur & Valette-Florence, 2014), showing that positive emotions increased craving and negative emotions decreased craving. Importantly, we also directly compared these relationships across message types and found them to be universally stronger for pro- compared to anti-alcohol information. This suggests that craving is more emotionally driven in response to pro-alcohol messages. Some prior work has hypothesized that pro-alcohol advertising is more successful in engaging

emotional responses (Austin et al., 1999), but in our sample the average strength of emotionality was comparable across pro- and anti-alcohol messages (Figure 2A). Alternatively, the observed effects might be due to a valence imbalance in participants' emotion-regulation tendencies. A generally positive image of alcohol among young adults could result in uncomfortable cognitive dissonance when experiencing negative emotions in response to anti-alcohol ads. Cognitive dissonance theory (Festinger, 1957) predicts that this discomfort motivates individuals to resolve the dissonance, for instance by dismissing the negative emotions or otherwise down-regulating them (Agrawal & Duhachek, 2010; Doré et al., 2019). Down-regulating dissonant emotions in response to anti- but not pro-alcohol messaging may explain comparatively weak effects of initially experienced emotions linked to anti-alcohol messages on craving. More comparative research is needed to understand and empirically test the mechanisms and implications of this imbalance. For instance, will emotional anti-alcohol appeals always be overpowered by emotional pro-alcohol appeals viewed in close spatio-temporal proximity? And what is the role of specific discrete emotions in this process?

Our results further show that participants were substantially more familiar with pro- than anti-alcohol content. Peer-produced pro-alcohol content was even comparable in similarity to non-alcoholic content. This is in line with prior work which suggests that exposure to anti-alcohol content is rare on social media (Hendriks et al., 2017) and in interpersonal conversations (Scholz et al., 2019). Pro-alcohol sentiments are incentivised by strong positive social norms around alcohol (Borsari and Carey, 2001; Duckworth et al., 2021). Although prior work suggested that familiarity enhances message effectiveness (Cosme et al., 2022; Kim et al., 2016; Lustria et al., 2013), only pro-alcohol messages benefited from recipients' familiarity with the displayed characters and scenes in our data. For anti-alcohol messages, the relationship between familiarity and craving remained positive, even though it was significantly weaker than that for pro-alcohol messages. This difference may further explain the finding that frequent binge drinkers showed heightened sensitivity to pro- but not anti-alcohol information. Higher frequency drinking may be associated with higher overall familiarity, which is in turn more strongly linked to craving for pro- compared to anti-alcohol messages.

Strikingly, across all analyses, we did not find pronounced effects of message source.

Professionally designed alcohol content did not outperform peer-produced content, even though the peer produced content came from unknown others who likely exert less influence than close friends. This stands in contrast to work showing that production quality indicators of persuasive messages (e.g. attractiveness), which are, on average, more pronounced in professionally produced messages, are positively related to persuasiveness (Amos et al., 2008). One possible explanation is that peer-produced messaging makes up for lower production quality through greater relatability and authenticity. Prior work, although mostly not in the context of health messaging, has shown that message authenticity is positively related to persuasiveness (Petraglia, 2009; Zheng et al., 2024) and is particularly relevant in the social media context (Pöyry et al., 2021). Frequent exposures to content of lower production quality in the social media context may limit people's sensitivity to differences in production quality and instead emphasize other aspects like authenticity (Lawrence et al., 2013). Indeed, some work even suggests that user generated content is more persuasive if it has lower production quality, because it is more trustworthy (Hautz et al., 2014). More comparative work is needed to understand the boundary conditions of potential source effects such as the role of social closeness or brand attitudes, especially given the current lack of related work in the context of health communication (Jenkins et al., 2020).

Furthermore, we originally expected that peer-produced anti-alcohol content would play a special role in the alcohol information environment, because of a greater ambiguity in the persuasive intention and emotionality of these messages. Ambiguity and uncertainty is most commonly studied in the context of science communication and has been shown to be negatively associated with persuasiveness (e.g. Gustafson and Rice, 2020). Theoretically, when a message is ambiguous about its stance towards alcohol, it allows those who favor alcohol and may feel cognitive dissonance in response to anti-alcohol messages to easily discount the messages (Keating and Fan, 2023). Yet, our results show substantially similar emotional, familiarity, and craving responses to peer and professionally produced anti-alcohol content. It is possible that our sample of peer-produced anti-alcohol content is biased in that we purposefully selected content to clearly manipulate content valence and reinforced that manipulation through disambiguating hashtags. Thereby, we may have removed some of the inherent ambiguity in peer-produced

anti-alcohol messages, which may, for instance, present negative outcomes of drinking in a humorous light. Additional work is needed to fully understand source differences, but, on average, our results highlight striking similarities between professional and peer-produced content.

Constraints on Generality

The generalizability of this set of results is limited in two important ways. First, our convenience sample of English-speaking young adults is not representative of the population of alcohol consumers and follow-up work with more diverse samples in terms of demographic as well as drinking-habit indicators are needed to further substantiate the evidence. Second, although our set of 160 message stimuli is more representative of the alcohol information environment than many comparable studies, it does not cover all message types and facets present in that environment and our design may in fact have limited certain aspects of external generalizability in favor of internal validity (e.g. within-subject design with an alcohol-only environment rather than a more diverse information environment, disambiguated message conditions).

Conclusions

We directly compared the effects of competing alcohol message types varying in valence and source in the same participants. Anti-alcohol messages were substantially less effective at impacting alcohol craving than pro-alcohol messages, especially in frequent binge drinkers. Mirroring this imbalance, emotionality and familiarity, key mechanisms underlying persuasive message effects, were found to more consistently and more strongly support pro-alcohol rather than anti-alcohol message effects. Pending further substantiation of these results by replication and extension studies, our work suggests that more emphasis should be put on removing pro-alcohol from rather than adding anti-alcohol content to the information environment. Our work further highlights the importance of more comparative work in persuasion research to empirically chart and theoretically account for currently unpredictable interference effects that may occur when a message recipient is exposed to competing messages in close temporal and/or spatial proximity.

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Table 1*Condition Effects on Standardized Craving (B [95% CI], p-value)*

effect	term	Study 1a	Study 1b	Study 2
fixed	Intercept	-0.53 [-0.63;-0.43], p = <.001	-0.31 [-0.53;-0.09], p = 0.006	-0.49 [-0.61;-0.37], p = <.001
fixed	Valence 1: pro-alcohol	1.06 [0.95; 1.18], p = <.001	1.46 [1.17; 1.76], p = <.001	0.85 [0.75; 0.95], p = <.001
fixed	Valence 2: non-alcoholic		-0.04 [-0.30; 0.23], p = 0.791	
fixed	Source: professional	-0.03 [-0.15; 0.09], p = 0.602	0.05 [-0.25; 0.34], p = 0.759	-0.03 [-0.13; 0.07], p = 0.554
fixed	Cue Type: non-alcoholic			1.23 [1.11; 1.34], p = <.001
fixed	Valence 1 x Source	0.05 [-0.12; 0.21], p = 0.586	0.10 [-0.32; 0.51], p = 0.641	0.08 [-0.06; 0.22], p = 0.261
fixed	Valence 2 x Source		0.19 [-0.19; 0.57], p = 0.323	
fixed	Valence 1 x Cue Type			-1.54 [-1.67;-1.41], p = <.001
fixed	Source x Cue Type			-0.02 [-0.15; 0.11], p = 0.791
random	pID Intercept	0.54	0.39	0.34
random	sID Intercept	0.23	0.30	0.11
random	Residual	0.62	0.69	0.82

^a Note. pID = participant ID; sID = stimulus ID; Model equations: Study 1a & b: Standardized alcohol craving ~ valence * source + (1|participant) + (1|stimulus), where valence has two categories (pro/anti-alcohol) in Study 1a and an additional third category (non-alcoholic) in Study 1b. Study 2: Standardized craving (alcoholic and non-alcoholic) ~ valence * source + valence * cue type + source * cue type + (1|participant) + (1|stimulus)

Table 2

Relationship between grand mean-centered positive and negative emotions in response to alcohol-related messages ("Emotion Effect") and perceived familiarity of the messages ("Familiarity Effect") and alcohol craving in Studies 1a/b by message type)

effect	Emotion Term	Emotion Effect	Familiarity Term	Familiarity Effect
fixed	Intercept	2.1 [1.98, 2.21], p < .001	Intercept	1.74 [1.61, 1.87], p < .001
fixed	Positive emotions (PosEmo)	0.32 [0.28, 0.36], p < .001	Familiarity Index (FI)	0.25 [0.21, 0.29], p < .001
fixed	Negative emotions (NegEmo)	-0.05 [-0.08, -0.01], p = 0.005		
fixed	Valence: pro-alcohol	0.79 [0.67, 0.9], p < .001	Valence: pro-alcohol	1.44 [1.31, 1.56], p < .001
fixed	Source: professional	0.05 [-0.04, 0.14], p = 0.27	Source: professional	0.24 [0.12, 0.36], p < .001
fixed	PosEmo x Valence	0.22 [0.18, 0.27], p < .001	FI x Valence	0.27 [0.23, 0.32], p < .001
fixed	NegEmo x Valence	-0.09 [-0.14, -0.04], p < .001	FI x Source	-0.01 [-0.05, 0.03], p = 0.523
fixed	PosEmo x Source	0.01 [-0.03, 0.05], p = 0.508		
fixed	NegEmo x Source	-0.02 [-0.05, 0.02], p = 0.429		
random	pID Intercept	0.76	pID Intercept	0.79
random	sID Intercept	0.22	sID Intercept	0.31
random	Study intercept	0	Study Intercept	0
random	Residual	0.98	Residual	1.06

^a pID = participant ID; sID = stimulus ID; Trials displaying non-alcoholic stimuli in Study 1b are excluded from these analyses. Emotion model equation: alcohol craving ~ positive emotions * valence + negative emotions * valence + positive emotions * source + negative emotions * source + (1|participant) + (1|stimulus) + (1|study); Familiarity model equation: alcohol craving ~ familiarity * valence + familiarity * source + (1|participant) + (1|stimulus) + (1|study)

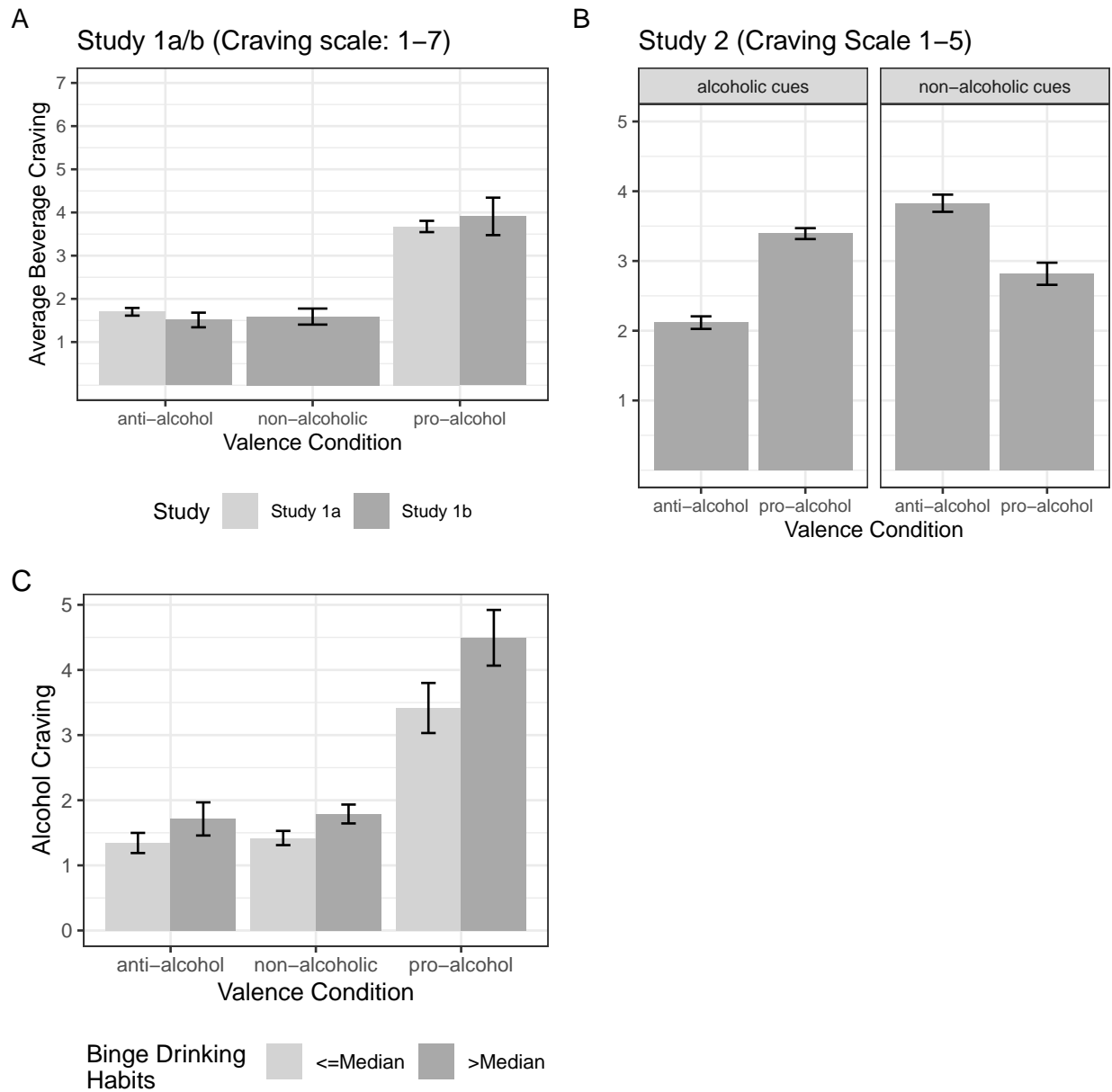


Figure 1

Average Beverage Craving by Stimulus Valence and Binge Drinking Habits; A. Alcohol craving in Studies 1a/b by valence condition, B. Alcohol and non-alcoholic craving in Study 2 by valence condition, C. Alcohol craving in Study 1b by valence condition and binge drinking frequency. Error bars represent standard errors.

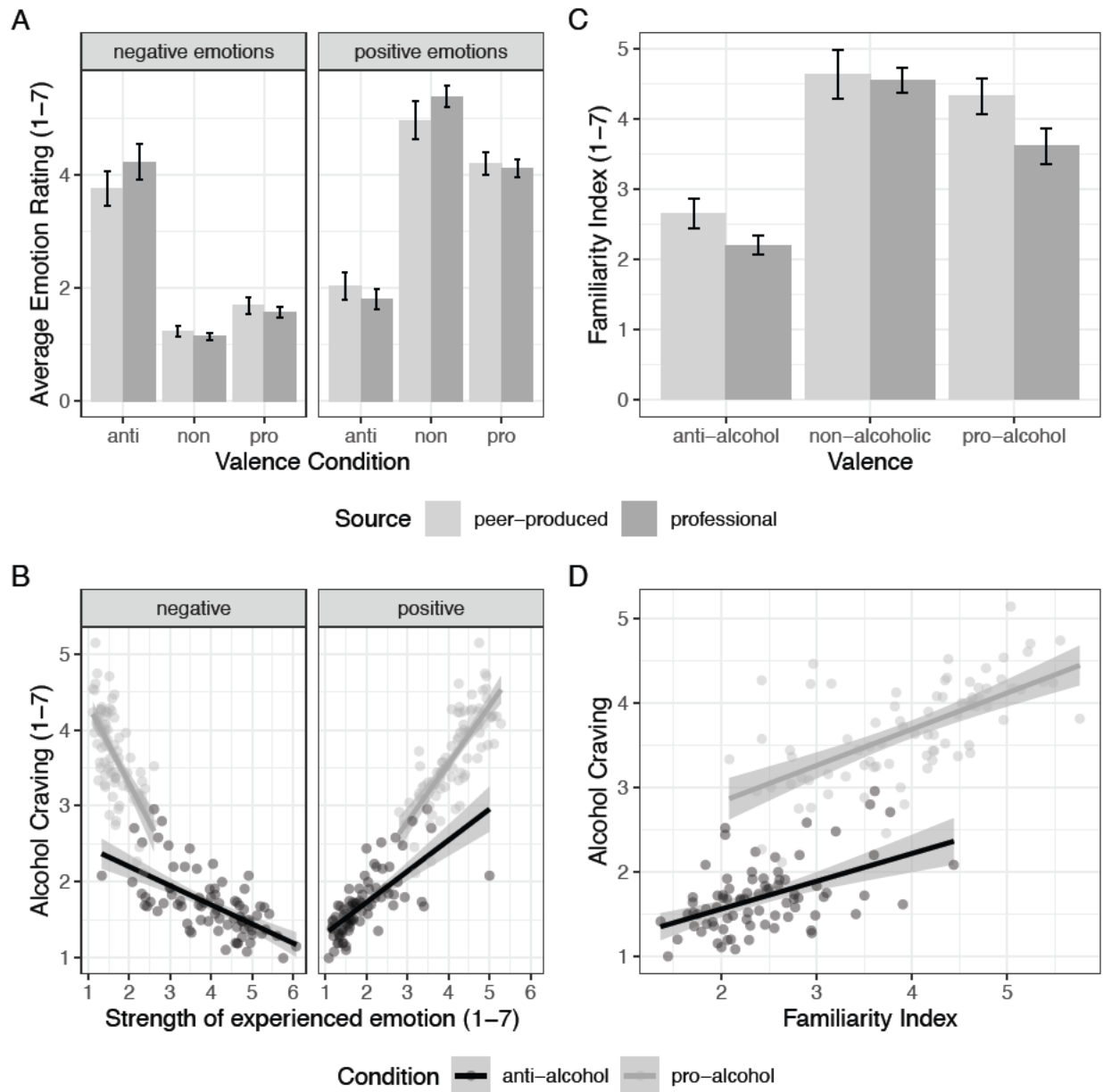


Figure 2

Drivers of Alcohol Craving in Studies 1a/b. A. Emotional responses by message type, B. Relationship between negative and positive emotional responses and alcohol craving, C. Perceived familiarity by message type, D. Relationship between perceived familiarity and alcohol craving. Error bars in A and C represent standard errors.

Supplementary Methods

Messages

Supplementary Figure 1 shows visual templates used to present messages to study participants.

Procedures

Supplementary Figure 2 provides a visualization of an example trial completed by Study 2 participants.

Self-Report Measures and Manipulation Checks

Supplementary Table 1 shows averages of key self-report measures disaggregated by study and message condition.

Study 1a and 1b participants rated two manipulation check items per trial to assess whether the stimuli were perceived as intended according to the manipulated dimensions of valence and source. The items are presented in Supplementary Table 2.

Supplementary Results

Manipulation Checks

We used the manipulation checks assessed in Study 1a and 1b (Supplementary Table 2) in order to examine whether the stimuli were perceived as intended.

First, we assessed whether the valence of alcohol-related stimuli (pro- vs. anti-alcohol) was manipulated successfully in Study 1a by regressing the extent to which participants thought a stimulus showed positive and negative outcomes of alcohol consumption on a valence condition factor, accounting for random intercepts across participants and stimuli (Supplementary Table 3). Indeed, in Study 1a, pro-alcohol stimuli were rated as portraying much less negative and more positive outcomes of alcohol consumption than anti-alcohol stimuli (also see Supplementary Figure 3A for condition-averages).

Second, we assessed whether participants were able to identify the manipulated source for images with alcoholic drinks (Study 1a) and images with non-alcoholic drinks (Study 1b)

by estimating three multi-level regression models per study, regressing the extent to which participants were certain that each of three types of users (professional, influencer, and peer) was the source of each stimulus on a manipulated source condition factor (professional>peer), accounting for random intercepts across participants and stimuli (Supplementary Table 4, and Supplementary Figure 3B and C). Stimuli from professional sources showed higher ratings for certainty that the stimulus was created by a professional user compared to stimuli from peer-produced sources and vice versa for ratings of certainty that a peer produced the stimulus. This effect holds for both alcohol-related and non-alcoholic stimuli. Of note, professional stimuli were more often attributed to influencers compared to peer-produced stimuli.

Drinking habits and message receptivity

A key result in the main manuscript suggested that anti-alcohol messages (relative to non-alcoholic messages) had smaller effects on alcohol craving than pro-alcohol messages. In the main manuscript, we further report a follow-up analysis exploring the effect of binge drinking habits on message receptivity to examine the possibility that anti-alcohol messages only truly resonate with those who are targeted most directly, frequent binge drinkers. In concert with Figure 1c in the main manuscript, the multi-level regression model fit to Study 1b data in Supplementary Table 5 refutes this hypothesis. Frequent binge drinkers showed higher sensitivity to pro- but not anti-alcohol messages.

Table 1*Descriptive Statistics (M, SD) for Self-Report Measures by Condition and Study*

Study	Valence	Source	Craving	Positive Emotion	Negative Emotion	Familiarity Index
1a	anti-alcohol	professional	1.70, 1.17	1.80, 1.37	4.23, 2.08	2.16, 1.40
1b	anti-alcohol	professional	1.63, 1.10	1.69, 1.23	4.59, 1.94	2.62, 1.48
2	anti-alcohol	professional	2.09, 1.20			
1a	anti-alcohol	social	1.70, 1.26	2.05, 1.57	3.76, 2.11	2.65, 1.66
1b	anti-alcohol	social	1.40, 0.92	1.51, 1.18	4.31, 2.17	2.46, 1.58
2	anti-alcohol	social	2.14, 1.20			
1b	non-alcoholic	professional	1.79, 1.47	5.37, 1.49	1.14, 0.56	4.54, 1.73
1b	non-alcoholic	social	1.38, 0.92	5.03, 1.73	1.24, 0.73	4.67, 1.77
1a	pro-alcohol	professional	3.68, 1.87	4.14, 1.76	1.58, 1.11	3.59, 1.82
1b	pro-alcohol	professional	3.93, 2.08	4.01, 1.93	1.34, 0.91	4.03, 1.68
2	pro-alcohol	professional	3.44, 1.29			
1a	pro-alcohol	social	3.67, 1.90	4.21, 1.87	1.67, 1.28	4.31, 1.78
1b	pro-alcohol	social	3.86, 2.00	4.27, 1.86	1.85, 1.43	4.65, 1.74
2	pro-alcohol	social	3.36, 1.33			

^a Note. For Study 2, only trials in which alcoholic cues were presented are included.

Table 2*Manipulation Checks*

Measure	Assessed in	Wording	Answer Options
Manipulation check valence	Study 1a	To what extent does this image show [positive/negative] aspects of drinking alcohol? (2 items)	Scale: 1 = Not at all, 7 = Very much
Manipulation check source	Study 1a/b	Below are three types of Instagram users. For each type, please indicate how certain or uncertain you are that this type of user posted this image. [A professional or company account/An influencer/An average user (that is someone with relatively few followers, who uses the platform for non-commercial purposes)] (3 items)	Scale: 1 = Certainly did not post this, 7 = Certainly posted this

Table 3*Condition Effects on Perceived Valence (Study 1a)*

DV	effect	term	estimate	95% CI	p
negative	fixed	Intercept	5.88	[5.71; 6.05]	<.001
negative	fixed	Valence: pro-alcohol	-3.96	[-4.20;-3.73]	<.001
negative	random	pID Intercept	0.41		
negative	random	sID Intercept	0.70		
negative	random	Residual	1.23		
positive	fixed	Intercept	1.53	[1.37; 1.70]	<.001
positive	fixed	Valence: pro-alcohol	3.23	[3.02; 3.43]	<.001
positive	random	pID Intercept	0.76		
positive	random	sID Intercept	0.61		
positive	random	Residual	1.22		

^a Note. DV = Dependent Variable. The equation used to fit the two models in this table was Perceived Valence [Positive/Negative] ~ Valence (pro- > anti-alcohol) +(1|participant ID) + (1|stimulus ID)

Table 4

Effects of source condition on each of three perceived source ratings in Study 1a & 1b, Freq. = Frequency, pID = participant ID; sID = stimulus ID

DV	effect	term	estimate	95% CI	p
	STUDY 1a Alcoholic Drinks				
professional	fixed	Intercept	1.97	[1.77; 2.16]	<.001
professional	fixed	source: professional	3.15	[2.90; 3.41]	<.001
professional	random	pID Intercept	0.64		
professional	random	sID Intercept	0.75		
professional	random	Residual	1.54		
peer	fixed	Intercept	5.66	[5.47; 5.84]	<.001
peer	fixed	source: professional	-2.55	[-2.78;-2.31]	<.001
peer	random	pID Intercept	0.7		
peer	random	sID Intercept	0.69		
peer	random	Residual	1.56		
influencer	fixed	Intercept	3.3	[3.04; 3.56]	<.001
influencer	fixed	source: professional	0.73	[0.38; 1.08]	<.001
influencer	random	pID Intercept	0.85		
influencer	random	sID Intercept	1.06		
influencer	random	Residual	1.56		
	STUDY 1b Non-Alcoholic Drinks				
professional	fixed	Intercept	3.42	[2.82; 4.02]	<.001
professional	fixed	source: professional	2.63	[1.81; 3.45]	<.001
professional	random	pID Intercept	0.74		
professional	random	sID Intercept	1.05		
professional	random	Residual	1.55		
peer	fixed	Intercept	5.26	[4.81; 5.71]	<.001
peer	fixed	source: professional	-2.25	[-2.81;-1.70]	<.001
peer	random	pID Intercept	1.08		
peer	random	sID Intercept	0.68		
peer	random	Residual	1.46		
influencer	fixed	Intercept	4.59	[4.09; 5.09]	<.001
influencer	fixed	source: professional	0.72	[0.06; 1.37]	0.033
influencer	random	pID Intercept	1.02		
influencer	random	sID Intercept	0.81		
influencer	random	Residual	1.54		

^a Note. DV = Dependent Variable. The equation used to fit the three models per study in this table was Perceived source certainty ~ Source condition + (1|participant ID) + (1|stimulus ID)

Table 5*Effect of valence and binge-drinking habits on alcohol craving in Study 1b*

effect	term	estimate	95% CI	p-value
fixed	Intercept	1.59	[1.36;1.81]	p = <.001
fixed	Binge Drinking Frequency (BD)	0.09	[0.02;0.16]	p = 0.017
fixed	Valence 1: Anti- vs. Non-Alcoholic	-0.10	[-0.40;0.20]	p = 0.524
fixed	Valence 2: Pro- vs. Non-Alcoholic	2.36	[2.06;2.66]	p = <.001
fixed	BD x Valence 1	0.00	[-0.09;0.09]	p = 0.982
fixed	BD x Valence 2	0.18	[0.09;0.27]	p = <.001
random	sID	0.47		
random	pID	0.59		
random	Residual	1.12		

^a Note. ID = participant ID; sID = stimulus ID; Model equation: alcohol craving ~ binge drinking frequency * valence + (1|participant) + (1|stimulus)

Figure 1

Visual templates used for stimulus presentation

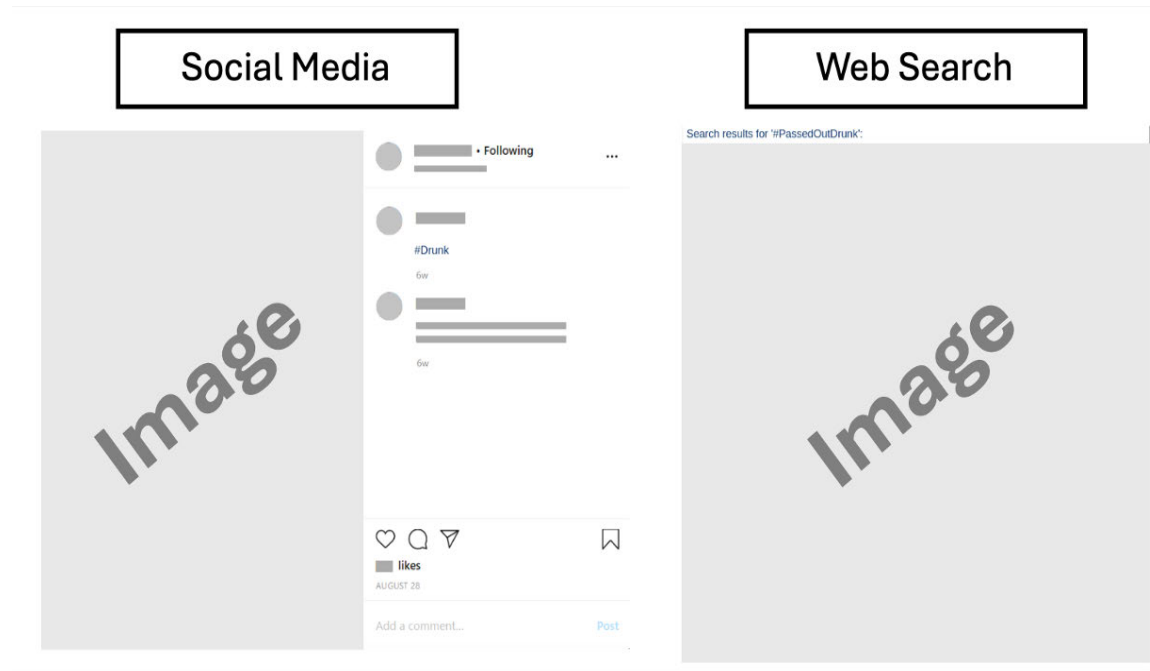
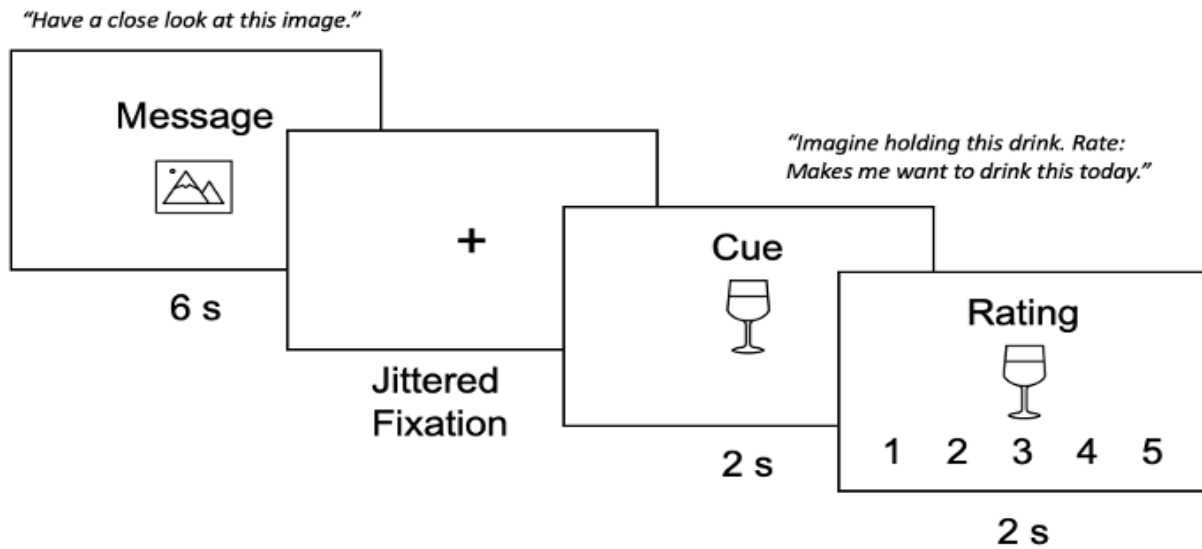


Figure 2

Example Trial and Instructions Study 2 Task (To protect copyright interests, this figure depicts icons instead of the actual stimuli and beverage cues. See the GitHub reproducibility package [REDACTED] for stimulus descriptions and sources. Original stimuli are available from the corresponding author upon request.)



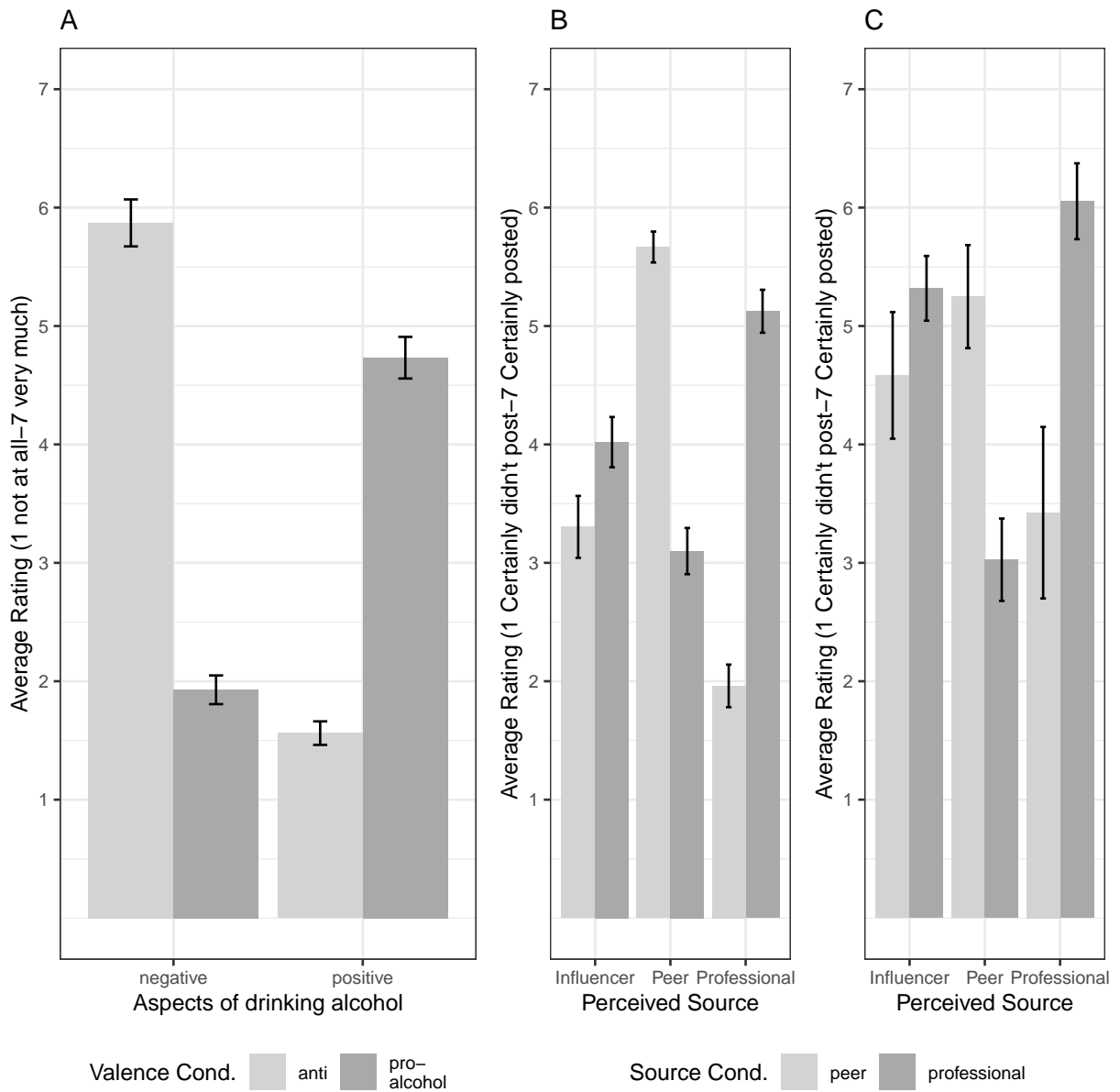


Figure 3

Manipulation Checks for A) Stimulus Valence (Study 1a) and Source for B) alcohol-related stimuli (Study 1a) and C) non-alcoholic stimuli (Study 1b); Error bars indicate 95 percent confidence intervals